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THE IMPACT OF TLTRO2 ON THE ITALIAN CREDIT MARKET: SOME ECONOMETRIC EVIDENCE

by Lucia Esposito[♥], Davide Fantino[♥] and Yeji Sung[♠]

Abstract

This paper evaluates the impact of the second series of Targeted Longer-Term Refinancing Operations (TLTRO2) on the amount of credit granted to non-financial private corporations and on the interest rates applied to loans in Italy, using data on credit transactions, bank and firm characteristics and a difference-in-differences approach. We find that TLTRO2 had a positive impact on the Italian credit market, encouraging medium-term lending to firms and reducing credit interest rates. While firms overall benefited from TLTRO2 irrespective of their risk category and size, we document heterogeneous treatment effects. Regarding firms' risk category, the effects on credit quantities are larger for low-risk firms while those on credit interest rate are larger for high-risk firms. Regarding firms' size, smaller firms benefited the most both in terms of amounts borrowed and interest rates. Furthermore, our evidence suggests that monetary policy transmission of TLTRO2 is stronger for banks with a low bad debt ratio in their balance sheets.

JEL Classification: E51, E52.

Keywords: unconventional monetary policy, pass-through, policy evaluation.

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1. Introduction¹

On 10 March 2016 the Governing Council announced a second series of Targeted Longer-Term Refinancing Operations (TLTRO2), aimed to reinforce the ECB's accommodative monetary policy stance and strengthen the transmission of monetary policy. The new operations offered long-term funding to banks at attractive conditions to further ease private sector credit conditions and to stimulate bank lending to the real economy. Given that the ECB recently announced a third series of targeted funding operations, it is of interest to assess to what extent the previous operations have been successful in strengthening bank lending.

Descriptive evidence suggests that, in conjunction with the other non-standard measures, TLTRO2 have contributed to reducing credit interest rates to non-financial private sector (figure 1) and stimulating credit recovery from the trough of 2013 (figure 2), both in the euro area and in Italy. Figure 1 shows that lending rates for euro area non-financial firms declined substantially once the credit-easing packages were delivered. The reductions in lending rates have been more pronounced in vulnerable countries, where lending rates were higher than those prevailing in other euro area countries; as a result, the dispersion of lending rates across euro area countries has markedly decreased.

This paper, using bank-firm level data for Italy and a difference-in-differences approach, evaluates the impact of TLTRO2 on the amount of credit granted to non-financial private corporations and on the interest rates applied to loans. The main findings of our analysis are that TLTRO2 had a positive impact on the Italian credit market. Banks borrowing liquidity from these operations increased the medium-term lending and reduced interest rate. Such effects realized immediately after the program started rolling. Firms benefited from TLTRO2 irrespectively of their risk category and size. The effects on credit quantities are larger for low-risk firms while the effects on credit interest rate are larger for high-risk firms. Smaller firms benefited the most both in terms of borrowed quantities and interest rates. Interestingly, interest rates decreased only for those firms that were charged a relatively higher interest rate (i.e. riskier firms, loans with longer maturity, etc.) in the pre TLTRO2 period. Finally, we show that monetary policy transmission of TLTRO2 is stronger for banks with a low bad debt ratio in their balance sheets.

¹ We are grateful to Fabio Busetti, Sarah Holton, Francesco Manaresi, Alessandro Secchi, one anonymous referee and to seminar participants at Columbia University, Bank of Italy and ECB for useful comments. The opinions expressed are those of the authors and do not necessarily reflect the views of the Bank of Italy or of the Eurosystem. All errors are our own.

Fig. 1: Average of interest rates on new loans to non-financial corporations

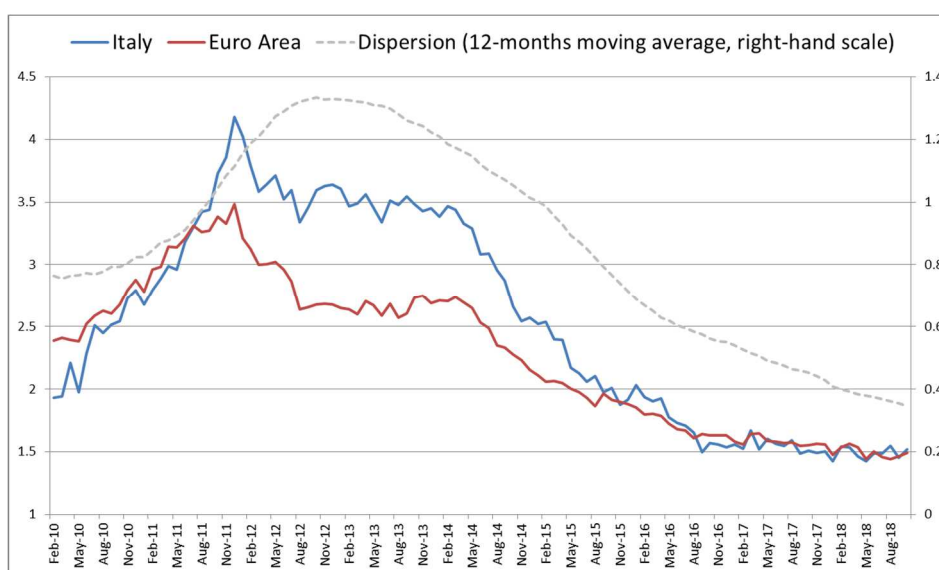
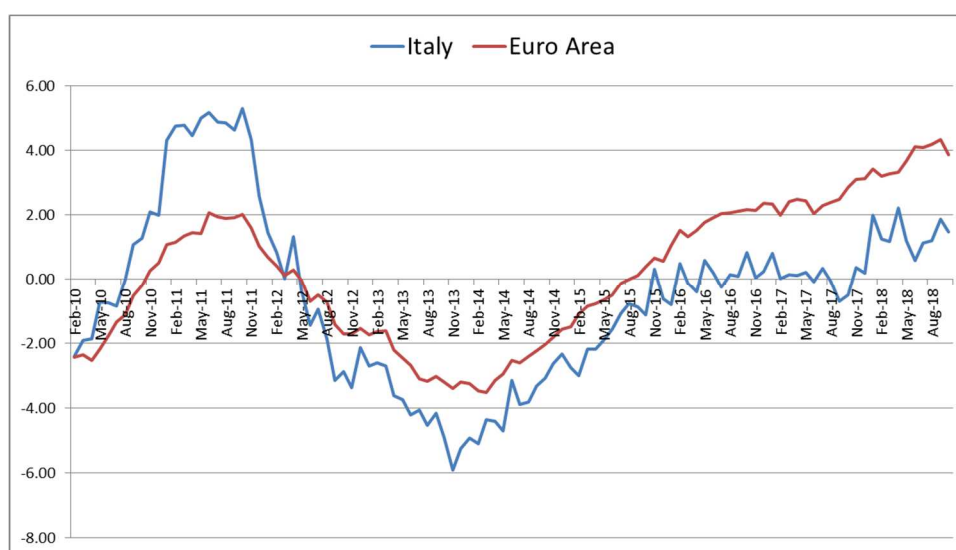


Fig. 2: New loans to non-financial corporations



We contribute to the empirical literature on the transmission of unconventional monetary policy. To the best of our knowledge this is the first study containing micro-econometric estimates on the effectiveness of the TLTRO2 in supporting credit in Italy. Related literature includes Benetton and Fantino (2018) who show that TLTRO1 lowered the cost of loans to Italian firms and that banks' market power can significantly impair the effectiveness of these policy measures. Andreeva and Garcia-Posada (2019) find similar results regarding the impact of TLTRO1 on the European credit market, exploring as well the implications of a theoretical model. Mouabbi and Sahuc (2016) quantify the macroeconomic effects of the ECB unconventional monetary policies using a DSGE model. In

their model, however, the effect of the TLTROs cannot be disentangled from that of forward guidance. ECB (2017a) argues that TLTROs seem to have supported higher intermediation volumes in less vulnerable euro area countries and a slowdown of the contraction in bank lending in vulnerable countries. Other related studies focus on the provision of long-term funding by the very Long-Term Refinancing Operations launched by the ECB in 2011-12 (vLTRO; see Jasova, Mendicino and Supera, 2018; Chan, Duquerroy and Mullins, 2018; Carpinelli and Crosignani, 2017).

The remaining sections of the paper are organized as follows. Section 2 describes the institutional details of TLTROs and Section 3 presents descriptive evidence from the bank-level data. Afterwards, we focus on the analysis of transaction level data: Section 4 describes the dataset and discusses our empirical strategy, Section 5 contains the main findings, Section 6 presents robustness checks, and Section 7 concludes.

2. Background of the Targeted Longer-Term Refinancing Operations

2.1 Design of the TLTROs

Targeted Longer-Term Refinancing Operations (TLTROs) are policy measures designed to incentivize bank lending to the real economy and to pass on a reduction of the funding costs to firms and households. The defining features of the operations are two-fold. First, banks are offered an opportunity to borrow liquidity from the Eurosystem with a maturity up to four years at a low interest rate, enabling the reduction of banks' funding costs. Second, as will be clear below, the overall structure of the operations aims at enhancing banks' lending to private sector: the allotment of the borrowing allowance and the incentive structure of the operation are designed to reward banks with good lending performance.

The three waves of TLTROs share the following common features. Banks are allowed to participate as a group, which encouraged the participation of small-sized banks, that may not meet the technical requirements of the program and moreover may benefit from risk sharing with other banks. The design of the operations provides a customized bank-specific (or group-specific) incentive structure: for each bank, the Eurosystem sets a bank-specific lending benchmark based on its past lending performance and offers an incentive structure that depends on how much bank's lending performance improves compared to its benchmark.

On 5 June 2014, the ECB announced a first wave of eight operations (TLTRO1) over a time window of two years. In the first two operations, banks could borrow up to a maximum allowance of 7% of their amount of loans to firms and households outstanding as of 30 April 2014, excluding loans to households for house purchase (ECB, 2014). Furthermore, for each bank, the flow of overall net lending of eligible loans in the 12-months ending on 30 April 2014 has been set as a lending benchmark. Banks whose net lending in the 24-months ending on 30 April 2016 was lower than their benchmark were required to repay their TLTRO1 borrowings before the maturity of the operations which was set to September 2018 for all of them. A different incentive structure was adopted for the six remaining operations. At each operation date, banks could cumulatively borrow up to three times the amount by which their net lending had exceeded the bank-specific lending benchmark.

On 10 March 2016, the ECB announced a second wave of four operations (TLTRO2) to be conducted every quarter from June 2016 to March 2017. TLTRO2 had at least two distinguishing features compared to TLTRO1 (ECB, 2016a). First, the key incentive structure of the TLTRO1 that banks that lent more could borrow more from the Eurosystem was dropped. Instead, throughout the four operations, banks could borrow up to 30% of their amount of loans to firms and households outstanding as of 31 January 2016, excluding the loans for house purchase and net of the outstanding debt from the first two TLTRO1. Second, banks whose eligible net lending in the period between 1 February 2016 and 31 January 2018 exceeded their benchmark received a rate reduction, which could amount, in the most favorable case, to the difference between the rate on the Main Refinancing Operations (MRO) and the one on the deposit facility (40 basis points).

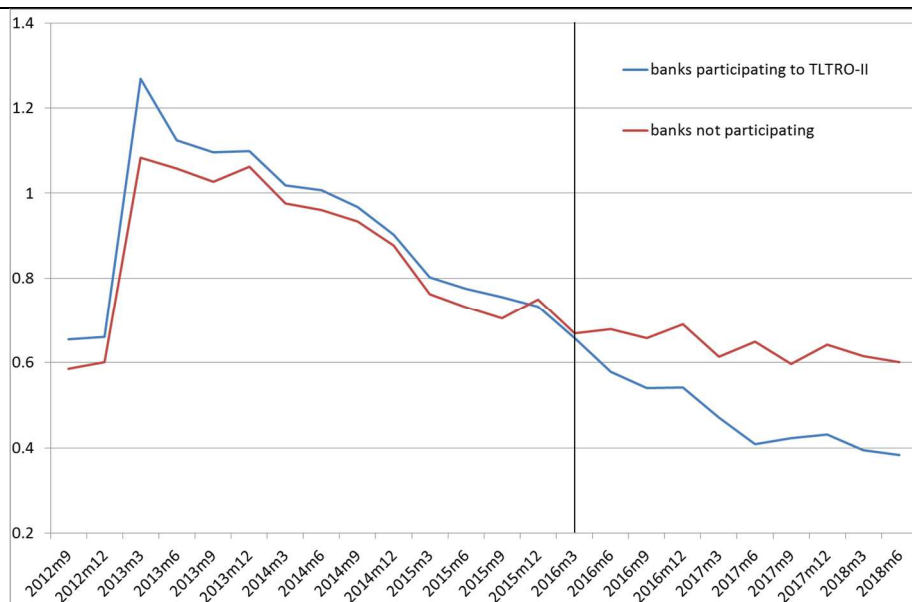
At the meeting of March 2019, the ECB decided to launch a new series of quarterly Targeted Longer-Term Refinancing Operations (TLTRO3), starting in September 2019 and ending in March 2021, each with a maturity of three years². The features of these operations are the following ones (ECB, 2019a-b): the maximum cumulated borrowing allowance in all the auctions is equal to 30% of the stock of eligible loans at the end of February 2019, net of the amount borrowed from TLTRO2 and still outstanding at the date of the auction; in addition to this constraint, the maximum bid of each TLTRO group in one auction is one third of its maximum cumulated borrowing allowance; the basic interest rate on the operations will be equal to the MRO rate over the life of each operation and TLTRO groups satisfying a benchmark based on the net lending of eligible loans between April 2018 and March 2019 will receive a discount.

² After the initial announcement, the ECB lengthened the maturity of operations from two to three years and reduced the basic interest rate by 10 basis points in September 2019.

2.2 Bank Behavior and TLTRO2 Participation

The focus of this paper is on TLTRO2: 402 Italian banks participated to TLTRO2 and in total had taken up 32.4% of the aggregate amount allotted to euro area. Also, these banks ended up borrowing almost as much as they could: Italian banks in total borrowed 238.4 billion euros while the maximum allowance was 263.4 billion euros, yielding a take-up rate of 90%. According to the bank-level data from the Supervisory reports, banks that did not participate in TLTRO2 are smaller and more capitalized than participating ones, but they do not differ significantly in terms of share of loans and government bonds to total assets and of bad loans to total loans.³

Fig. 3: Average funding cost and TLTRO2 participation



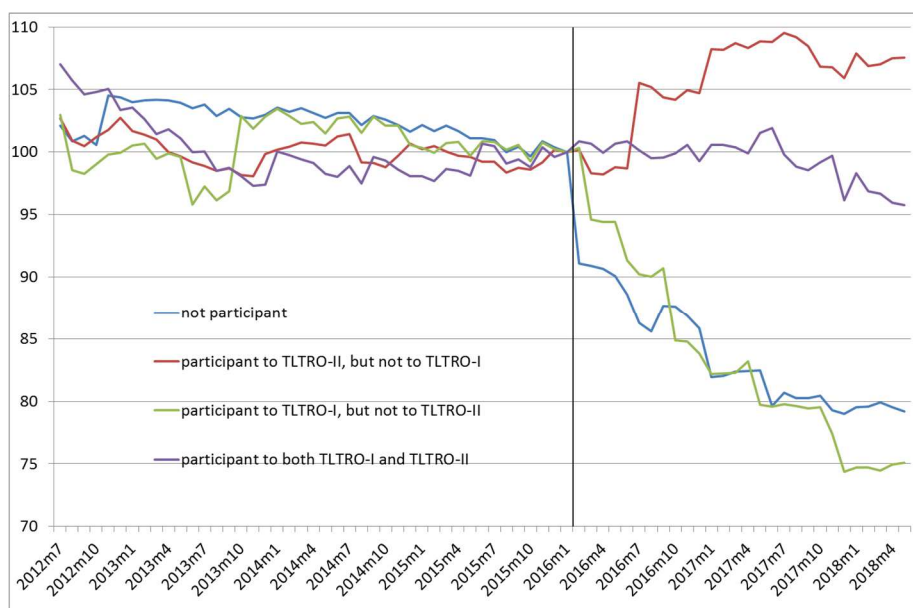
Note: The average funding cost is imputed from the income statement of banks and is computed as a weighted average of costs from all funding sources including interbank market, securities, deposits, and the commission fees.

Figure 3 shows that the average cost of funding has been declining for all banks in the last few years, due to several monetary policy decisions including quantitative easing, liquidity injections, negative deposit rates, and forward guidance on future policy stance. However, it is only after TLTRO2 announcement that the funding costs of participants and non-participants to this program start diverging. In fact, Italian banks mainly used previous Eurosystem longer-term liquidity to substitute their MRO funding; since the cost of these two sources of financing are similar, we do not observe a significant difference in the reduction of the average funding cost between the two groups

³ According to ECB (2016b, 2017b-c), euro area banks not participating to TLTRO2 auctions decided to do so because they were comfortable about their liquidity position and were not subject to funding constraints.

of banks, even if many banks participating to TLTRO2 already participated to TLTRO1. By contrast, that gap widened markedly after the announcement of TLTRO2, with a decline in the cost of funding of participating banks and roughly unchanged cost for the others. One interpretation of this evidence is that participating banks optimally rebalanced their funding portfolio, becoming less reliant on more expensive sources of funding such as bank bonds.

Fig. 4: Credit dynamics and TLTRO2 participation



Note: Total outstanding loans to firms and households excluding loans to household for house purchase purposes. Each series is normalized to be 100 in 2016 January.

The decrease in participating banks’ funding costs contributed to the reduction in interest rates, thus supporting the recovery of credit extended to firms and households by participating banks. Indeed, figure 4 show that lending patterns diverged markedly between participating and non-participating banks after the announcement of TLTRO2. The latter banks experienced a sharp decline in outstanding total credits.

3. Data Sources and Summary Statistics

We study the impact of TLTRO2 on the Italian credit market using a dataset that includes almost all the firm-bank loan relationships from the Credit register. We also acquire detailed information on firms’ characteristics from the Company Accounts Data Service (CADS), managed by Cerved, and information on banks’ income statements and balance sheets from Supervisory reports. Individual bank data are aggregated at a holding-company level (using the banking group

information from the Supervisory register), enabling us to construct a firm-banking group transaction level dataset. Finally, we use confidential data on banks' TLTRO2 participation decisions.

Final dataset is a quarterly balanced panel with the time period from the first quarter of 2015 up to the end of 2017. This dataset comprises the outstanding amount of credit for 159,876 firm-bank term loan relationships, involving 110,808 firms and 339 banking groups.⁴ We observe the interest rates applied to a subset of the same term loan relationships (Taxia sample).

Table 1: Descriptive statistics

| | Obs | Mean | Std. Dev. | Min | Median | Max |
|--|-------------------------|---------|-----------|---------|--------|-----------|
| <i>Transaction level variables (1st quarter 2015-4th quarter 2017)</i> | | | | | | |
| Interest rate on term loans including expenditures (%) | 1279428 | 3.21 | 1.62 | 0.64 | 2.98 | 7.72 |
| Interest rate on term loans including expenditures (%; 1 st quarter 2015) | 106619 | 3.76 | 1.69 | 1.21 | 3.57 | 7.72 |
| Interest rate on term loans without expenditures (%) | 1279428 | 3.20 | 1.61 | 0.64 | 2.98 | 7.67 |
| Interest rate on total credit including expenditures (%) | 2567184 | 5.57 | 3.96 | 0.71 | 4.58 | 19.85 |
| Credit amount of term loans, in the contract (euros) | 1918512 | 485056 | 604431 | 1083 | 206582 | 2000000 |
| Credit amount of term loans, drawn (euros) | 1918512 | 441505 | 544991 | 1 | 191660 | 1829501 |
| Short term ¹ credit amount of term loans, in the contract (euros) | 140796 | 490942 | 552863 | 4 | 250000 | 1997170 |
| Medium term ² credit amount of term loans, in the contract (euros) | 622752 | 225187 | 265968 | 1 | 104201 | 880081 |
| Long term ³ credit amount of term loans, in the contract (euros) | 942216 | 539242 | 683634 | 5667 | 225796 | 2322432 |
| Total credit amount, in the contract (euros) | 3804084 | 568324 | 664688 | 20000 | 278436 | 2322432 |
| <i>TLTRO variables</i> | | | | | | |
| Take-up (million euros; TLTRO2) | 283 | 782.25 | 4453.36 | 5.35 | 77.63 | 59515.50 |
| Net take-up (million euros; TLTRO2) | 90 | 685.40 | 1765.00 | 0.001 | 114.90 | 11390.00 |
| Maximum allowance (million euros; TLTRO2) | 339 | 737.41 | 4245.29 | 2.83 | 76.54 | 59515.50 |
| Maximum allowance (million euros; 1 st -2 nd TLTRO1) | 339 | 154.60 | 901.60 | 0.07 | 18.28 | 12500.00 |
| Interest rate charged to borrowed amounts (%; TLTRO2) | 283 | -0.37 | 0.11 | -0.4 | -0.4 | 0 |
| <i>Other bank level variables (1st quarter 2015)</i> | | | | | | |
| Assets (million euros) | 339 | 9141.21 | 59848.54 | 55.81 | 659.10 | 814749.81 |
| Loans over assets ratio (%) | 339 | 51.34 | 11.96 | 0.66 | 53.10 | 80.10 |
| Bad loans over loans ratio (%) | 339 | 9.67 | 6.15 | 0.00 | 8.97 | 33.69 |
| Government bonds over assets ratio (%) | 339 | 26.92 | 11.88 | 0.00 | 26.15 | 63.80 |
| Tier 1 capital ratio (%) | 339 | 18.20 | 8.72 | 6.29 | 16.15 | 105.37 |
| Securities (million euros) | 339 | 1892 | 11720 | 0 | 181 | 158300 |
| Mortgages (million euros) | 339 | 394 | 2252 | 0 | 48 | 35085 |
| Credit demand index (2015) | 339 | 0.0172 | 0.0180 | -0.0278 | 0.0200 | 0.1428 |
| <i>Firm level variables (2014)</i> | | | | | | |
| Fixed assets (thousand euros) | 110808 | 5962 | 283258 | 1 | 441 | 55567629 |
| | Percentage distribution | | | | | |
| Classes: | 1-3 | 4-6 | 7-9 | | | |
| Credit rating | 17% | 57% | 26% | | | |

¹ Initial maturity <= 1year. - ² Initial maturity >1 year and <=5 year. - ³ Initial maturity > 5 year.

In table 1 we report the descriptive statistics of our dataset. The term loan interest rate ranges from 0.6 to 7.7, with an average of 3.2. The average amount of credit issued in each term loan contract is around 500 thousands euros and the credit actually drawn by firms is slightly smaller. The size of the average term loan relationship is about 85% of the average total credit exposition. Around 60%

⁴ About further 50 banking groups are excluded by the transaction level analysis as they were subject to mergers and acquisitions or they were part of a foreign group.

of the term loan contracts are long term ones (longer than 5 years) and about 30% are medium term (between 1 and 5 years). We also investigate whether the effects of TLTRO2 were heterogeneous among contracts of different maturity.⁵

Out of 339 banking groups, 283 banking groups participated to TLTRO2 and took up 782 million euros on average. A sizable portion of this liquidity was used for refinancing, as banks switched out of TLTRO1 to TLTRO2. In fact, only 90 out of 283 banking groups increased the amount of liabilities toward the Eurosystem, net of the deposit facility. These 90 banks increased the liability toward the Eurosystem by 685 million euros on average.

The maximum allowance of funding reported in the table has been computed for both participants and not participants to TLTROs. Bank level variables that we consider in the analysis are assets, loans over assets, bad loans over loans, Government bonds over assets, Tier 1 capital ratio, securities and mortgages. We also use in some diagnostic tests a bank specific credit demand index constructed as a weighted average of the province level value added growth rates, where the weights are based on the bank's credit allocation among Italian provinces. For firm level variables, we use the amount of fixed assets and the credit worthiness. The credit score is codified in nine categories (1 being the safest and 9 being the riskiest)⁶ and aggregated in three broader buckets.

4. Empirical Strategy

Our goal is to capture the effect of liquidity injections throughout TLTRO2 that go beyond refinancing. Therefore, we consider the increase in the amount of liabilities towards the Eurosystem, net of the deposit facility, between the 1st quarter 2016 and the 1st quarter 2017 as the treatment intensity, if it is positive and the bank signaled participation to the auctions in the confidential data. This amount is a good proxy for TLTRO2 net take-up, as there was no other large scale operation during the TLTRO2 period involving a direct transaction between commercial banks and the central

⁵ The sum of the number of short, medium and long term credit observations is smaller than the overall number of observations in the dataset because in the analysis by maturity of credit the requirement that the dataset must be balanced have to be satisfied for each maturity.

⁶ The methodology used in the calculation of the credit rating is explained in Altman et al. (1994).

bank.^{7,8} Based on our definition of treatment variable, the treatment group banks are the ones that borrowed more than enough to roll over, if any, remaining liabilities from the first two TLTRO1 auctions and did not simply deposit the additional liquidity in the deposit facility.⁹

Table 2: Descriptive statistics for treated and controls before treatment

| | Treated | | | Controls | | |
|--|---------|---------|-------------------------|----------|--------|-----------|
| | Obs | Mean | Std. Dev. | Obs | Mean | Std. Dev. |
| <i>Transaction level variables (1st quarter 2015-1st quarter 2016)</i> | | | | | | |
| Interest rate on term loans including expenditures (%) | 498480 | 3.53 | 1.68 | 34615 | 3.79 | 1.53 |
| Interest rate on term loans including expenditures (%; 1 st quarter 2015) | 99696 | 3.75 | 1.70 | 6923 | 3.93 | 1.55 |
| Interest rate on term loans without expenditures (%) | 498480 | 3.52 | 1.67 | 34615 | 3.77 | 1.50 |
| Interest rate on total credit including expenditures (%) | 995445 | 6.11 | 4.13 | 74215 | 5.31 | 3.21 |
| Credit amount of term loans, in the contract (euros) | 693650 | 513034 | 625664 | 105730 | 362136 | 480974 |
| Credit amount of term loans, drawn (euros) | 693650 | 465736 | 566692 | 105730 | 346306 | 449590 |
| Short term ¹ credit amount of term loans, in the contract (euros) | 54540 | 493310 | 540231 | 4125 | 302182 | 400953 |
| Medium term ² credit amount of term loans, in the contract (euros) | 230890 | 242451 | 269759 | 28590 | 143531 | 190857 |
| Long term ³ credit amount of term loans, in the contract (euros) | 326335 | 596548 | 724253 | 66255 | 425992 | 541418 |
| Total credit amount, in the contract (euros) | 1379645 | 585390 | 673666 | 205390 | 442873 | 537766 |
| <i>TLTRO variables</i> | | | | | | |
| Maximum allowance (million euros; 1 st -2 nd TLTRO1) | 90 | 510.50 | 1704.00 | 249 | 26.01 | 54.32 |
| Maximum allowance (million euros; TLTRO2) | 90 | 2436.86 | 8010.02 | 249 | 123.15 | 332.72 |
| <i>Other bank level variables (1st quarter 2015)</i> | | | | | | |
| Assets (million euros) | 90 | 30258 | 113501 | 249 | 1509 | 6186 |
| Loans over assets ratio (%) | 90 | 54.85 | 10.17 | 249 | 50.07 | 12.32 |
| Bad loans over loans ratio (%) | 90 | 8.99 | 4.73 | 249 | 9.92 | 6.58 |
| Government bonds over assets ratio (%) | 90 | 21.75 | 10.59 | 249 | 28.78 | 11.79 |
| Tier 1 capital ratio (%) | 90 | 15.48 | 10.70 | 249 | 19.18 | 7.67 |
| Securities (million euros) | 90 | 5843 | 22140 | 249 | 464 | 1855 |
| Mortgages (million euros) | 90 | 1222 | 4245 | 249 | 94 | 323 |
| Credit demand index (2015) | 90 | 0.0166 | 0.0093 | 249 | 0.0174 | 0.0203 |
| <i>Firm level variables (2014)</i> | | | | | | |
| Fixed assets (thousand euros) | 95322 | 5972 | 265764 | 15486 | 5900 | 373314 |
| | | | Percentage distribution | | | |
| Classes: | 1-3 | 4-6 | 7-9 | 1-3 | 4-6 | 7-9 |
| Credit rating | 17% | 58% | 25% | 13% | 56% | 31% |

¹ Initial maturity <= 1year. - ² Initial maturity >1 year and <=5 year. - ³ Initial maturity > 5 year.

In table 2 we compare the treatment and control groups at the transaction, bank and firm level in the first quarter of 2015. Banks in the treatment group and firms borrowing from these banks are larger than banks and firms in the control group. However, these two groups are not too different

⁷ In June 2016, the last auction of TLTRO1 and the first one of TLTRO2 were simultaneously regulated so our net take-up for this date does not distinguish between the two auctions, nevertheless the amount borrowed by Italian banks in the last TLTRO1 auction was only 3.6% of the net overall amount borrowed by Italian banks in that month.

⁸ In general, the joint effect of TLTRO1 and TLTRO2 on bank intermediation cannot be easily disentangled into the separate contributions of the two series of operations. Anyway, we have to consider that most of the TLTRO1 liquidity was supplied at the end of 2014 in the first two auctions and the incentive mechanism was in fact disabled with the announcement of TLTRO2, as banks had the possibility to convert TLTRO1 liquidity from the first two TLTRO1 auctions to the conditions of TLTRO2. For these reasons, TLTRO1 effects are likely to have been substantially unfolded at the start of TLTRO2 and should be easily captured by our bank level fixed-effects and controls.

⁹ In an additional not reported exercise, we used a take-up net of TLTRO1 rollover, but not corrected for deposit facility. The estimates were the same as those shown here.

when comparing other observable characteristics.¹⁰ Additional evidence regarding the composition of the sample of banks come from table 3, where we split banks in the four quartiles of the maximum allowance and compare their characteristics in the first quarter of 2015. Also in this case, the table shows relevant differences in the assets once again and limited ones in the ratios.

Table 3: Balancing of bank level variables by quartile of TLTRO2 maximum allowance

| | Average by quartile ¹ | | | |
|--|----------------------------------|-----------------|-----------------|-----------------|
| | 1 st | 2 nd | 3 rd | 4 th |
| Assets (million euros) | 213 | 521 | 1429 | 34703 |
| Loans over assets ratio (%) | 45.36 | 51.75 | 53.84 | 54.46 |
| Bad loans over loans ratio (%) | 9.12 | 9.22 | 10.61 | 9.74 |
| Government bonds over assets ratio (%) | 32.32 | 28.15 | 25.66 | 21.48 |
| Tier 1 capital ratio (%) | 24.31 | 18.5 | 15.08 | 14.85 |
| Securities (million euros) | 87 | 175 | 413 | 6952 |
| Mortgages (million euros) | 13 | 36 | 86 | 1452 |
| Credit demand index (2015) | 0.0180 | 0.0163 | 0.0169 | 0.0177 |

¹ 1st quarter 2015, if not specified otherwise.

We estimate the following equation using a difference-in-differences approach:

$$Y_{bft} = \alpha * I(t \geq 2016Q2) * TLTRO_b + \beta * X_{bt} + \gamma_{ft} + \gamma_b + \varepsilon_{bft}$$

where the dependent variable Y_{bft} is either the log of outstanding amount of term loans or the interest rate charged on the same loans by bank b to firm f at time t .¹¹ $TLTRO_b$ is the treatment variable, which is zero for the non-participating banks in all specifications and for participating banks is given by either the log of the intensity of treatment as defined before (continuous treatment) or by a dummy variable equal to 1 if the intensity of treatment is strictly positive (binary treatment); $I(t \geq 2016Q2)$ is an index function with value equal to 1 when TLTRO2 is in effect; α is the coefficient of interest that captures the differential effect of the policy between treated and control banks. We add three additional terms of control variables in the equation. First, we add firm-time fixed effects (γ_{ft}) to control for demand factors and firms characteristics, as in Khwaja and Mian (2008). Our estimates regards therefore the intensive margin of credit issued to multi-lender firms.¹² Second, we include bank fixed-effects (γ_b) to control for any time-invariant bank characteristic, including any medium

¹⁰ To further corroborate the evidence of absence of contextual effects due to structural differences among treated and controls, we calculated the existing correlation between the growth based credit demand index and the growth rate of the eligible assets of the banks on the cross-section for each year between 2011 and the start of TLTRO2 and we found that the existing correlation is never positively significant.

¹¹ The use of the outstanding amount of credit in the analysis implies that our results can be interpreted as a lower bound of the impact of the policy on the new business loans, as part of our credit aggregate is not influenced by the policy.

¹² Transactions with multi-lender firms represent about 65 per cent of the overall amounts lent by Italian banks.

run level shift in the dependent variable caused by TLTRO1. Third, we also control for observable time-varying bank characteristics X_{bt} (log of assets, ratios of loans over assets, bad loans over loans, Government bonds over assets, Tier 1 capital). Including bank fixed-effects and time varying bank controls allow us to reduce concerns coming from contextual effects due to structural differences in the evolution of different groups of banks such as those shown in tables 2 and 3. Last, we cluster the standard errors by firm and by bank and time.

The estimated α from the specification above is potentially biased. For example, if banks choose to participate in TLTRO2 because they already planned to expand their loan supply, the bias would be positive. On the other hand, if banks choose to participate only to get excess liquidity and invest in securities, the bias would be negative. Therefore, we use an instrument variable to isolate the effect of exogenous increase in liquidity. Specifically, we instrument the treatment intensity with the maximum borrowing allowance in TLTRO2. The identification assumption is that, holding our control variables fixed, this allowance (defined by the ECB on the basis of the amount of eligible loans outstanding for each bank at the 31st of January 2016) affects a bank's future lending decision only through the net take-up of TLTRO2. The maximum allowance for each bank is predetermined at the time of the TLTRO2 announcement (June 2016),¹³ which makes it unlikely for banks to manipulate its value. The validity of the exclusion restriction is corroborated moreover from the fact that before the start of TLTRO2 the correlation existing between the past stock of eligible loans, which is the main determinant of our instrument, and its growth after one, two or three periods is always less than 1% in magnitude.

Table 4: First stage regressions

| Dependent variable | Binary treatment (1) | Continuous treatment (2) |
|---|-------------------------|-----------------------------|
| $I(t \geq 2016Q2) \times \log$ of allowance | 0.11*** (0.003) | 2.72*** (0.058) |
| Firm-time fixed effects | yes | yes |
| Bank fixed effects | yes | yes |
| Bank time-varying characteristics | yes | yes |
| Kleibergen-Paap LM statistic | 272.544 | 252.927 |
| Kleibergen-Paap Wald F statistic | 1374.559 | 2162.004 |
| # of observations | 959976 | 959976 |
| Adjusted R ² | 0.94 | 0.96 |

Significance: *** 99%, ** 95%, * 90%.

¹³ The architecture of TLTRO2 minimizes endogeneity in the calculation of its borrowing limit from TLTRO1 as the maximum borrowing limit for TLTRO2 is calculated net of the amount borrowed by the commercial banks in the first two TLTRO1 auctions still outstanding at the time of the first TLTRO2 auction.

The results of the first stage regression are shown in table 4 and there is a positive and significant relation between the variables of interest; according to the Kleibergen-Paap LM and F tests the instrument we use does not suffer of problems of underidentification and weakness.

Table 5: Effects of TLTRO2 on credit markets

| Dependent variable Kind of treatment variable Estimation method | Log of outstanding amount of credit | | | | Credit interest rate | | | |
|---|-------------------------------------|--------------------|----------------------|----------------------|----------------------|---------------------|-----------------------|----------------------|
| | Binary | | Continuous | | Binary | | Continuous | |
| | OLS (1) | IV (2) | OLS (3) | IV (4) | OLS (5) | IV (6) | OLS (7) | IV (8) |
| l(t>=2016Q2) x TLTRO | 0.042*** (0.010) | 0.14*** (0.020) | 0.0023*** (0.000) | 0.0054*** (0.001) | -0.084*** (0.017) | -0.34*** (0.044) | -0.0047*** (0.001) | -0.012*** (0.002) |
| Firm-time fixed effects | yes | yes | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes | yes | yes | yes | yes |
| # of observations | 959976 | 959976 | 959976 | 959976 | 603240 | 603240 | 603240 | 603240 |
| Adjusted R ² | 0.55 | 0.55 | 0.55 | 0.55 | 0.49 | 0.49 | 0.49 | 0.49 |

Significance: *** 99%, ** 95%, * 90%.

5. The Effect of TLTRO2 on Bank Lending Supply

5.1 Effects on Loan Size and Interest Rates

The main results from the estimates are shown in table 5. In the first half of the table we show that TLTRO2 had a very significant and positive impact on quantities lent to firms; the effect is stronger in the IV estimates (columns 2 and 4) than in the OLS ones (columns 1 and 3), showing that the latter are affected by a downward bias. The estimated coefficients imply that, after controlling for firms' credit demand and characteristics of firms and banks, treated banks increased their amount of credit to the same firm by between 10 (continuous treatment) and 14 (binary treatment) percent relative to control banks, on average, between the second quarter of 2016 and the end of 2017.¹⁴ In the right panel of the table we show the effects on interest rates charged to firms; the interest rates are reduced following TLTRO2, and again the estimated response is stronger with IV than it is with OLS. The size of the coefficient implies that treated banks reduced the interest rate charged to any individual firm by between 23 (continuous treatment) and 34 (binary treatment) basis points on average.¹⁵

¹⁴ The average impact of the policy in the case of continuous treatment can be calculated by multiplying the coefficients in columns (4) and (8) of table 4 by the average of (the log of) treatment intensity for treated banks, which equals 19.34.

¹⁵ A comparison with Benetton and Fantino (2018), which analyses the impact of the first two auctions of TLTRO1, suggests that TLTRO2 has been more effective than TLTRO1 in facilitating the transmission of lower policy rates to borrowing conditions for the non-financial private sector.

Table 6: Time varying effects of TLTRO2 on credit markets

| Dependent variable | Log of outstanding amount of credit | | Credit interest rate | |
|-----------------------------------|-------------------------------------|----------------------|----------------------|-----------------------|
| | Kind of treatment variable | | Binary | Continuous |
| | IV | IV | IV | IV |
| Estimation method | (1) | (2) | (3) | (4) |
| I(t=2016Q2) x TLTRO | 0.091*** (0.021) | 0.0035*** (0.001) | -0.14*** (0.022) | -0.0047*** (0.001) |
| I(t=2016Q3) x TLTRO | 0.14*** (0.017) | 0.0054*** (0.001) | -0.28*** (0.062) | -0.0095*** (0.002) |
| I(t=2016Q4) x TLTRO | 0.078*** (0.018) | 0.0030*** (0.001) | -0.33*** (0.087) | -0.011*** (0.003) |
| I(t=2017Q1) x TLTRO | 0.14*** (0.020) | 0.0053*** (0.001) | -0.30*** (0.053) | -0.010*** (0.002) |
| I(t=2017Q2) x TLTRO | 0.18*** (0.022) | 0.0068*** (0.001) | -0.40*** (0.053) | -0.014*** (0.002) |
| I(t=2017Q3) x TLTRO | 0.22*** (0.034) | 0.0084*** (0.001) | -0.45*** (0.074) | -0.016*** (0.002) |
| I(t=2017Q4) x TLTRO | 0.16*** (0.037) | 0.0061*** (0.001) | -0.53*** (0.079) | -0.018*** (0.002) |
| Firm-time fixed effects | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes |
| # of observations | 959976 | 959976 | 603240 | 603240 |
| Adjusted R ² | 0.55 | 0.55 | 0.49 | 0.49 |

Significance: *** 99%, ** 95%, * 90%.

In table 6 we re-estimate the effect of TLTRO2 allowing the coefficient α to change over time:

$$Y_{bft} = \sum_{\tau=2016Q2}^{2017Q4} \alpha_{\tau} * I(\tau = t) * TLTRO_b + \beta * X_{bt} + \gamma_{ft} + \gamma_b + \varepsilon_{bft}.$$

The policy affected the credit market immediately after the first and second auctions (in June 2016 and September 2016, respectively), where the differential effect between treated and control banks amounted to about 15% for credit and 30 basis points for interest rates. The weaker effect recorded at the end of 2016 could reflect the uncertainty preceding the approval by the government of measures aimed at supporting the banking system. The expansionary stance of lending supply seems to continue after the last TLTRO2 operation. One possibility is that banks were still trying to meet the lending target to get the rate reductions, which can increase competition among banks. This mechanism is in line with the evidence from the Bank Lending Survey (ECB, 2018), that documents the easing in lending standards observed since 2014 and the strengthened competition in all the euro-area countries due to the availability of TLTRO funds.

5.2 Heterogeneous Treatment Effects

In table 7 we explore the impact on quantities lent to firms in contracts with different maturities. TLTRO2 had a significant and large impact on quantities for medium term loans, while reduced short term loans by a negligible amount. The estimated coefficients in the binary treatment imply that, after controlling for demand factors and characteristics of the firms, treated banks increased their amount of credit to the same firm in medium term contracts on average by 39 percent relative to control banks. The effect on long term loans is negligible. This evidence suggests that Italian banks matched the maturity of the TLTRO2 funding with that of the loans granted to non-financial corporations.

Table 7: Heterogeneous effects by maturity of credit

| Dependent variable | Log of outstanding amount of credit | | | | | |
|-----------------------------------|-------------------------------------|------------|--------------------------|------------|------------------------|------------|
| | Short term ¹ | | Medium term ² | | Long term ³ | |
| Estimation method | IV | IV | IV | IV | IV | IV |
| Kind of treatment variable | Binary | Continuous | Binary | Continuous | Binary | Continuous |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| I(t>=2016Q2) x TLTRO | -0.078* | -0.0030* | 0.46*** | 0.017*** | -0.011 | -0.00043 |
| | (0.045) | (0.002) | (0.065) | (0.002) | (0.027) | (0.001) |
| Firm-time fixed effects | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes | yes | yes |
| # of observations | 59556 | 59556 | 196848 | 196848 | 302424 | 302424 |
| Adjusted R ² | 0.67 | 0.67 | 0.59 | 0.59 | 0.45 | 0.45 |

Significance: *** 99%, ** 95%, * 90%. - ¹ Initial maturity <= 1year. - ² Initial maturity >1 year and <=5 year. - ³ Initial maturity > 5 year.

Interesting results stem from the study of heterogeneous effects among different subsamples of firms. In a first exercise we introduce in the main regression three dummies interacted with the treatment variable, respectively, low (CADS credit rating classes 1, 2 and 3), medium (classes 4, 5 and 6) and high (classes 7, 8 and 9) ex ante credit risk. The results, reported in table 8, show that the impact of TLTRO2 is significant for all subgroups. The effects of an exposure to TLTRO2 operations are economically significant for all subgroups, but their intensity varies. In particular, the impact on credit quantities is larger for low-risk firms while the impact on credit interest rate is larger for high-risk firms. In other words, a bank more exposed to TLTRO2 is more likely to increase credit quantity to low-risk firms but more likely to cut interest rates for high-risk firms. A possible interpretation of

these findings is that banks' margin adjustment comes from quantity expansion for low-risk firms, while banks are more willing to adjust interest rates for high-risk firms.¹⁶

Table 8: Heterogeneous effects by firm rating

| Dependent variable | Log of outstanding amount of credit | | Credit interest rate | |
|---|-------------------------------------|----------------------|----------------------|----------------------|
| | Binary | Continuous | Binary | Continuous |
| Kind of treatment variable | IV | IV | IV | IV |
| Estimation method | (1) | (2) | (3) | (4) |
| I(t>=2016Q2) x TLTRO x | | | | |
| Dummy Low risk | 0.19*** (0.052) | 0.0071*** (0.002) | -0.20** (0.088) | -0.0070** (0.003) |
| Dummy Medium risk | 0.15*** (0.021) | 0.0060*** (0.001) | -0.34*** (0.049) | -0.012*** (0.002) |
| Dummy High risk | 0.085*** (0.023) | 0.0033*** (0.001) | -0.44*** (0.078) | -0.015*** (0.003) |
| Firm-time fixed effects | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes |
| # of observations | 959592 | 959592 | 602964 | 602964 |
| Adjusted R ² | 0.56 | 0.56 | 0.5 | 0.5 |
| Wald test of equality of TLTRO coefficients (p-value) | 0.00 | 0.01 | 0.17 | 0.18 |

Significance: *** 99%, ** 95%, * 90%.

Table 9: Heterogeneous effects by level of credit interest rate in 2015Q1

| Dependent variable | Log of outstanding amount of credit | | Credit interest rate | |
|---|-------------------------------------|----------------------|----------------------|----------------------|
| | Binary | Continuous | Binary | Continuous |
| Kind of treatment variable | IV | IV | IV | IV |
| Estimation method | (1) | (2) | (3) | (4) |
| I(t>=2016Q2) x TLTRO x | | | | |
| Dummy Interest rate >2% | 0.16*** (0.032) | 0.0055*** (0.001) | -0.48*** (0.049) | -0.018*** (0.002) |
| Dummy Interest rate <=2% | 0.18*** (0.032) | 0.0061*** (0.001) | 0.12** (0.048) | 0.0096*** (0.002) |
| Firm-time fixed effects | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes |
| # of observations | 603240 | 603240 | 603240 | 603240 |
| Adjusted R ² | 0.59 | 0.59 | 0.56 | 0.56 |
| Wald test of equality of TLTRO coefficients (p-value) | 0.22 | 0.21 | 0.00 | 0.00 |

Significance: *** 99%, ** 95%, * 90%.

¹⁶ Differently from these findings, Benetton and Fantino (2018) do not find evidence of a negative impact of TLTRO1 on interest rates for high-risk firms.

In a second exercise we consider two dummies, interacted with the treatment variable, according to whether firms were paying a high ($\geq 2\%$) or low ($< 2\%$) interest rate on loans outstanding in the first quarter of 2015 (table 9).¹⁷ We find that while the quantity of credit is affected in the same way for both groups, there is a negative significant impact on the interest rate (of about 50 basis points) for the firms with an ex ante higher interest rate and a negligible positive impact on the other ones.

Table 10: Heterogeneous effects by firm size

| Dependent variable | Log of outstanding amount of credit | | Credit interest rate | |
|---|-------------------------------------|----------------------|----------------------|----------------------|
| | Binary | Continuous | Binary | Continuous |
| Kind of treatment variable | IV | IV | IV | IV |
| Estimation method | (1) | (2) | (3) | (4) |
| $I(t \geq 2016Q2) \times TLTRO \times$ | | | | |
| Dummy Small firm | 0.19*** (0.030) | 0.0076*** (0.001) | -0.47*** (0.078) | -0.016*** (0.003) |
| Dummy Big firm | 0.12*** (0.020) | 0.0047*** (0.001) | -0.30*** (0.044) | -0.010*** (0.002) |
| Firm-time fixed effects | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes |
| # of observations | 959976 | 959976 | 603240 | 603240 |
| Adjusted R ² | 0.55 | 0.56 | 0.49 | 0.49 |
| Wald test of equality of TLTRO coefficients (p-value) | 0.02 | 0.01 | 0.03 | 0.02 |

Significance: *** 99%, ** 95%, * 90%.

In the third exercise, we interact the treatment variable with two dummies, based on the median of the firm size distribution (table 10). We find that firms benefited irrespective of their size. The impact for both credit amount and interest rate is bigger for smaller firms.¹⁸

Finally, we look at heterogeneous effects among different subsamples of banks, specifically those with a low and a high share of bad loans over total loans. Table 11 shows that the impact of TLTRO2 is significant for all subgroups; nevertheless, the positive impact on the quantity of credit and the negative impact on credit interest rates are both larger if the bank has a low ratio of bad loans over total loans. The question of whether non-performing exposures in general (NPLs) impair banks' capacity to finance the real economy has been frequently addressed by European policy makers over

¹⁷ In this exercise we have to restrict the sample to the relationships where the interest rate is observed (Taxia sample) also when we analyze credit quantities. The first quarter of 2015 represents the first available time period of our dataset while the threshold 2% corresponds to about 20th percentile of the distribution of interest rates in that quarter.

¹⁸ This differs from Benetton and Fantino (2018), where no evidence of an impact of TLTRO1 on interest rates was found for bigger firms.

the past years (see Accornero et al., 2017); our evidence suggests that monetary policy transmission, i.e. the effectiveness of TLTRO2, is influenced by the level of bad debt ratios.

Table 11: Heterogeneous effects by bank bad loans over loans ratio

| Dependent variable | Log of outstanding amount of credit | | Credit interest rate | |
|---|-------------------------------------|----------------------|----------------------|-----------------------|
| | Binary | Continuous | Binary | Continuous |
| Kind of treatment variable | IV | IV | IV | IV |
| Estimation method | (1) | (2) | (3) | (4) |
| I(t>=2016Q2) x TLTRO x | | | | |
| Dummy Low bad loans | 0.16*** (0.020) | 0.0062*** (0.001) | -0.39*** (0.042) | -0.014*** (0.001) |
| Dummy High bad loans | 0.11*** (0.019) | 0.0041*** (0.001) | -0.28*** (0.041) | -0.0084*** (0.001) |
| Firm-time fixed effects | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes |
| # of observations | 959976 | 959976 | 603240 | 603240 |
| Adjusted R ² | 0.55 | 0.55 | 0.49 | 0.49 |
| Wald test of equality of TLTRO coefficients (p-value) | 0.00 | 0.00 | 0.00 | 0.00 |

Significance: *** 99%, ** 95%, * 90%.

6. Robustness Analysis

The main results presented in table 5 are robust to several small changes in the methodology and data we use, as shown in table 12 for the impact on credit quantities and in table 13 for the impact on interest rates.

Table 12: Robustness checks for amount of credit

| Dependent variable | Log of outstanding amount of credit | | | | | | | |
|-----------------------------------|-------------------------------------|---------------------|--------------------|----------------------|--------------------|----------------------|---------------------|-----------------------|
| | Raw TLTRO2 amounts | | Firm and time f.e. | | Drawn amount | | Total credit | |
| Estimation method | IV | IV | IV | IV | IV | IV | IV | IV |
| Kind of treatment variable | Binary | Continuous | Binary | Continuous | Binary | Continuous | Binary | Continuous |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| I(t>=2016Q2) x TLTRO | 0.75*** (0.110) | 0.013*** (0.002) | 0.13*** (0.016) | 0.0054*** (0.001) | 0.17*** (0.022) | 0.0064*** (0.001) | 0.026*** (0.009) | 0.0010*** (0.0004) |
| Firm fixed effects | no | no | yes | yes | no | no | no | no |
| Time fixed effects | no | no | yes | yes | no | no | no | no |
| Firm-time fixed effects | yes | yes | no | no | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes | yes | yes | yes | yes |
| # of observations | 959976 | 959976 | 1940664 | 1940664 | 959976 | 959976 | 2613888 | 2613888 |
| Adjusted R ² | 0.55 | 0.55 | 0.79 | 0.79 | 0.52 | 0.52 | 0.77 | 0.77 |

Significance: *** 99%, ** 95%, * 90%.

Table 13: Robustness checks for interest rates

| Dependent variable | Credit interest rate | | | | | | | |
|-----------------------------------|----------------------|----------------------|---------------------|----------------------|---------------------|----------------------|---------------------|-----------------------|
| | Raw TLTRO2 amounts | | Firm and time f.e. | | No expenditure | | Total credit | |
| Estimation method | IV | IV | IV | IV | IV | IV | IV | IV |
| Kind of treatment variable | Binary | Continuous | Binary | Continuous | Binary | Continuous | Binary | Continuous |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| I(t>=2016Q2) x TLTRO | -2.10*** (0.320) | -0.025*** (0.003) | -0.35*** (0.051) | -0.012*** (0.002) | -0.35*** (0.044) | -0.012*** (0.002) | -0.44*** (0.125) | -0.015*** (0.0043) |
| Firm fixed effects | no | no | yes | yes | no | no | no | no |
| Time fixed effects | no | no | yes | yes | no | no | no | no |
| Firm-time fixed effects | yes | yes | no | no | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes | yes | yes | yes | yes |
| # of observations | 603240 | 603240 | 1286496 | 1286496 | 603240 | 603240 | 1719348 | 1719348 |
| Adjusted R ² | 0.49 | 0.49 | 0.75 | 0.76 | 0.49 | 0.49 | 0.62 | 0.62 |

Significance: *** 99%, ** 95%, * 90%.

In columns (1)-(2) we consider as a treatment variable the gross take-up instead of the net one; the net take-up takes into account the voluntary reimbursement of TLTRO1 borrowings and the amount stored in the deposit facility, which are potentially endogenous. In columns (3)-(4) we use separate firm and time fixed effects instead of joint firm-time enlarging the sample of firms in the estimates; in this way we include not only the firms having a relationship with multiple bank but the entire sample, at the cost of having a less accurate control for demand factors. In the other columns we use alternative definitions of the dependent variables. In particular, in (5)-(6) we use the drawn amount of credit instead of the contractual one in table 12 and the interest rate without expenditure in table 13. In (7)-(8) in both tables we use quantities and rates for the overall credit exposition of each relationship and not only for the term loans component. This last robustness check allows, moreover, to exclude the possibility that the differential increase in term loans has been compensated substituting other technical forms of credit, such as credit lines. All the regressions qualitatively confirm the main results.

Finally, in table 14 and table 15 we present a last series of robustness checks using alternative instruments in our IV specification. Specifically, in columns (1)-(2) we consider the outstanding amount of securities as it represents a proxy for the amount of collateral available to the bank. In columns (3)-(4) we use the outstanding amount of mortgages at the end of January 2016, which is the component of credit issued by banks not influenced by TLTROs. Last, in columns (5)-(6) we exploit the maximum allowance of the first two auctions of TLTRO1, which was predetermined at the start of TLTRO1, and calculated on the eligible loans outstanding at the end of April 2014. Also in this case, the regressions broadly confirm our findings.

Table 14: Robustness checks on the instrument for amount of credit

| Dependent variable | Log of outstanding amount of credit | | | | | |
|-----------------------------------|-------------------------------------|----------------------|--------------------|----------------------|--------------------|----------------------|
| | Securities | | Mortgages | | TLTRO1 allowance | |
| Instrument | IV | IV | IV | IV | IV | IV |
| Estimation method | IV | IV | IV | IV | IV | IV |
| Kind of treatment variable | Binary | Continuous | Binary | Continuous | Binary | Continuous |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $I(t \geq 2016Q2) \times TLTRO$ | 0.16*** (0.020) | 0.0061*** (0.001) | 0.14*** (0.019) | 0.0055*** (0.001) | 0.12*** (0.022) | 0.0046*** (0.001) |
| Firm-time fixed effects | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes | yes | yes |
| # of observations | 962712 | 962712 | 956820 | 956820 | 965340 | 965340 |
| Adjusted R ² | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |

Significance: *** 99%, ** 95%, * 90%.

Table 15: Robustness checks on the instrument for interest rates

| Dependent variable | Credit interest rate | | | | | |
|-----------------------------------|----------------------|----------------------|---------------------|----------------------|---------------------|-----------------------|
| | Securities | | Mortgages | | TLTRO1 allowance | |
| Instrument | IV | IV | IV | IV | IV | IV |
| Estimation method | IV | IV | IV | IV | IV | IV |
| Kind of treatment variable | Binary | Continuous | Binary | Continuous | Binary | Continuous |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $I(t \geq 2016Q2) \times TLTRO$ | -0.32*** (0.052) | -0.010*** (0.002) | -0.37*** (0.053) | -0.012*** (0.002) | -0.27*** (0.046) | -0.0090*** (0.002) |
| Firm-time fixed effects | yes | yes | yes | yes | yes | yes |
| Bank fixed effects | yes | yes | yes | yes | yes | yes |
| Bank time-varying characteristics | yes | yes | yes | yes | yes | yes |
| # of observations | 603240 | 603240 | 603036 | 603036 | 603240 | 603240 |
| Adjusted R ² | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 |

Significance: *** 99%, ** 95%, * 90%.

7. Conclusions

We use a difference-in-differences methodology to study the effectiveness of TLTRO2 on the Italian credit market. We show that this unconventional policy measure has been effective: for a given firm, throughout the second quarter of 2016 and the end of 2017, banks that had additional liquidity from the ECB i) increased lending by 10 to 14 percent more on average (depending on the estimation approach) and ii) lowered interest rates by 23 to 34 basis points on average than banks that did not have received additional liquidity from the ECB.

The effects were strong immediately after the first and second operations (June and September 2016). TLTRO2 did not affect significantly long term loans, while it had a very significant and large impact on medium term ones and a negative negligible effect on short term ones. This evidence suggests that Italian banks matched the maturity of the TLTRO2 funding with that of the loans granted to non-financial corporations.

The effects on quantities and interest rates are significant across firms of different risk category and size, suggesting that the policy has been successful in strengthening credit availability and easing funding conditions of the non-financial private sector, irrespectively of borrower's characteristics. The reduction in interest rates is found to have been significant only for firms that had been charged a relatively higher interest rate in the pre-TLTRO2 period. Finally, our evidence suggests that monetary policy transmission, i.e. the effectiveness of TLTRO2, is influenced by the level of bad debt ratios in banks' balance sheets: banks with lower bad debt ratios benefited the most from the second series of targeted operations.

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