Paying banks to lend? Evidence from the Eurosystem's TLTRO and the euro area credit registry*

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Abstract

Since March 2020 the Eurosystem has provided subsidies to Euro-Area banks, via its Targeted Longer-Term Refinancing Operations (TLTRO). Under this program, banks can borrow from the Eurosystem at a rate as low as -1%, conditional on their lending to the real economy. This paper uses a simple theoretical model to disentangle between so-called "targeted" and "profitability" channels. We test those channels on the new Euro-Area credit registry data (AnaCredit). To overcome reverse causality, we employ novel identification strategies based on TLTRO parameters set before the pandemic and unexpected changes afterward. We find support for both channels and conclude the targeted channel is stronger.

Keywords: TLTRO ; ECB ; funding-for-lending; AnaCredit
JEL: E51; E52; E58; G21

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1 Introduction

For more than a decade, major central banks have implemented so-called "funding-for-lending" schemes, providing loans to banks at preferential interest rates, conditional on increasing lending to the "real economy". This new instrument was introduced to stimulate demand even as short-term interest rates were close or at their effective lower bound. The Bank of Japan pioneered this approach in 2010, followed by the Bank of England in 2012, and recently the Federal Reserve discussed using such instrument (Carlson, D'Amico, Fuentes-Albero, Schlusche, and Wood (2020)). But it is probably the Eurosystem that has made the most extensive use of funding-for-lending, with its "Targeted Longer Term Refinancing Operations" (TLTRO), which started in 2014, and have since replaced all other types of central bank refinancing in the Euro-Area (Figure 1).

On 12 March 2020, the Eurosystem changed the pricing of TLTRO and made the program fundamentally different from any other central bank schemes we know of. With this change, banks could borrow for at least two years at a rate as low as -1%, if they exceed the lending target set by the Eurosystem.[1] For the first time in its history, the Eurosystem lends at a rate lower than the remuneration of banks' reserves (currently -0.5%). Thus, banks can borrow at the TLTRO and (on aggregate) immediately redeposit these reserves with the Eurosystem at a higher interest rate (Figure 2). TLTRO therefore allow banks to make a 50 basis points margin, an extremely profitable trade by the standards of the money market.

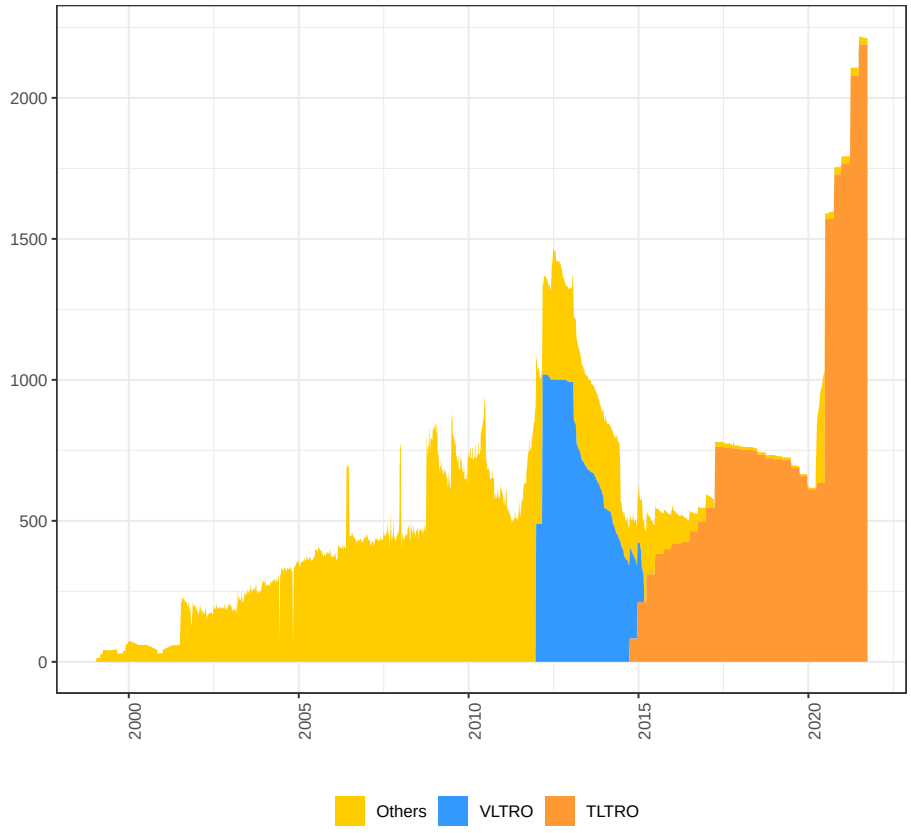
While many monetary policy measures can have incidental redistributive effects between different groups (e.g. debtors vs. creditors), TLTRO III are unique as they imply a direct transfert from the central bank to the commercial banks.

At the time of writing, there were EUR 2,190 bn of TLTRO III borrowings outstanding, meaning that the Eurosystem could pay a subsidy up to EUR 11 bn per year (2,190 times 50 bps). To put this figure in perspective, it is larger than the combined dividend payments made by the Eurosystem two largest members, the Bundesbank (EUR 5.9 bn) and the Banque de France (EUR 3.4 bn) to their national government in 2019.[2] This approach is different

[1] In order to pay the interest rate of -1% over June 2020 to June 2022, banks' loan to households and non-financial corporations portfolio (excluding mortgages) had to increase over some "reference periods". The March 2020 decision provided that banks could borrow at rate as low as -75 basis points. This rate was lowered to -1% on 30 April 2020 for the period June 2020-June 2021. In December 2020, this period was extended from June 2021 to June 2022. For more details, see section 3.

[2] The ECB distributes dividends to its shareholders, the National Central Banks, which in turn may distribute dividends to their shareholders, national governments (in the case of France and Germany). Germany and France accounted for 47% of ECB capital key in 2019. National central banks' profits include ECB div-

Figure 1: Central bank refinancing in the Euro-Area, by type of operations (EUR billion)



Source: Eurosystem proprietary market operations databases.

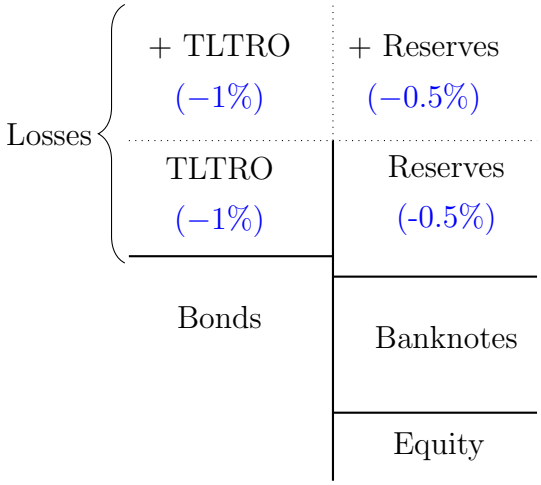
Note: "VLTRO" stands for Very Long-Term Refinancing Operation (i.e. 3-year operations). "Others" contain the Main Refinancing Operations, 1-month Longer Term Refinancing Operations (LTRO), 3-month LTROs, 6-month LTRO, 1-year LTROs, Bridge LTROs, PELTROs, Fine tuning operations and marginal lending facility.

from previous longer-term lending programs where the Eurosystem lent at rates generally more favourable than market funding conditions (TLTRO II, TLTRO I, VLTRO, etc.) but not below the rates of reserve remuneration. When the central bank lends (e.g. for three years) at a rate below secured market lending (e.g. the yield of a three-year covered bond), it accepts to forfeit the term premium. This is a subsidy to banks but it does not take anything

idends, monetary policy operations (e.g. TLTRO lending to banks in their country minus excess reserves remuneration) and other revenues arising for instance from FX reserves.

away from the central bank, which may not need to demand any term premium given that is has no illiquidity risk.[3] By contrast, lending below the rate of remuneration of reserves triggers a direct and immediate loss for the public sector. It is therefore crucial to understand the economic benefits of such an extreme version of funding-for-lending schemes.

Figure 2: Stylized central bank's balance sheet



Note: This diagram represents a stylized version of the Eurosystem consolidated balance sheet. Any increase in TLTRO lending translates into one-to-one increase in reserves held by banks with the Eurosystem. This is because TLTRO are settled in central bank money. Autonomous liquidity factors (such as the net amount of banknotes and coins issued), which could drain reserves away from the banking system are not impacted by TLTRO lending. Thus, any additional euro lent by the Eurosystem at -1% will result into an increase in reserves (remunerated at -0.5%) and therefore a net loss of half a cent.

The first contribution of our paper is to write a simple theoretical model of bank lending to understand the channels through which TLTRO may stimulate loan supply, and the role of the different TLTRO parameters (interest rates, maximum borrowing allowance, etc.). Our model is able to take into account that TLTRO are central bank reserves lent directly to commercial banks. Banks may in turn increase the supply of loans to non-financial corporations and households, settled in commercial bank money (bank deposits). This institutional difference between the two types of monies being used is (to our knowledge) completely absent from existing models of funding-for-lending schemes. The main insight of our model is that TLTRO stimulate the supply of so-called "eligible" loans as long as banks have not reached the lending target set by the central bank to get the most generous interest rate. We call this channel the "targeted channel". Once banks have fulfilled the lending target set by the central

[3]The central bank may also be able to demand a lower interest rate than the market because of its higher seniority status, which makes lending less risky.

bank, TLTRO may still stimulate credit by increasing banks profits, a channel we call the "profitability" channel. This second channel may affect all loans ("eligible" and"ineligible" loans). We note that a necessary condition for TLTRO to impact credit is that the interest rate at which they are provided is below the comparable market rate (i.e. the interest rate for a 3-year bond or stable deposits). But it does not need to be below the remuneration of reserves.

The second, and most important contribution of our paper is to assess empirically the effectiveness of post-March 2020 TLTRO program on banks' lending, and to estimate the relative strength of the two channels. In other words, we intend to provide the first estimates of the effects of a program that subsidizes banks to lend.

Evaluating empirically the effects of this program on bank lending is challenging mainly due to reverse causality. Banks decide whether to participate or not to TLTRO operations. Reverse causality arises if banks participating to the TLTRO were doing so because they expected their lending performance to exceed the target set by the Eurosystem (and that they would pay the most favorable interest rate, at -1%). In such a setting, TLTRO do not cause higher lending growth. It is instead the expectation of high lending growth that causes TLTRO participation. To deal with this issue, papers on previous TLTRO programs (where interest rates were higher or equal to the deposit facility rate of the Eurosystem) used an instrumental variable approach (Benetton and Fantino (2021), Andreeva and García-Posada (2021), Esposito, Fantino, and Sung (2020) and Laine (2021)). We show that this instrument cannot be considered exogenous in the case of TLTRO III.

A second empirical challenge, which is linked to the attractive pricing of the operations, is the large participation to the program (87% of banks), and only few small banks did not participate.[4] Banks that did not participate to TLTRO cannot be used as a control group for TLTRO III under such circumstances.

To overcome these two issues, we use a simple feature of the program. By construction, lending performance of banks is measured over some time period, called the "reference period". We consider the reference period announced by the ECB on 12 March 2020, which run from 1 March 2020 to 31 March 2021. Concretely, banks could borrow at -1 % if the growth of their loan portfolio between 1 March 2020 and 31 March 2021 exceeded 0% (i.e. if

[4]Our figure of 87% is based on the minimum reserve requirements of all banks that could be found in the Centralised Securities Database (CSDB), which should contain all institutions that issued at least one debt security since 2018. The idea is to include only those banks that have alternative market sources for this calculation. If one considers all banks irrespective of whether they issued a bond, the participation was around 75 %

their stock of loans increased over the period).

This implies that banks knew that any new loan they granted would count in their lending performance only if it matured after the 31 March 2021. We call these loans "eligible loans". By contrast, loans maturing before 31 March 2021 would not count in banks' lending performance (it is granted during the reference period but repayed before the end-date, thus would not be in the bank's portfolio in March 2021).

This 31 March 2021 cut-off was never changed during the life of TLTRO III program. It offers an exogenous change in the eligibility status of bank loans. We therefore test the effect of the eligibility status of a given bank loan on the size of the loan. We expect to find that eligible loans are ceteris paribus larger than non-eligible loans after TLTRO announcement. As we advance in the sample, mechanically, more loans may mature after 31 March 2021. We control for the average maturity of bank loans, using several sets of maturity fixed-effects, and for the impact of COVID through bank-time and firm-time fixed effects.

This strategy allows to estimate the effect of TLTRO through its "targeted" channel by looking at the systematic difference between eligible and ineligible loans. But we are also interested in the "profitability" channel. To test for this second channel we exploit an exogenous variation of the amount banks could borrow - i.e. their borrowing allowance. We use the December 2020 announcement, which unexpectedly increased by 10% the amount that banks could borrow from TLTRO. If we detect an impact of this change on ineligible loans, or on all loans but by banks that already meet the lending performance at the time of the announcement, we know for sure this does not come from the "targeted" channel, but rather from a "profitability" channel. We show that this 10% increase is perfectly correlated with banks' actual borrowing at the following operation. We use use this exogenous increase as an instrument for TLTRO borrowing at the March 2021 operation.

We apply our strategies on the newly-available Euro-Area credit registry data, called AnaCredit. Thanks to AnaCredit, we are able to access loan-by-loan information on all credit granted by Euro-Area banks to non-financial corporations since January 2019. The information include notably the lender, the borrower, the date the loan was granted, the maturity of the loan and the guarantor, if any. This rich dataset allows us to control for other credit supply factors through bank-time fixed effects, and for credit demand factors through firm-time fixed effects. To our knowledge, this paper is the first to make use of AnaCredit. Our main variable of interest is the amount of new loans granted by banks participating to TLTRO III.

We find large, significant and robust effects of the "targeted" channel. Our most satu-

rated regression shows that for banks that participated to TLTRO, the origination of "eligible loans" (i.e. loans that mature after 31 March 2021) increased by 32% in the quarter immediately after the announcement of the subsidy, and by 19% in the following quarter. Conditional on participating to TLTRO, borrowing 1% more from the central bank stimulates credit to non-financial corporations by 0.15% in the following two quarters, via the targeted channel.

We make sure these results are not driven by an increase in the supply of long-term loans vs. short term loans, by running placebo tests. In these tests, we move the cut-off date by one period forward. The significance coefficients either diminishes markedly or disappears altogether, showing that there is a specific effect related to the 31 March 2021 deadline. We are not aware of any other regulation or program that creates a discontinuity at the 31 March 2021, except the TLTRO.[5]

As for the profitability channel, results from our instrumental variable approach points to an effect on all types of loans (eligible and ineligible). We find a stronger effect for eligible loans than for ineligible (elasticity of TLTRO to loan supply of 0.16% vs. 0.05%) in line with what we expect: eligible loans are affected by both targeted and profitability channel, while ineligible loans are only affected by the second channel. Similarly, we find that banks already fulfilling their lending target are less responsive than other banks. These results suggest that the profitability channel while also effective, is weaker than the targeted channel.

Our findings have important policy implications. We show that paying banks to lend is indeed effective to stimulate credit. Our estimates allow policy makers to weight the financial cost of such program against the economic benefits. Based on our theoretical model and on previous studies on funding-for-lending schemes, we note that providing banks with funding below market rate may be enough to stimulate credit.

Section 2 reviews the literature, section 3 details the institutional set-up, section 4 lays out our theoretical model, section 5 describes our data, section 6 explains our empirical strategies and our results. Section 7 draws some policy implications and concludes.

2 Literature review

To our knowledge, our paper is the first on TLTRO III. Benetton and Fantino (2021) and Esposito, Fantino, and Sung (2020) are the two papers closest to ours. They study respectively the effects of TLTRO-I and TLTRO-II on credit supply in Italy, using loan-level data

[5]Some countries have put in place state-guarantees for bank lending around March 2020, but we be control for all time-varying country events through our fixed effects. We also exclude all State-guaranteed loans in our robustness section, and show results are qualitatively unaffected.

from the Italian credit registry. Other papers, using bank-by-bank data study the effect of TLTRO I and II: Andreeva and García-Posada (2021), Afonso and Sousa-Leite (2019), Bats and Hudepohl (2019) and Laine (2021). While the TLTRO III were initially extremely close to the TLTRO II in terms of pricing and bidding limits, the changes that were made on 12 March 2020 significantly increased the size of the program compared to previous ones, and more importantly added an explicit subsidy component, which made this scheme a unique experiment. We therefore contribute to this literature by looking for the first time at the effect of this subsidized "funding-for-lending" scheme using loan-level data for the whole Euro-Area.

We also make important methodological contributions to the literature on TLTRO. In principle, we could use the same instrumental variable as Benetton and Fantino (2021), Esposito, Fantino, and Sung (2020), Andreeva and García-Posada (2021) or Laine (2021). The instrument used is the maximum amount banks can borrow (the "borrowing allowance"), which itself depends on the size of banks' loan portfolio at the start of the program. However, we show that in our case, and possibly in previous TLTRO programs banks could strategically affect their allowance by including some entities of their banking group and exclude others from the "TLTRO group" they reported to the Eurosystem. We use different empirical strategies, notably based on the date of the end of the lending performance, which is the same for all banks and was never changed in 2019 or 2020 (despite the pandemic) ruling out any endogeneity. Also, our data allow us to disentangle empirically between the different TLTRO channels.

We contribute also to the empirical banking literature, which disentangles supply and demand effect using loan-level data. This approach, pioneered by Khwaja and Mian (2008) looks at firms which borrow from two banks simultaneously and uses firm-time fixed effects to neutralize all time-varying variables that affect loan demand. Other examples of papers using similar techniques include Jiménez, Ongena, Peydró, and Saurina (2014), Iyer, Peydró, da Rocha-Lopes, and Schoar (2014), Minoiu, Presbitero, Sette, Peydro, Polo, and Bottero (2019). Thanks to our detailed dataset, we can observe new flows for loans (not only changes in outstanding amounts). Moreover, we are able control for the maturity of loan, a key parameter that most credit-registry data do not contain. Also, our study uses the Euro-Area credit registry AnaCredit. To our knowledge our paper is the first one to make use of this dataset.[6]

[6]In our understanding, Altavilla, Laeven, and Peydró (2020) and Bubeck, Maddaloni, and Peydró (2020) both combine several credit registries from Euro-Area countries. These credit registries were combined in a preparatory phase to AnaCredit.

At last, our paper contributes to the broader literature on the empirical assessment of unconventional monetary policies, i.e. measures taken by central banks other than changing the level of short-term interest rates. While the profession has witnessed an explosion of contributions on forward guidance and central bank asset purchase, the literature on "funding for lending" schemes remains limited. In the euro area, for instance, Rostagno, Altavilla, Carboni, Lemke, Motto, Saint Guilhem, and Yiangou (2019) and Rostagno, Altavilla, Carboni, Lemke, Motto, and Saint Guilhem (2021) extensively study negative rates, asset purchases and forward guidance but not TLTRO. Outside the euro area, the empirical assessment of funding for lending schemes is also extremely sparse, set aside Havrylchyk (2016) and Churm, Joyce, Kapetanios, and Theodoridis (2021) for the UK experiment and Kandrac (2021) for a US program put in place in the 1970's. This paper intends to fill the gap by studying the largest "funding-for-lending" scheme on record, which was put in place during an exceptional crisis.

3 Institutional environment

3.1 Untargeted refinancing operations

Since it started to conduct market operations in January 1999, the Eurosystem has provided liquidity to Euro-Area banks through refinancing operations.[7] Initially Eurosytem lending took the form of "Main Refinancing Operations" (MRO) with one-week maturity and Longer-Term Refinancing Operations (LTROs), which had maturities of maximum three months (Figure 1).[8] These relatively short term operations, together with the "corridor" enabled the Eurosystem to control money market rates.[9]

From 2007, in the face of deteriorating market conditions for long-term funding, the Eurosystem dramatically increased the maturity of its operations, with 6-month TLTRO conducted from April 2008 and 1-year LTROs from June 2009. This effort to extend the maturity of refinancing operations culminated with two 3-year LTROs in December 2011

[7] Euro-Area banks needs for central bank liquidity was then higher than the liquidity provided by central bank outright purchases. This configuration is known in central bank parlance as "structural liquidity deficit" and implied that banks had to constantly roll-over their central bank refinancing to fulfill their liquidity needs.

[8] From 1999 to 2004 MRO had two-week maturity, with one MRO conducted each week and two overlapping operations outstanding at all time. Prior to 2008, the Eurosystem allotted a limited amount of liquidity through a discriminatory price auction (Cassola, Hortacsu, and Kastl (2013)).

[9] For a model of the money market in the Euro-Area and the interaction with central refinancing operations and corridor, see (Vari (2020)).

and March 2012, nicknamed "Very Long-Term Refinancing Operations" (VLTROs).

By lengthening the maturity of its operations, the Eurosystem intended to lower long-term financing costs for banks to make sure they could provide credit to the non-financial sector at affordable conditions (Andrade, Cahn, Fraisse, and Mésonnier (2019)). Ceteris paribus, central bank refinancing translates into bank reserves piling up at the central bank, not necessarily bank loans.[10] Thus, these operations worked mainly through the pricing of banks' funding and probably much less through the quantities lent by the central bank.

The introduction of longer-term refinancing operations, in particular 3-year LTROs, has generally been assessed as effective in avoiding a Euro Area credit crunch in 2011 (Andrade, Cahn, Fraisse, and Mésonnier (2019)). However, some have argued that these operations enabled banks to use Eurosystem funding to invest in higher yielding government securities ("carry-trade" effect) at the risk of reinforcing the sovereign-bank nexus (Crosignani, Faria-e Castro, and Fonseca (2020) and Acharya and Steffen (2015)).

3.2 Targeted Longer-Term Refinancing Operations (TLTROs)

To ensure that its refinancing operations stimulate bank lending to the "real economy", the Eurosystem made a significant change in 2014, and engaged into "Targeted Longer-Term Refinancing Operations" (TLTROs). Three programmes of TLTROs have been conducted as shown in Table 1: TLTROs I, TLTROs II and TLTROs III. While the set-up varied for each programme, they shared three general features:

- **Lending performance and lending targets**: the interest rate a given bank pays on its TLTRO borrowing is calculated ex-post depending on whether the bank "lending performance", i.e. the growth of its loan portfolio, is higher than some target set by the Eurosystem (i.e. 1.15% growth of the loan portfolio). This target is called the "lending target".

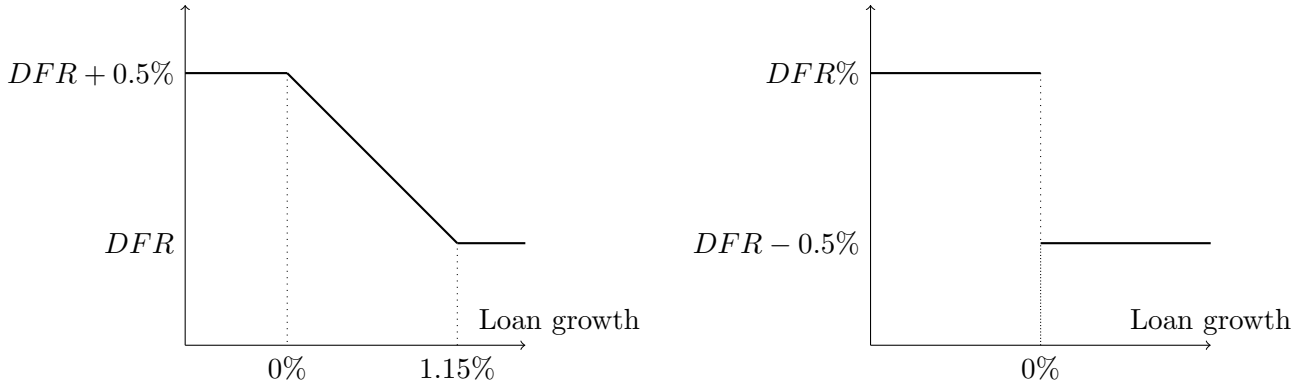
- **The reference period**: the lending performance of a bank is defined as the growth of its loans portfolio between the start and the end of a time period set by the Eurosystem, and called the"reference period". The start of the reference period is always anterior to the announcement of the TLTRO program or amendments to avoid that the reference point is manipulated.

[10]By identity, when loans increase on the asset side of the banking system consolidated balance sheet, deposits increase as well. Other liabilities toward non-banks may increase, such as bonds or shares, but this would require banks to actively issue securities. By default an increase in bank loans generates an increase in banks deposits.

- **The borrowing allowance**: the maximum amount that banks can borrow (the "borrowing allowance") is a fraction of their stock of loans (at the time the program is announced) to non-financial corporations and households, excluding home mortgages.

Under this scheme, banks pay more favorable interest rates on the amount they borrowed at the TLTRO if their lending performance exceeds some lending target. As shown on diagram 1 certain operations had a progressive pricing structure, with interest rates decreasing linearly with the performance (e.g. TLTRO III operated in 2019), while operations conducted in 2020 have an interest rate structure which is binary, i.e. the interest rate paid drops from -0.5% to -1% when the bank exceeds the lending target by 1 euro.

Diagram 1: TLTROs pricing, progressive vs. binary



Note: The first TLTRO III post-pandemic conducted in March 2020 offered interest rates of $DFR - / + 0.25\%$

This pricing scheme is applicable during the (additional) special interest rate period (June 2020 to June 2022)

Since their introduction, TLTROs parameters tended to become more generous, with higher borrowing allowance, lower interest rates, lower targets/shorter reference periods (Table 1). A major change occurred on 12 March 2020, when the ECB Governing Council decided to lower the most favorable rate on TLTROs-III below the deposit facility rate.[11] It meant that banks could earn a risk-free profit of 50 bps per euro borrowed by participating to the TLTROs and placing the proceeds at the deposit facility.[12]

The participation of banks to the TLTRO III was subdued for the first two operations (Figure 3). Since March 2020, banks' participation has increased and by June 2020 has

[11]Initially, the most favorable rate was set 25 bps below the deposit facility rate, and then lowered to 50 bps below the deposit facility rate on 30 April 2020.

[12]This interest rate schedule, when announced in March 2020, applied only between June 2020 and June 2021. In December 2020, the ECB Governing Council extended it to June 2022.

Table 1: Summary of TLTRO parameters (simplified)

Programme	Date	Allowance	Interest rate(s)	Target(s)	Reference period
I (8 operations)	2014-16	7%	DFR+0.35%	0%	May 14-Apr 16
II (4 operations)	2016-17	30%	DFR/DFR+0.5%	0% & 2.5%	Feb 16-Jan 18
III 2019 (2 operations)	2019	30%	DFR/DFR+0.5%	0% & 1.15%	Apr 19-Mar 21
III 2020 (4 operations)	2020	50%	DFR-0.5%/DFR	0%	Mar 20-Mar 21
III 2021 (4 operations)	2021	55%	DFR-0.5%/DFR	0%	Oct 20-Dec 21

Note: DFR stands for "deposit facility rate". For TLTRO III 2019, the indicated pricing does not apply between June 2020 and June 2022. Then, it is the pricing shown for TLTRO III 2020 and 2021 that applies. For TLTRO III 2020 and TLTRO III 2021, the indicated pricing only applies between June 2020 and June 2022. Outside of this period, it is the pricing of TLTRO III 2019 that applies.

become almost systematic, with more than 87% of banks coming at one of the TLTRO III windows.[13] The remaining 13% were either very small credit institutions with operational constraints that did not allow them to enter this complex program, or banks specialized in home-mortgages, excluded from the TLTRO scheme.

Similarly, the net take-up (bank's borrowing minus reimbursement of previous TLTROs) was actually negative for operations in 2019. Net borrowing became positive after parameters were changed in March 2020, and gross take-up surpassed EUR 1,300 bn in June 2020 (Figure 4), which was the largest central bank lending operation ever conducted. It was more than double the size of VLTROs operations in 2011, and 2012, which previously held that record (Crosignani, Faria-e Castro, and Fonseca (2020)).[14]

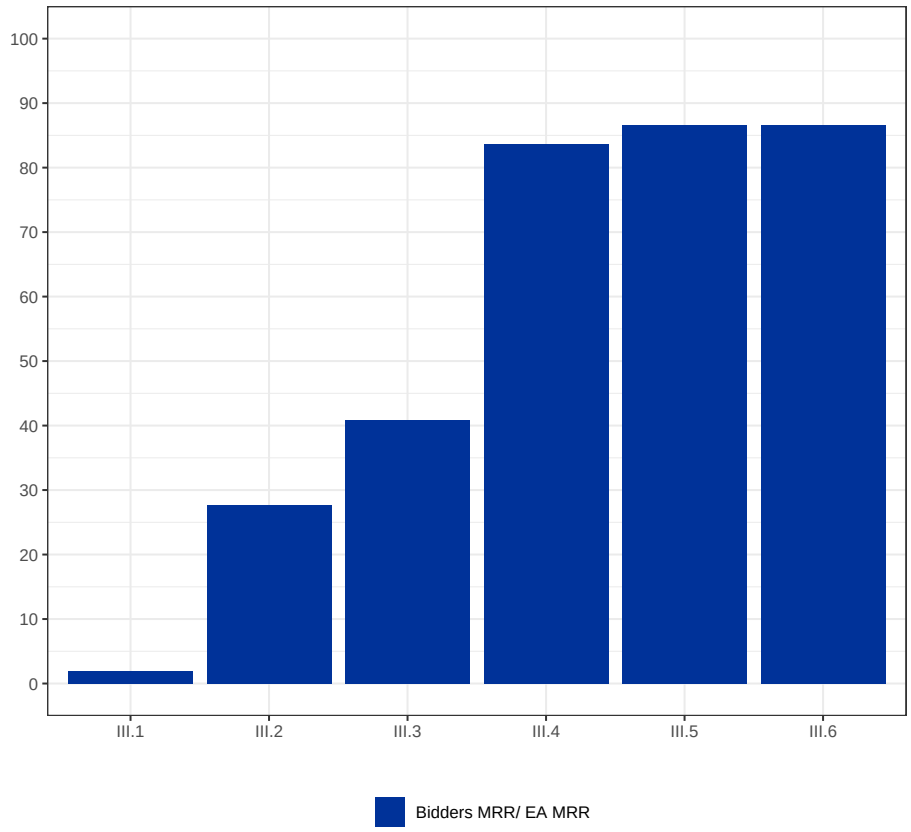
3.3 How TLTROs stimulate credit

Contrary to pre-GFC refinancing operations, TLTROs were not expected to stimulate credit through a decline of money market rates (which would ultimately transmit to lending rates), or longer-term funding rates. TLTROs were conducted in a context of abundant excess

[13]Banks had to submit their application by 20 February 2020 to borrow at the March operation. Given that few banks participated to the program prior to that date, effectively, it meant that most banks were precluded from borrowing at the March 2020 operation, even if they wanted to. Moreover, at the time, the -1% interest rate applied only to the June 2020-June 2021 period, which made it more attractive to borrow from the June operation.

[14]We include in repayments, the scheduled repayments that occur at the maturity of any TLTRO, and anticipation repayments that banks have option to make after a certain time, depending on TLTRO programs.

Figure 3: Bank's participation to TLTRO III (% of bidders' size to all banks' size in terms of reserve requirements, in cumulative terms since TLTRO III.1)

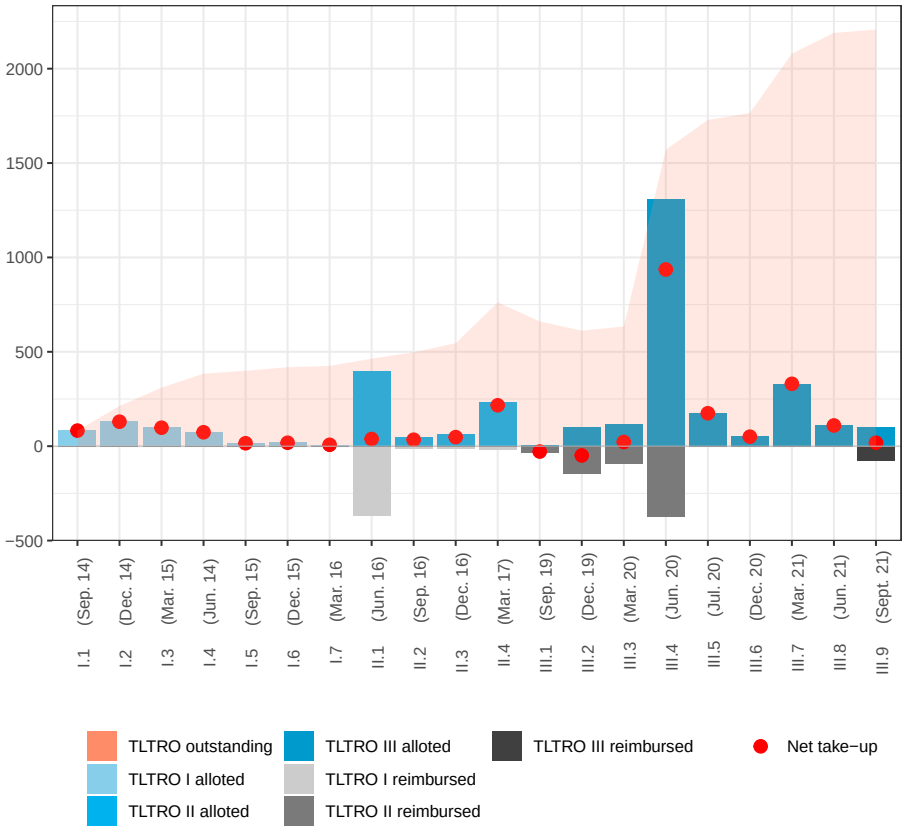


Source: Eurosystem proprietary market operations databases, CSDB, MPEC as of March 2021.

Note: This graph compares the total size of bidders to the total size of the banking system. Size is measured in terms of reserve requirements (MRR: minimum reserve requirements, a measure of size available to us for all banks in the Euro-Area), which reflects size in terms of deposits. We exclude from the calculations banks that are not allowed to borrow from the Eurosystem, and banks that did not issue bonds since 2018 (the start of our public bond database, CSDB).

liquidity and short term interest rates were already at the lower end of the central bank corridor. In this context, additional excess liquidity has very limited effects on the overnight market interest rates. Even if banks can borrow reserves from the Eurosystem at a rate as low as -1%, by arbitrage banks have no incentive to lend unsecured funds at a rate below the ECB deposit facility rate, which remunerates bank reserves at -0.5%. TLTRO with their 3-year maturity and -1% interest rate are in principle an attractive option of long-term funding.

Figure 4: TLTROs net take-up and amount outstanding (EUR billion)



Source: Eurosystem proprietary market operations databases.

However, there is no visible decline of bank' securities issuance since the start of TLTRO III (see figure 13 in appendix).[15] In the rest of this section we lay out the two channels through which TLTRO can stimulate credit.

As formally shown in our model, TLTRO may affect credit through two channels. We call the first channel, the "targeting channel". It arises from the incentive of banks to increase the supply of loans that count in their lending performance i.e. loans that mature after the end of the reference period). We will call these loans "eligible loans". Increasing the size of their portfolio of "eligible loans" allows banks to reach the lending targets set under the TLTRO and benefit from a lower interest on their central bank borrowings. This channel

[15]Data show some moderate decline in issuance of securities with initial maturity below 1 year. This decline however starts before the TLTRO III were introduced.

should affect only the supply of eligible loans.

We call the second channel the "profitability channel". It works by allowing banks to conduct a risk-free arbitrage, by borrowing from the Eurosystem's TLTROs and leaving the proceeds on their central bank account at an interest rate 50 bps higher. If banks are competitive, this additional profits may lead them to lend more, which would reduce again their profits and restore the zero-profit condition. At the opposite, banks may chose to distribute additional profits to their shareholders by increasing dividends.

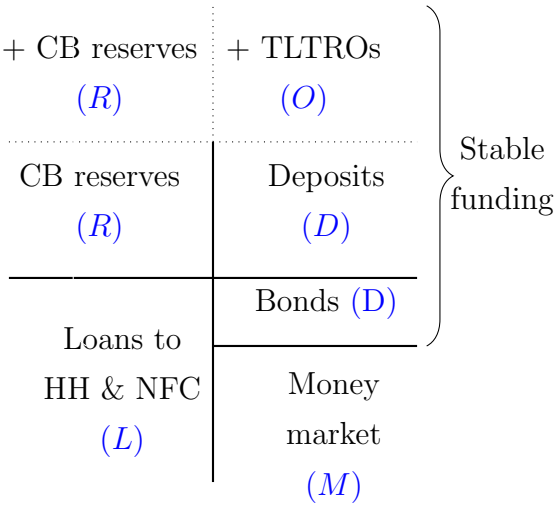
4 Theoretical model

4.1 General set-up

We consider a representative bank that holds loans and central bank reserves. The bank funds itself through money market borrowings, bonds, retail deposits, and central bank refinancing, as shown on Figure 5. The funding constraint for the representative bank therefore writes:

$$L + R = O + D + M \tag{1}$$

Figure 5: The representative bank's balance sheet



Where L is the stock of loans to households and non-financial corporations held by the bank, R is the amount of reserves held at the central bank. D is the stock of deposits, O is the amount borrowed from the central bank, M is amount borrowed on the money market.[16]

[16]The banking system has a net liability on the money market due to non-bank actors (such as money market fund) who deposit funds for short period of time with banks.

All balance sheet items should be thought as end-of-day stock variables averaged over one year, expressed in euros.

Moreover, for prudential reasons, banks are required to finance at least a fraction of their loan portfolio with "stable funding" (deposits or central bank financing). We call this exogenous fraction α.[17] Thus banks face an additional constraint:

$$O + D \geq \alpha L \tag{2}$$

Further, loans can be divided into: "Eligible" loans (L^E), which will be taken into account by the central bank to compute the lending performance of each bank and decide on the interest rate the bank pays on its TLTRO, and "Ineligible" loans (L^I), such that:

$$L = L^E + L^I \tag{3}$$

In the current set-up, we will consider that "Eligible" and "Ineligible" loans differ only with respect to their maturity date (before or after a cut-off date set by the central bank). Our model is sufficiently general to be applied to other situation, such as "green" vs. "brown" loans, for "green TLTRO", as discussed in van 't Klooster and van Tilburg (2020).

The profit function (Π) of the representative bank over a one year horizon writes

$$\Pi = r_E L^E + r_I L^I + r_R R - r_D D - r_O O - r_M M - C(L^E) - C(L^I) \tag{4}$$

r_E, r_I, r_R, r_D, r_O and r_M are nominal interest rates associated with each balance sheet item.

The bank acts as price-taker on the loan market, and faces interest rate r_E and r_I. $C(L^i)$ is the cost to find new lending opportunities on the loan markets $i = \{I, E\}$. It captures search and screening costs. We use a quadratic cost function (as in Drechsler, Savov, and Schnabl (2017) for instance), with $C(L^i) = c\frac{(L^i)^2}{2}$ where $c > 0$.

Banks face a deposit supply function of the following form: $r_D = r_M + d_1$, where $d_1 > 0$ is a mark-up above the money market rate. It captures both the premium banks are ready to pay for locking-in long-term funds (see Bechtel, Ranaldo, and Wrampelmeyer (2019)) and the fact that some deposits could be subject to zero lower bounds, while money market deposits are not.

[17] This constraint matches closely the Net Stable Funding Ratio (NSFR) set by the Basel Committee on Banking Supervision. We assume that it is set solely for prudential reasons without any monetary policy considerations. The disconnect between monetary and prudential regulation is documented in Monnet and Vari (2020).

We assume that the money market rate is equal to the deposit facility rate set by the central bank:

$$r_M = r_{DF} \tag{5}$$

where, r_{DF} is a policy rate directly controlled by the central bank.

This assumption reflects the situation of abundant excess liquidity created by asset purchase programs, which push money market rates close to the deposit facility rate, the bottom of the central bank corridor (Poole (1968), or Vari (2020)).

4.2 The targeted channel of TLTROs

We model targeted refinancing operations as loans offered by the central bank to banks for one year. The amount of the loan ranges between 0 and $\bar{O}$, where $\bar{O}$ is the borrowing allowance set by the central bank. Bank endogenously chose the amount they borrow within the $[0; \bar{O}]$ interval, depending on the level of the TLTRO interest rate they expect to pay r_O compared to the market interest rate on stable funding r_D, the money market rate r_M, and the amount of loan they grant (L).

The interest rate on the operation (r_O) depends on the size of the eligible loan portfolio at the end of the year (L^E). The level of interest rate changes depending on whether L^E exceeds or not some threshold $\underline{\mathrm{L}}^E$ set by the central bank, and a second threshold $\underline{\mathrm{L}}^E + g$, where $g > 0$ is also set by the central bank. We restrict ourselves to the following type of functions:

$$\begin{cases} r_O(L^E) = \bar{r_O} & \forall L < \underline{\mathrm{L}}^E \\ r_O(L^E) = \bar{r}_O + \underline{\mathrm{L}}^E \frac{\bar{r}_O - \underline{\mathrm{r}}_O}{g} - L^E \frac{\bar{r}_O - \underline{\mathrm{r}}_O}{g} & \forall L \in [\underline{\mathrm{L}}^E; \underline{\mathrm{L}}^E + g] \\ r_O(L^E) = \underline{\mathrm{r}}_O & \forall L > \underline{\mathrm{L}}^E + g \end{cases}$$

This type of functions fits all types of TLTROs. It corresponds exactly to TLTRO II and the pre-pandemic TLTROs III (see Table 1). When g tends to zero, the function fits the post pandemic TLTROs III. In order to keep the model as general as possible we explore here the case whenre $g > 0$, and keep the analysis of $g = 0$ for Appendix B.2.1.[18]

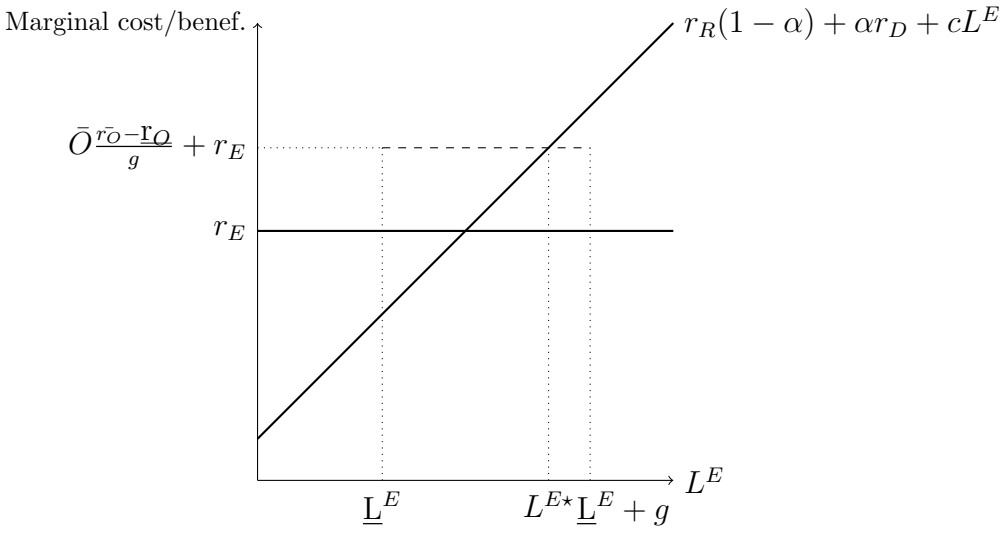
We also restrict the analysis to cases where the interest rates on TLTROs is always lower than the market for stable funding ($\bar{r}_O \leq r_D$), to fit the context of Eurosystem' s TLTROs. The model can easily be extended to a more general setting, as shown in Appendix B.2.2.

The problem of the bank, can be written with the following Lagrangian:

$$\mathcal{L} = \Pi - \lambda(L + R - O - D - M) - \gamma(\alpha L - D - O) - \delta(O - \bar{O}) \tag{6}$$

[18]Further, by setting the maximum rate $\bar{r_O}$ to r_D and the minimum rate to $DFR + 35bps$, the function replicates the payoff from the TLTROs I.

Figure 6: The bank's problem with TLTROs



Maximizing $\mathcal{L}$ with respect to the amount of loans (L) and deposits (D), interbank borrowing and (M) and central bank borrowings (O) and combining these equations yield the following conditions (Appendix B.2.1):

$$r_E - \bar{O}\frac{\partial r_O}{\partial L^E} = \frac{\partial C}{\partial L^E} + r_M(1-\alpha) + \alpha r_D \tag{7}$$

$$r_I = \frac{\partial C}{\partial L^I} + r_M(1-\alpha) + \alpha r_D \tag{8}$$

$$O = \bar{O} \tag{9}$$

The left-hand sides of equations (7) and (8) represent the marginal benefit of increasing loan supply, while the right-hand sides represents the marginal cost. In case of (7) the central bank scheme increases the marginal benefit through the following term: $\bar{O}\frac{\partial r_O}{\partial L^E}$.

Equation (7) is not continuous for all values of L^E, due to the fact that $\frac{\partial r_O}{\partial L^E}$ is null, except over $[\underline{L}^E; \underline{L}^E + g]$ where it is strictly negative. This dynamic is represented on Figure 6.

The amount of accommodation provided by the TLTROs can be found with (7) (8), using the functional forms of C^i, and r_O:

$$L^{I\star} = \frac{r_I - r_M(1-\alpha) - \alpha r_D}{c} \tag{10}$$

$$L^{E\star} = \frac{r_E - r_M(1-\alpha) - \alpha r_D}{c} + \bar{O}\frac{\bar{r_O} - \underline{r_O}}{gc} \tag{11}$$

Equation (10) shows the supply function of the bank for loans that are not eligible to be counted in the TLTRO lending performance. Supply is increasing in the price of loans r_I, and decreasing in the average cost of funding $r_M(1-\alpha)-\alpha r_D$, where the weight α corresponds to the share of stable funding a bank must raise to grant news loans. This basically means that conventional central bank policies that lower short-term rates (r_M) and longer term rates (r_D), stimulate loan supply in a way which is completely distinct from TLTROs. The supply of loans is also decreasing in c, the slope of the marginal cost function.

This intuitive supply function also applies to "Eligible" loans (first term of equation (11)). The second term of equation (11) gives the amount of additional lending resulting from the TLTROs. $\bar{O}$ is the amount of accommodation provided and $\frac{\bar{r_O}-\underline{r}_O}{gc}$ is the amount of accommodation per unit lent. It is equal to the the marginal decline in the interest rate on central bank lending per unit of additional loans granted by the bank, divided by the marginal cost per unit of TLTRO.

4.3 The profitability channel

We just described the situation where parameters $\underline{L}^E$, g and c are such that the equilibrium amount of loans $L^{E\star}$ is in the interval $[\underline{L}^E;\underline{L}^E+g]$, meaning that the representative bank makes a marginal gain by lending more to the economy. This is because the interest rate it pays to the central bank decreases as it lends more. Ceteris paribus, for lower values of c, the marginal cost function would be "too flat", and we would have $L^{E\star} > \underline{L}^E + g$. In this case TLTROs do not change the profit maximization of the representative bank. In this case TLTRO are a pure "boon" for banks.

However, if we assume that the banking sector is competitive, i.e. it operates under zero profits, the behavior of the representative bank may still change, such that another channel may kick-in. We call it the "profitability channel".[19]

In this particular case, we can rewrite the profit function (4) in the following way:

$$r_E L^E + r_I L^I + r_R R - \bar{O}\underline{r}_O - r_D D - r_M M - C(L^E) - C(L^I) = 0 \tag{12}$$

Using this equation together with identities that must hold at the level of the banking sector, Appendix B.2.3 shows that:

$$\frac{dL}{d\underline{r}_O} = \frac{\bar{O}}{(1-\alpha)(r_M - r_D)} \tag{13}$$

[19]The following reasoning would also hold if banks were making positive but constant profit margins.

This derivative is always negative ($\alpha < 1$ and $r_M < r_D$), implying that any decrease of the interest rate on TLTRO ($\underline{r_O}$) may stimulate loan supply (eligible and non-eligible loans), even if the targeted channel is muted. The impact is proportional to the borrowing allowance ($\bar{O}$).

The intuition behind this channel is the following: even if the bank marginal incentives are unchanged, when it receives the subsidy from the central bank, this increases it profits. In order to prevent entry, the bank will increase lending and thus reducing its profits to zero.

4.4 Main insights from the model

Our model allows us to make a series of predictions, that we will test in the data:

- TLTRO may stimulate the supply of eligible loans (only), through the "targeted channel".
- Whether the targeted channel is effective or not depends on bank unobservable (and possibly time-varying) characteristics such as marginal costs.
- The targeted channel is effective only for banks which loan supply is not "too high" relative to the lending target set by the central bank.
- Apart, from the targeted channel TLTRO may affect loan supply (for both types of loans) through a profitability channel.
- The effect of both channels on loans supply depend on the amount of TLTRO funding borrowed by the bank.

5 Data

Our data sources consist of confidential bank-by-bank information on borrowings of banks from the TLTROs, taken from the Eurosystem proprietary market operations database. We match these data with loan-level information from the AnaCredit database. We obtain a panel of bank loans at the quarterly frequency.[20]

[20] We could in principle use a higher frequency. However, TLTROs occur only once every quarter, which make quarterly frequency sufficient. Using this frequency makes our results immediately comparable with the literature, and it is more convenient as it reduces somehow the size of our dataset and avoids having too many coefficients.

5.1 Market Operations Database

The Eurosystem market operations database (MOPDB) consolidates confidential bank-by-bank information on all operations from the 19 euro-area national central banks. It contains end-of-day positions (deposits and borrowings) of all banks of the Euro-Area, as well as other related information (collateral use, borrowing limits, etc.). Each bank is identified via a unique a RIAD code, which also identifies institutions in Anacredit, and makes the merging of the two database immediate[21]. We take end-of-quarter TLTRO borrowings for all participating institutions.[22] TLTRO borrowing applies to a given "TLTRO group", i.e. a set of institutions from a given banking group that decide to participate together to the TLTRO. We therefore attribute the same participation status and the same borrowing amount to all the banks of a given "TLTRO group".

5.2 AnaCredit

AnaCredit (*Analytical Credit Dataset*) is a ESCB proprietary database reporting loan-by-loan data on credit granted by all credit institutions resident in the euro area, to companies and other legal entities.[23] The database harmonizes and extends granular credit data collected by each euro area member states and provides a complete overview over credit instruments, debtors, creditors and other parties such as guarantors.[24] The database contains 88 attributes based on harmonised definitions common to all participating countries. An extensive description of the AnaCredit methodology, reporting and attributes is available in the AnaCredit reporting manuals[25]

Data start is September 2018 and is updated on a monthly basis. A loan is uniquely identified by instrument, contract, debtor and creditor identifiers, which allows us to detect new loans (i.e. on the first date the loan appears in the database). A loan can then be tracked with all its details (outstanding amount, etc.) at a monthly frequency during its lifetime. In terms of coverage, Anacredit reports only loans to legal entities, (excluding households).

[21] RIAD stands for Register of Institutions and Affiliates Data.

[22] TLTROs III operations occur once every quarter and are settled between the 27th and the 29th of the last month of the quarter, except in December when they settled on the 20th and the 21 of December 2019 and 2020. TLTRO repayments always take place on the settlement day of new operations.

[23] Foreign branches of credit institutions also report to AnaCredit, provided that these branches are resident in a euro area Member State

[24] The Governing Council of the ECB adopted Regulation (EU) 2016/867 on the collection of granular credit and credit risk data (ECB/2016/13) in May 2016

[25] https://www.ecb.europa.eu/stats/money_credit_banking/anacredit/html/index.en.html

Around 25 millions individual loans are reported monthly, granted by around 7000 individual credit institutions to approximately 5 million of individual debtors.

We perform extensive consistency checks using other data source (BSI, national credit registries) to ensure the data quality by the Eurosystem. On Figure 7, we simply provide a comparison of loan outstanding to NFC between the public BSI dataset (Balance sheet items dataset) and Anacredit.

We take all new loans granted from January 1st 2019 until December 31st 2020. We consider only "plain" loans, meaning we do not take credit card debt, credit lines and overdraft.[26] We restrict ourselves to loans to non-financial corporates (counterparty institutional sectors equal to 'S_11'). We first look only at "bullet" amortization structure loans, i.e. loans with a single reimbursement of the principal at the maturity of the loan.

By restricting the sample to bullets loans, we avoid the issue of loans that are partly amortized before 31 March 2021. Such loans would count only partially for banks lending performance (only the principal that remains outstanding as of 31 March 2021).

We run our regressions on all types of amortization structure in the robustness checks and in our IV exercise. Looking at the maturity structure of loans to NFCs (figure 8), we note that there are very few loans with maturity above 40 quarters, which leads us to drop all observations with maturity longer than 10 years. At last, we remove outliers (the top and bottom 0.5 % of the distribution in terms of amount outstanding).

The descriptive statistics of our sample after cleaning can be seen on table 2. Summary statistics for our dataset before aggregation can be seen on table 3.

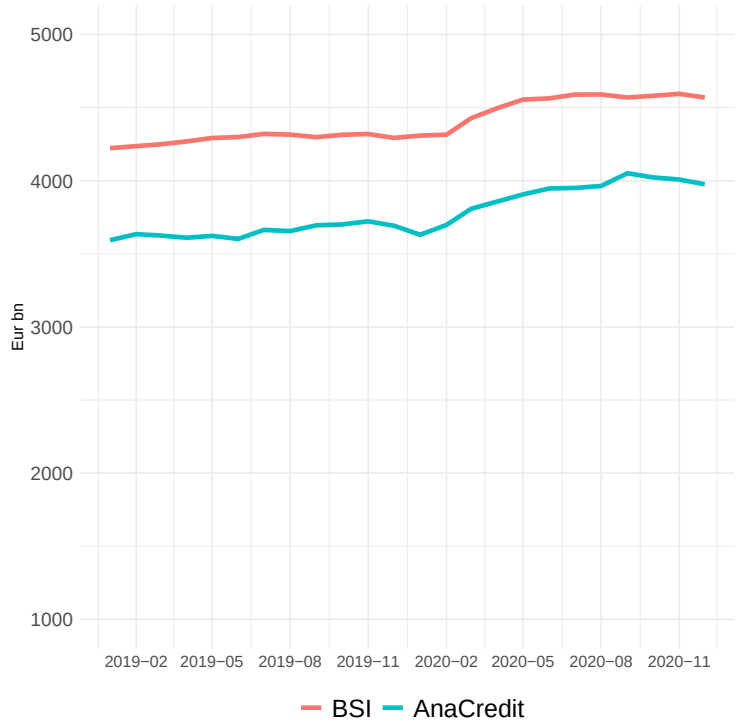
6 Empirical strategies and results

When evaluating the impact of TLTRO, researchers may face significant reverse causality issues. Typically, a bank that was planning to strongly expand credit (even in the absence of TLTRO), knows it would benefit from borrowing at the TLTRO, and could make a risk-free profit (see section 3). The specific credit dynamic of a bank may thus cause it to borrow at the TLTRO, as much as borrowing at the TLTRO may impact a particular bank's credit supply.

Up to now, the literature has dealt with this issue by using an instrumental variable

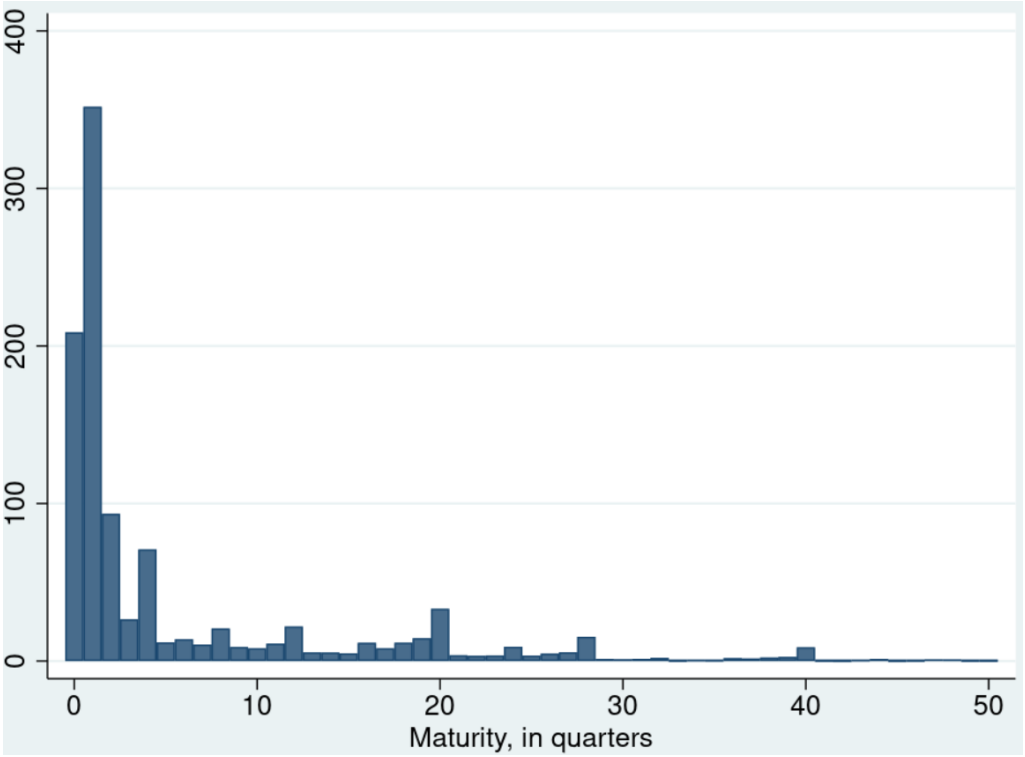
[26] To be precise, we select the instrument type "1004", which is described in the manual as "Loans other than overdrafts, convenience credit, extended credit, credit card credit, revolving credit other than credit card credit, reverse repurchase agreements, trade receivables and financial leases". We also exclude loans with purpose 12 (residential real estate purchase), 4 (Margin lending).

Figure 7: Comparison of reported credit to Non-financial corporations, BSI vs AnaCredit, Jan 2019 to Dec 2020



Note: This figure shows the comparison of credit amount outstanding granted by EA resident banks from two sources: public source (BSI serie 'ECB/BSI/M.U2.N.A.A20.A.1.U2.2240.EUR.E'), and Anacredit aggregated one from loan-level data. For both, we take the amount outstanding (stock) of credit to NFC denominated in Eur.

Figure 8: Maturity structure of bullet loans in Anacredit



Note: This figure shows the amount of "plain" bullets loans granted between January 2019 to December 2020, in billion of euros. Loans with a maturity of 0 quarters are those which maturity date is within the same calendar quarter as their settlement date.

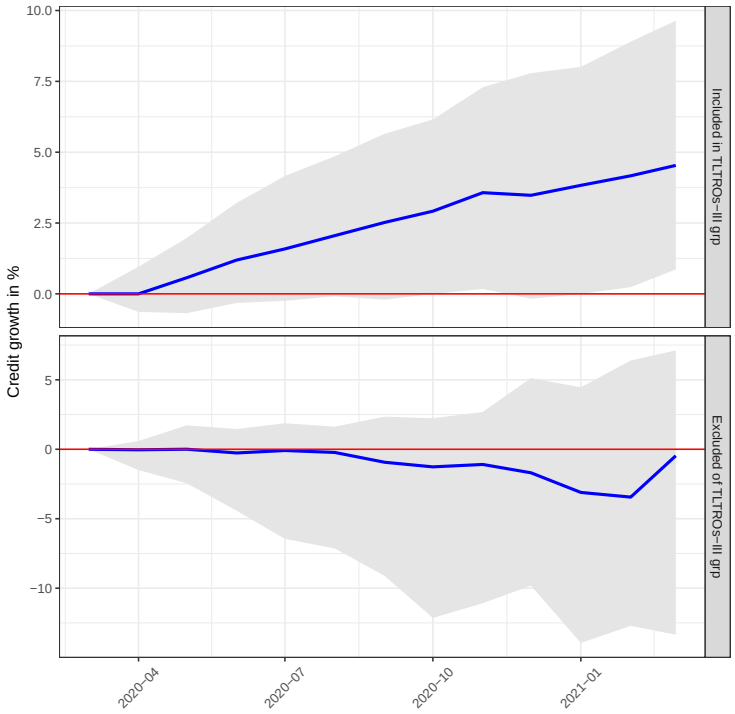
approach (Benetton and Fantino (2021), Esposito, Fantino, and Sung (2020) and Andreeva and García-Posada (2021)). The instrument used is the maximum amount banks can borrow at the TLTRO (the borrowing "allowance"), which is equal to a fraction of the bank's loan portfolio at some date decided by the central bank.[27] We think this approach is not possible for TLTRO III, because banks can strategically affect the size of their allowance. Indeed, the size of the loan portfolio depends on the composition of the group that the bank "declares" when it borrows at the TLTRO.[28] Banks do not have to include all the entities with which they have capitalistic links. It is up to the entity that bids to say which member of its banking group should be counted in its TLTRO group. We show on Figure 9 that banks tend to include entities that perform well compared to the rest of the capitalistic group. The

[27] This date is always anterior to the announcement of of the TLTRO program to avoid that banks manipulate the reference point.

[28] The process through which banks can submit the composition of their TLTRO group, is explained in its 29 July 2014 press release.

positive relationship found in these papers may reflect this selection bias in which types of entities are included to measure the performance of the group.

Figure 9: Entities included in TLTRO groups vs. entities (voluntarily) excluded from TLTRO groups



Source: IBSI. Loans to Non-Financial Corporations and households (excluding home mortgages) between March 2020 and March 2021. Note: This figure compares the credit performance of entities that were included in a TLTRO groups vs. entities excluded from TLTRO groups (but belonging to the capitalistic group of entities that participated to TLTRO). Gray area are second and third quartiles of the distribution. Blue lines are the median of the distribution.

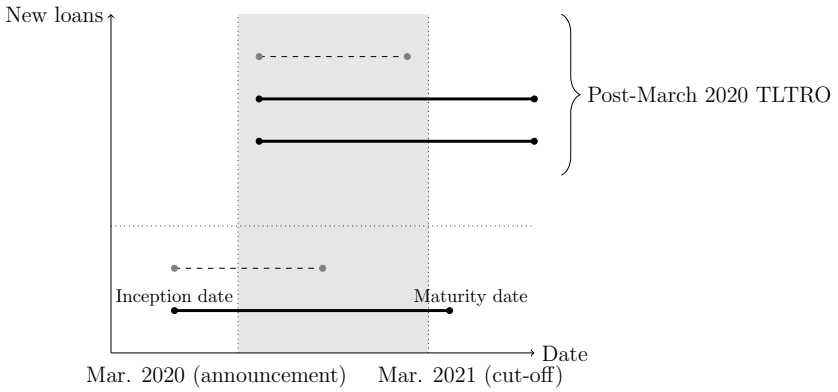
6.1 Testing for the targeted channel

We exploit an exogenous discontinuity created by the TLTRO programs. The credit performance of banks (used to compute ex-post the rate they will pay at the TLTRO) is measured by comparing their stock of credit at some final date with their stock of credit at some initial date. In the case of the TLTRO III, the final date was set as 31 March 2021. The initial date has changed during the life of the program, but it was always set at the date anterior to the announcement, to avoid that banks manipulate the reference point of the exercise.

The main advantage of using the end-date of the reference period, is that it represents a clear discontinuity, which is completely exogenous (banks cannot influence it in any way). It is one of the rare parameters of the TLTRO III that hasn't changed since the program was initially announced on 6 June 2019. Moreover, looking at loans that mature after March 31st 2020 vs. loans that mature before allows us to focus on the "targeted effet" of the TLTRO, i.e. we capture only the effect of TLTRO on the incentive of banks to meet the lending performance target. We avoid taking into account any positive or negative side-effect of TLTRO on profitability or other conventional effect such as lowering term funding rate, an effect that was already present in previous untargeted programs.

Concretely, we are going to estimate the effect of the TLTRO III announcement, on the growth of loans maturing after 31 March 2021, compared to loans maturing prior to 31 March 2021. We tag the loans maturing after 31 March 2021 as "eligible loans", because they will be eligible to count in the lending performance of banks, while loans maturing before 31 March 2021 are not eligible. We use a quarterly panel of bank loans, and we look at eligible vs. non-eligible loans at each period, expecting to see a change in their relative behavior around the TLTRO announcement, as shown on Figure 10. Because, we will compare loans made by the same banks to the same firms during the same period, we factor out the effect of COVID and other time-varying economic developments.

Figure 10: Identification strategy



Note: This diagram represent the loan supply of a representative banks. Each line represents a loan from its inception to its maturity. Dotted lines represent loans that mature before 31 March 2021 (loans not eligible to count in the lending performance of the bank). Thick lines represent loan that mature after 31 March 2021. We look at loans origination at different dates (the inception date), reflecting our panel setting. Our identification assumption is that there should be more loans maturing after 31th 2021, after the announcement of the changes of the parameters of the TLTRO III, in March 2020, compared to before the announcement.

We expect an increase in the supply of loans that mature after the March 31st cut-off date. This is confirmed by looking at the evolution of the maturity of loans during the sample period (Figure 11). The average maturity structure is relatively stable in 2019 and early 2020. Right after the change in TLTRO III parameters is announced (at the end of Q1 2020), we see a sizeable increase in the amount of loans granted with maturities long enough to be eligible. Originations of eligible loans remain higher than usual afterward, even if the increase is less spectacular. Banks don't seem to lower their loan supply for shorter maturities in order to increase their supply of "eligible" loans, i.e. we do not see evidence of substitution. Figure 11 suggests that controlling for the maturity structure of loans portfolio is crucial. We do so by using three types of maturity fixed effects. First, we use simple maturity fixed-effects to control for the average maturity (in quarters) of loan portfolios in the Euro-Area. While such fixed effects are useful to account for systematic differences in the maturity of eligible vs. ineligible loans, they ignore possible differences in the maturity structure across countries. We introduce maturity-country fixed effects for that purpose. At last, recognizing that some banks may be specialized in specific segments of the market, we introduce maturity-bank fixed effects.

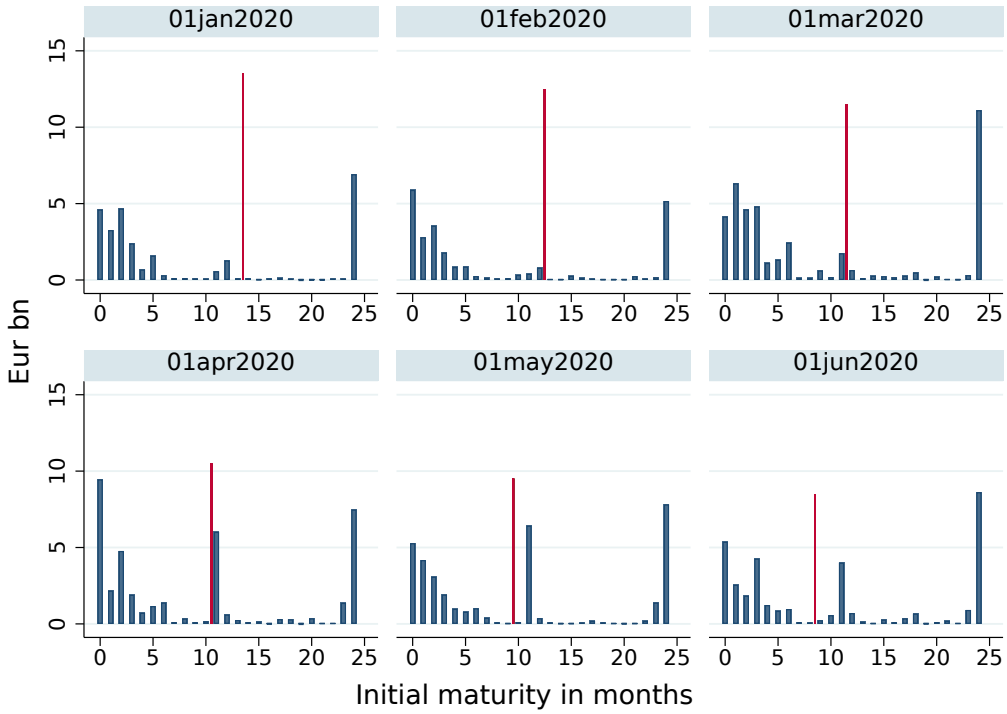
We run our regressions only on banks that participated to TLTRO III, because almost all banks participated, except few small banks that are arguably not comparable with the rest of the sample (see section 3). Our baseline regression looks as follows:

$$log(NewLoans)_{b,f,m,t} = \beta_t * Eligible_{b,f,m,t} + FE_{b,t} + FE_{f,t} + FE_{m,b} + \epsilon_{b,f,m,t} \tag{14}$$

Where, $ln(NewLoans)_{b,f,m,t}$ is the logarithm of the total amount of new loans (in euros) granted by bank b, to firm f, with a maturity m at time t.[29] $Eligible_{b,f,m,t}$ is a dummy variable equal to 1 when the loan matures after the cut-off date of 31st March 2021, and 0 otherwise. The β_t's are the coefficients of interest and measure the effect of being an "eligible" loans at each quarter, obtained by interacting the "eligible" dummy with a dummy for each quarter. We expect them to be significant only after the announcements of the TLTRO in late March 2020. $FE_{b,t}$, $FE_{f,t}$, $FE_{m,b}$ are respectively bank-time, firm-time, and maturity-bank fixed effects. This last fixed effect intends to control for the maturity of loans granted by each bank, in order to take into account any deformation of the maturity structure of the loan portfolio of banks related to the TLTRO or other events. The maturity is defined as the quarter when the loan matures minus the quarter when the loan was settled. We cluster standard errors at the bank-time level.

[29] We aggregate loans when one given firm borrowed several times from the same bank, during the same quarter at the same maturity.

Figure 11: Maturity structure of new loans in the sample



Note: This figure shows the maturity structure at of new loans for each month. The last bar (24 months) aggregates all loans with 2 years maturity or above. The vertical line represents 31 March 2021 and therefore included in the computation of banks lending performance.

We run placebo regressions resembling our baseline specification (equation 14) where we change the cut-off date for the variable "eligible", to confirm that the effect really comes from the parameters of TLTRO:

$$log(NewLoans)_{b,f,m,t} = \beta_t * Placebo_{b,f,m,t} + FE_{b,t} + FE_{f,t} + FE_{m,b} + \epsilon \tag{15}$$

The placebo tests consists in moving the cut-off one period (one quarter) forward, from March 31 2021 to June 30 2021.

This placebo tests come on top of our benchmark regressions where we include interaction between our eligibility variable and quarter dummies, for quarters before the announcements of TLTRO. One should expect these interactions to be insignificant. We will examine these interactions, thus performing another type of placebo test.

6.2 Results on the targeted channel

The results from our benchmark regressions are shown in table 4. The first three columns show our full sample (all banks that participated to the TLTRO III program), while the last three columns consider only banks that participated from March 2020 onward, in order to isolate better the effect of March 2020 announcements, and avoid mixing them up with those of TLTRO 2019 announcements. For each of these two samples, we try three ways to control for the maturity structure, via different fixed effects.

We find a significant and robust effect of being an eligible loan on credit supply. This effect manifest itself right after the announcement of TLTRO parameters changes in March 2020 (start of Q2 2020), as expected.[30] The effect in Q3 2020 is smaller but still large, significant and robust. Our preferred specification is in column 6 of table 4, because it uses the restricted sample, which is most likely to identify precisely the effect of 2020 announcements, and it has maturity-bank fixed effects, the most rigorous set of fixed-effects to control for the maturity structure of bank loan portfolio.

We run placebo regressions corresponding to equations (15). Results are displayed in table 5, and show that moving the cut-off date from March 2021 to June 2021 makes nearly all coefficients insignificant. It means that we are unlikely to be capturing a "short term" loans vs. "long-term" loans supply effects. With this placebo test, we are now convinced that this methodology is appropriate to identify the "targeted" effect of TLTRO, and that the last three columns of table 5 are the right benchmark.

We then test whether there is any additional effect on credit as banks borrowed more from TLTRO (as opposed to just participating or not), by running equation (16). In order to evaluate the effect of borrowing more at the TLTRO, we run the following type of regressions:

$$log(NewLoans_{b,f,m,t}) = \beta_{1,t} * Eligible_{b,f,m,t} + \beta_{2,t} * Eligible_{b,f,m,t} * log(Takeup_b) + FE_{b,t} + FE_{f,t} + FE_{m,b} + \epsilon_{b,f,m,t} \quad (16)$$

Where "$Take - up_b$" is a continuous variable equal to the maximum amount borrowed by bank b at the TLTRO III, in 2019 and 2020.

Results are shown in table 6. Our most saturated regression suggest that banks borrowing

[30] Recall that the announcement of changes in the parameters took place on 12 March 2021. Given the time needed to process the information, pass on the incentive mechanism to individual bankers and arrange loans with clients, we posit that it is reasonable to assume that the effect should not be visible before end-March 2020, end of Q1 2020.

1% more increase their supply of eligible loans by around 0.15% during the two quarters following the announcements and by 0.05% two quarters after.

6.3 Testing for the profitability channel

In order to test for the profitability channel we exploit an increase of the borrowing allowance announced by the Eurosystem in December 2020. The borrowing allowance was increased then, from 50% to 55% of the eligible loans portfolio, effective from the March 2021 TLTRO operation (operation III.7).[31] Concretely, at the time of the announcement, banks learnt that they would be able to borrow 10% more compared to their initial borrowing allowance. Moreover, the announcement provided that banks may borrow at a rate as low as -1% if they met the lending performance (still at 0%), based this time on a period going from 1st October 2020 and 31st December 2021. At this point, banks had information on their lending performance on a significant part of the reference period (from early October to end-December), much more than for the announcement of March 2020. Banks could therefore form a well informed guess on what their lending performance would be and whether they were already qualified for the preferential rate.

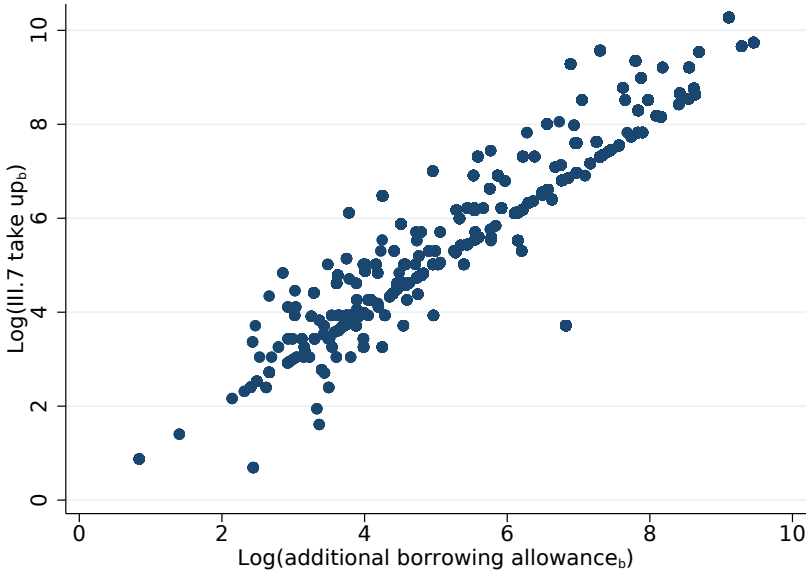
This set-up offers a good opportunity to test for the profitability channel. Our empirical strategy recognizes that borrowing to the March 2021 TLTRO are the decisions of banks, which are likely to be endogenous. However, the 10% increase in the borrowing allowance was both unexpected and exogenous to banks' decision. This makes the 10% increase, a priori, a suitable instrument.

On Figure 12 we plot the relationship between the additional borrowing allowance (10% x stock of eligible loans) at the bank level, announced in December 2020 (x-axis), and how much they borrowed at the operation immediately after (y-axis). The cross section regression for this variable delivers a coefficient of 1.02, significant at the 1% level. The R-square is 0.92 and an F-stat of around 100,000 ruling out the possibility of a weak instrument.

Together with the allowance increase announced in December 2020, the Eurosytem offered to banks the possibility to change their group composition ahead of the March 2021 operation. To avoid that banks strategic changes in the composition of their groups impact our instrument, we compute the extra allowance based on the group composition prevailing before the announcement. Thanks to this workaround, we can consider this extra-borrowing allowance as exogenous. Moreover, given the uncertainty over the size of the increase in the

[31] The loan portfolio used to compute the allowance remained unchanged during the whole TLTRO III program, and was measured as of end February 2019.

Figure 12: Extra borrowing allowances and TLTRO III-7 take up



Source: Eurosystem proprietary market operations databases.

borrowing allowance, we are confident that the change was not expected by bank and that we capture most if not all the effect.

Also, by construction, the increase in the borrowing allowance should affect loan supply only through bank's borrowing at the March 2021 operation, suggesting that the exclusion restriction is satisfied.

However, this exercise entails one additional difficulty compared to previous ones: the quarter immediately after the December 2020 was subject to two distinct reference periods. Indeed, the reference periods announced in the original program was still running (it ended on 31 March 2021). At the same time, the December 2020 announcement provided that interest rates for all future operations would be determined based on a reference period that was running from 1st October 2020 to 31 December 2021.

To avoid mixing-up the effects of the two reference periods we take the last possible data available at the time of writing (Q1 2021), and conduct a cross-sectional exercise on that quarter. We may add subsequent quarters in future versions of the paper, when they become available in Anacredit.

Our benchmark regression for this exercise writes at follows:

$$Log(NewLoans_{b,f}) = \beta_1 * Log(Takeup_{b,Mar21}) + \beta_2 * Controls_b + FE_f + \epsilon_{b,f} \qquad (17)$$

where $NewLoans_{b,f}$ is the amount of new loans granted by bank b to firm f in the first quarter 2021. $Takeup_{b,Mar21}$ is the take up of bank b at the March 2021 TLTRO operation (instrumented by the change in the borrowing allowance). We follow Benetton and Fantino (2021) for the choice of our bank-level control variables, and take all variables available in the Eurosystem IBSI database.[32] FE_f are firm fixed-effects that control for borrowers' characteristics.

The results from the second stage of this regression are shown in table 7, and point to a solid and significant relationship between TLTRO take up and loans supply (columns (1) and (2)). According to our results, a 1% increase in the TLTRO take-up raises loan supply by 0.06% to 0.07%. These results apply to all loans and are silent on the various channels.

To disentangle between the "targeted" and the "profitability" channel. We interact the variable take-up, with the dummy variables as follows:

$$Log(NewLoans)_{b,f,m} = \beta_1 * Log(Takeup_{b,Mar21}) * Eligible_m + \\ \beta_2 * Log(Takeup_{b,Mar21}) * Ineligible_m + \beta_3 * Controls_i + FE_f + \epsilon_{b,f} \quad (18)$$

where all notation are the same as in the previous equation, except "$Eligible_m$" and "$Ineligible_m$". Eligible is equal to 1 when the loan maturity date exceeds 31st December 2021 (the end of the reference period announced in December 2020) and 0 otherwise. Ineligible is equal to 1 minus eligible. Ineligible loans should be unaffected by the targeted channel, and only by the "profitability" channel.

Results for this regressions are in columns (3) and (4) of table 7. They clearly show that "ineligible" loans are impacted by TLTRO, with a 1% increase in the take-up, raising the supply of ineligible loans by 0.05% to 0.06%, suggesting the existence of a profitability channel. Moreover, and as one would expect the effect on eligible loans (which are subject to both channel) is significantly stronger (0.15% to 0.16%). This implies that the targeted channel alone is around 0.10% (0.15%-0.05% or 0.16%-0.06%), i.e. two times the profitability channel.

[32] These variables are: total amount of loans, total amount of mortgage loans, government bond holdings, equity. All variables are scaled by total assets. In the choice of controls we followed Benetton and Fantino (2021) and took the same variables as long as they were available in IBSI. We tested whether these controls would cover the same information as bank-time fixed effect by comparing regressions over a panel and replacing the bank-time fixed effects with our controls. The coefficients associated with TLTRO that we found were either not statistically different or lower with our controls than regressions with bank-time fixed effects.

To confirm this result, which has major policy implication, we determine two groups of banks, depending on their lending performance at the time of announcement of the increase in the borrowing allowance. We are especially interested in estimating the effect for banks that knew in December 2020 they already meet the lending performance, even without making additional effort. For that purpose, we create a dummy variable "$Achiever_b$" which is equal to 1 when bank b lending growth between 1st October 2020 (the start of the new reference period) and 31st December 2020 (when the announcement that this new period was introduced), exceeds 3% a level, comfortably above the 0% target set under this new program.

We compute this lending performance from the IBSI database, observing the eligible portfolio for each bank, and reconstituting the TLTRO groups as just before the December 2020 announcement. In theory, these banks know that they will meet the lending threshold even without changing their behavior, and thus should be unaffected by the targeted channel. We also look at the interaction with "$Non - achiever_b$", which is equal to $1 - Achiever_b$. Our regressions look as follow:

$$Log(NewLoans_{b,f}) = \beta_1 * log(Takeup_{b,Mar21}) * Achiever_b + \beta_2 * log(Takeup_{b,Mar21}) * (Non - Achiever_b) + \beta_3 * Controls_b + FE_f + \epsilon_{b,f} \quad (19)$$

The results from these regressions are displayed in columns (5) and (6) of table 7. As shown in our theoretical model, non-achievers are only affected by the targeted channel while achievers are only affected by the profitability channel. Non-achievers exhibit a stronger response than achievers to the TLTRO, suggesting again that the targeted channel is stronger.

At last, we also check whether incentivizing bank lending had, at some point, negative consequences for financial stability if banks grant riskier and riskier loans to meet the lending target. Figure 16 suggests instead that the weighted average default probability of new loans has remained rather stable before and after TLTROs, around 3% even in the midst of the pandemic.

6.4 Robustness

Other policy measures unrelated to TLTRO have been introduced in the wake of the pandemic. Our bank-time and firm-time fixed effects cover all country-specific time varying policies, and should control for most if not all such measures.

Still, during the pandemic, several European countries provided public guarantees for bank loans to NFCs. For the largest European countries, these guarantees stood between 60% to 90% of the loan amount[33]. Any aggregate supply effect should be effectively controlled by our set of fixed effects, in particular as schemes are country-specific. Similarly, effect from state-guarantee on firms' demand should be controlled for by the firm-time fixed effects. However, state-guarantees may still affect our identification strategy: for instance if state-guaranteed loans granted had a maturity that coincided with the way we define eligible loans under the TLTRO. To ensure our results are not affected these public schemes, we need first to identify state-guarantee loans in AnaCredit. As a general rule, we keep loans ultimately guaranteed by central governments (ESA sector S.1311) for a fraction larger than 60% of the principal amount, following Anderson, Papadia, and Véron (2020). When it is available, we also check the state-entity responsible for the state-guarantee scheme.

We check the amount of state-guaranteed loans in AnaCredit for the the four largest countries, and find an amount very close to aggregated figures provided by government to the ECB (see for instance Falagiarda, Prapiestis, and Rancoita (2020)).[34]

Equipped with a way to identify state-guaranteed loans, we are able to exclude those loans from our sample and re-run our benchmark regressions. Results are displayed on Table 8 and show that our results are preserved and robust to the exclusion of state-guaranteed loans.

In line with the literature, we have used firm-time fixed effects to control for loan demand. By construction, this excludes from the estimation firms that would contract a single type of loans (e.g."eligible") with a single bank, as we sum up eligible and ineligible loans at the quarter-firm-bank-level. Firms that contract both eligible and ineligible loans with a single bank are kept in the estimation, which theoretically may leave room for an omitted variable bias at the bank-firm relationship level. Therefore, along the lines of Khwaja and Mian (2008), we conduct a robustness check where we drop all firms that contract with only one bank, keeping effectively only "multi-bank" firms.

We run our baseline regressions on this restricted sample. Results are shown in Table 9 and are qualitatively identical to the benchmark regressions for the sample of banks that borrowed only from 2020 onward. Dropping single-bank firms weakens our results for Q3 2020.

[33]Details on these programmes can be found in Anderson, Papadia, and Véron (2020) and Falagiarda, Prapiestis, and Rancoita (2020)

[34]We were asked to take out any graphs on State-Guarantee as we are not allowed to show figures specific to single institutions (i.e. a specific public bank).

At last, we run our regressions on all types of loans (not only bullets), to make sure our results can be generalized. Results are shown in Table 10. The coefficients of Q2 and Q3 2020 are positive and significant. While other quarters show significant coefficients, Q2 and Q3 2020 are the only ones that are statistically significant robust across all sets of fixed-effects.

7 Conclusion

In this paper we have designed a new theoretical model to understand the channels through which TLTRO affects credit supply. We isolated two main channels, the targeted channel and the profitability channel. We then used a unique loan-level dataset, as well as two novel empirical strategies to estimate the real world impact of these channels. The two methods yield the same conclusion: TLTRO as calibrated after March-2020 had a significant effect on credit supply. Moreover, we found that the so-called targeted channel of TLTRO is more effective than the profitability channel.

However, we believe a caveat is in order: it might not be necessary to lend at an interest rate below the remuneration of reserves to have an effect on bank-lending. Estimates of programs with interest rate at or above the remuneration on excess reserves (e.g. VLTRO, TLTRO I, II) also found significant positive effects on lending. Kandrac (2021) also finds positive effects for a Fed program that lends to banks below market rate (but above the interest on reserves). Moreover, our theoretical model suggests that a positive effect on lending can be achieved as long as the most generous interest rate is below the comparable market rate, and does not need to be below the central bank remuneration of excess reserves.

This is a crucial distinction because the central bank can lend below market rates for three years without lowering its profits. As the only agent facing no liquidity risk in its own currency, the central bank has probably a marginal value for term liquidity that is lower than the market. But when the central bank lends below the interest rates on excess reserves it voluntarily lower the remittances it makes to the fiscal authority. Such a policy may need careful considerations. Based on a study on 150 central banks over 20 years, Goncharov, Ioannidou, and Schmalz (2021) show that central bankers do change their behavior to avoid reporting negative profits. Ultimately, profit considerations might alter their actions.

More fundamentally, such programs bear the question of whether the capital of the central bank is something central bankers are supposed to protect or whether it can be used as a policy tool, and if so in which circumstances.

A Tables

A.1 Descriptive statistics: regression sample

Table 2: Summary statistics

Variable	Obs	Mean	Std. Dev.	P10	P25	P50	P75	P90
Panel A: Regression sample - New loans								
Loan amount outstanding	994778	357959.2	1329165	10000	24800	62499.94	200000	600000
log(outstanding)	994778	11.18	1.65	9.21	10.12	11.04	12.21	13.3
Residual mat. (qtr)	994778	2.73	4.77	0	1	1	4	4
Panel B: Eligible new loans								
Loan amount outstanding	232819	466068.5	1686489	15203.64	30000	70000	200000	749000
log(outstanding)	232819	11.4	1.59	9.63	10.31	11.16	12.21	13.53
Residual mat. (qtr)	232819	7.57	7.93	3	4	4	5	22
Panel C: Ineligible new loans								
Loan amount outstanding	761959	324926	1196983	8550	21216	60442.1	199000	573744.5
log(outstanding)	761959	11.11	1.66	9.05	9.96	11.01	12.2	13.26
Residual mat. (qtr)	761959	1.25	1.03	0	1	1	2	2
Panel D:Number of banks and firms across specifications								
Number of unique banks								1784
Number of unique banks - bidding post Mar 2020								987
Number of unique banks - bidding post Mar 2020 but not before								592
Number of unique firms								424,466
Number of unique firms, multi-banks								33,079

A.2 Additional descriptive statistics - Anacredit granular data, before collapsing by quarter, all amortization type (Type instrument "1004")

Table 3: Summary statistics - Anacredit full sample, loan-level

Variable	Obs	Mean	Std. Dev.	Min	Max	P10	P25	P50	P75	P90
Panel A: All new loans										
Loan amount outstanding	17618639	186066.1	3091927	10	2.32e+09	2490	8346	23200	50716	175748
log(outstanding)	17618639	9.99	1.72	2.3	21.56	7.82	9.03	10.05	10.83	12.08
original mat. (yrs)	17618639	2.23	3.62	0	94.64	.17	.25	.58	3.03	6
residual. mat.	17618639	2.18	5.74	0	979.15	.16	.25	.5	3	6
Panel B: Eligible new loans										
Loan amount outstanding	7026753	284429.5	3256834	10	1.62e+09	7893.09	18829.73	33830.17	100000	318225.7
log(outstanding)	7026753	10.67	1.58	2.3	21.21	8.97	9.84	10.43	11.51	12.67
original mat. (yrs)	7026753	4.86	4.58	0	94.64	.5	1.5	4.94	6	10
residual mat.	7026753	4.82	8.41	.08	97.91	.5	1.5	4.42	6	9.91
Panel C: Ineligible new loans										
Loan amount outstanding	10591886	120810.9	2975698	10	2.32e+09	1648.83	4960	15669	35261.8	91682.15
log(outstanding)	10591886	9.54	1.66	2.3	21.56	7.41	8.51	9.66	10.47	11.43
original mat. (yrs)	10591886	.48	.47	0	3.56	.13	.24	.3	.52	1
residual mat.	10591886	.42	.41	0	2.5	.08	.17	.25	.5	1

A.3 Results

Table 4: Time decomposition of the effect - baseline sample of bullet loans

This table reports the coefficients of equation 14. The dependent variable is the log amount of new loans. Independent variables are the interactions of a dummy taking one when the loan is "eligible", ie. maturing after 31 March 2021 and a quarter-dummy. All specifications include bank-time and firm-time fixed effects and vary with respect to maturity fixed effects. *Maturity* is a fixed effect for the initial maturity (in quarter), controlling for the average amount of loans of a given maturity. *Maturity* × *Country* and *Maturity* × *Bank* controls for possible heterogeneity in the maturity structure of loans between countries and banks. Columns 1-3 run these specifications for all banks that bid at least to one of the post Mar-2020 TLTRO operations, while columns 4-6 restrict the sample to banks that bid post Mar-2020 but not before.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	No 2019 bid.	No 2019 bid.	No 2019 bid.
Eligible x Q1 2019	-0.104	0.0198	-0.0706	-0.294*	-0.128	-0.105
	(0.131)	(0.124)	(0.100)	(0.167)	(0.104)	(0.0885)
Eligible x Q2 2019	-0.271*	-0.130	-0.209**	-0.323	-0.203	-0.162
	(0.149)	(0.115)	(0.100)	(0.221)	(0.129)	(0.115)
Eligible x Q3 2019	-0.0534	0.0364	-0.0182	-0.167	-0.0930	-0.0160
	(0.119)	(0.109)	(0.0834)	(0.164)	(0.102)	(0.0991)
Eligible x Q4 2019	0.0532	0.161	0.00329	-0.126	-0.0582	-0.0245
	(0.142)	(0.158)	(0.115)	(0.175)	(0.168)	(0.159)
Eligible x Q1 2020	-0.179*	-0.103	-0.124	-0.0877	-0.0566	-0.0466
	(0.0987)	(0.0976)	(0.103)	(0.125)	(0.138)	(0.146)
Eligible x Q2 2020	0.299***	0.233***	0.216***	0.398***	0.256***	0.323***
	(0.0926)	(0.0653)	(0.0579)	(0.118)	(0.0758)	(0.0686)
Eligible x Q3 2020	0.174**	0.128*	0.0868*	0.280***	0.163***	0.189***
	(0.0767)	(0.0657)	(0.0527)	(0.0856)	(0.0633)	(0.0543)
Eligible x Q4 2020	0.0632	0.0567	0.0396*	0.0369	0.0197	0.0352
	(0.0584)	(0.0583)	(0.0238)	(0.0716)	(0.0674)	(0.0403)
Bank x Time	Yes	Yes	Yes	Yes	Yes	Yes
Firm x Time	Yes	Yes	Yes	Yes	Yes	Yes
Maturity	Yes	No	No	Yes	No	No
Maturity x Country	No	Yes	No	No	Yes	No
Maturity x Bank	No	No	Yes	No	No	Yes
R^2	0.778	0.782	0.786	0.824	0.829	0.830
Observations	521421	521362	518063	216394	216324	214061

Standard errors in parentheses

Note: SE clustered at the bank-time level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Placebo (using June 2021 instead of Mars-2021 as the cut-off)

This table is the analogue of table 4 and reports the results of a placebo regression in which we define the eligible loans as loans maturing after June 2021 instead of March 2021. The dependent variable is the log amount of new loans, and controls and fixed effects are unchanged.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	No 2019 bid.	No 2019 bid.	No 2019 bid.
Eligible x Q1 2019	-0.121	0.000885	-0.132	-0.400**	-0.233*	-0.236**
	(0.135)	(0.131)	(0.105)	(0.173)	(0.122)	(0.109)
Eligible x Q2 2019	-0.362**	-0.221*	-0.324***	-0.446**	-0.327**	-0.326***
	(0.167)	(0.126)	(0.114)	(0.226)	(0.145)	(0.121)
Eligible x Q3 2019	-0.0994	-0.0177	-0.0927	-0.292*	-0.230**	-0.182
	(0.120)	(0.113)	(0.0893)	(0.153)	(0.113)	(0.112)
Eligible x Q4 2019	-0.0177	0.0964	-0.0857	-0.279*	-0.211	-0.192
	(0.144)	(0.167)	(0.119)	(0.151)	(0.171)	(0.168)
Eligible x Q1 2020	-0.238**	-0.129	-0.202*	-0.225*	-0.193	-0.225
	(0.106)	(0.113)	(0.122)	(0.124)	(0.159)	(0.158)
Eligible x Q2 2020	0.197*	0.110	0.127	0.191	0.0532	0.0857
	(0.114)	(0.0924)	(0.0905)	(0.122)	(0.104)	(0.108)
Eligible x Q3 2020	0.0638	0.0384	-0.0182	0.0266	-0.0451	-0.0526
	(0.0776)	(0.0706)	(0.0584)	(0.0933)	(0.0924)	(0.0830)
Eligible x Q4 2020	0.0909	0.0676	-0.00660	-0.0941	-0.172	-0.182
	(0.107)	(0.107)	(0.0857)	(0.100)	(0.106)	(0.124)
Bank x Time	Yes	Yes	Yes	Yes	Yes	Yes
Firm x Time	Yes	Yes	Yes	Yes	Yes	Yes
Maturity	Yes	No	No	Yes	No	No
Maturity x Country	No	Yes	No	No	Yes	No
Maturity x Bank	No	No	Yes	No	No	Yes
R^2	0.778	0.782	0.786	0.824	0.829	0.830
Observations	521421	521362	518063	216394	216324	214061

Standard errors in parentheses

Note: SE clustered at the bank-time level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Intensive margin of TLTRO borrowing

This table reports the coefficients of equation 16. The dependent variable is the log amount of new loans. Independent variables are the triple interactions of a dummy taking one when the loan is "eligible", ie. maturing after 31 March 2021, the log amount of cumulative net take-up at TLTRO III operations and a quarter-dummy. Coefficients of the simple interactions of the each terms not shown.

	(1)	(2)	(3)
	No 2019 bid.	No 2019 bid.	No 2019 bid.
Eligible x take-up x Q1 2019	0.0405	0.136**	0.126
	(0.110)	(0.0602)	(0.0910)
Eligible x take-up x Q2 2019	-0.0490	-0.0736	-0.0757
	(0.0787)	(0.0567)	(0.103)
Eligible x take-up x Q3 2019	0.0705	0.0577	0.131
	(0.0652)	(0.0637)	(0.107)
Eligible x take-up x Q4 2019	-0.0138	-0.0485	-0.0182
	(0.0664)	(0.0676)	(0.0936)
Eligible x take-up x Q1 2020	-0.00158	-0.00482	0.0704
	(0.0737)	(0.0749)	(0.0869)
Eligible x take-up x Q2 2020	0.0156	0.0532	0.151**
	(0.0844)	(0.0563)	(0.0636)
Eligible x take-up x Q3 2020	0.152***	0.163***	0.148***
	(0.0445)	(0.0469)	(0.0416)
Eligible x take-up x Q4 2020	0.0824***	0.0585**	0.0531***
	(0.0239)	(0.0265)	(0.0185)
Eligible x Time controls	Yes	Yes	Yes
Bank x Time	Yes	Yes	Yes
Firm x Time	Yes	Yes	Yes
Maturity	Yes	No	No
Maturity x Country	No	Yes	No
Maturity x Bank	No	No	Yes
R^2	0.824	0.829	0.830
Observations	216394	216324	214061

Standard errors in parentheses

Note: SE clustered at the bank-time level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Profitability channel

In this table, we regress the log amount of new loans on the TLTRO take-up in the March 2021 operation. The take-up is instrumented with the 10% surprise increase in the borrowing allowance. We restrict our sample to banks that participated in the March 2021 TLTRO operation. The variables "Achiever" and "Non-achiever" are constructed with IBSI data which typically contain only a subset of Euro-Area banks. This explains the smaller number of observations in columns (5) and (6). We choose a threshold of 3% of lending growth. We also use IBSI to get our control variables, which again explains why we have less observations when we introduce controls.

	(1)	(2)	(3)	(4)	(5)	(6)
Take-up	0.0676***	0.0636***				
	(0.00701)	(0.00965)				
Take-up x Eligible			0.151***	0.158***		
			(0.0295)	(0.0299)		
Take-up x Ineligible			0.0644***	0.0580***		
			(0.00707)	(0.00975)		
Take-up x Non-achiever					0.107***	0.143***
					(0.0164)	(0.0311)
Take-up x Achiever					0.0675***	0.120***
					(0.0181)	(0.0342)
Bank controls	No	Yes	No	Yes	No	Yes
Maturity x Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
F-stat (1st stage)	195938	92749	22239	16831	17724	3236
Observations	43267	35774	43267	35774	15377	9381

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Time decomposition of the effect - excl. state guaranteed loans

This table is the analogue of table 4 and reports the results when we exclude state-guaranteed loans linked to the Pandemic.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	No 2019 bid.	No 2019 bid.	No 2019 bid.
Eligible x Q1 2019	-0.105	0.0164	-0.0714	-0.298*	-0.131	-0.106
	(0.131)	(0.125)	(0.101)	(0.167)	(0.104)	(0.0885)
Eligible x Q2 2019	-0.274*	-0.135	-0.218**	-0.328	-0.211	-0.168
	(0.149)	(0.115)	(0.101)	(0.221)	(0.129)	(0.116)
Eligible x Q3 2019	-0.0576	0.0290	-0.0270	-0.170	-0.0959	-0.0175
	(0.119)	(0.109)	(0.0833)	(0.164)	(0.102)	(0.0991)
Eligible x Q4 2019	0.0554	0.160	0.00358	-0.128	-0.0585	-0.0262
	(0.142)	(0.159)	(0.116)	(0.174)	(0.169)	(0.160)
Eligible x Q1 2020	-0.178*	-0.104	-0.128	-0.0918	-0.0590	-0.0522
	(0.0986)	(0.0977)	(0.103)	(0.124)	(0.138)	(0.144)
Eligible x Q2 2020	0.303***	0.239***	0.214***	0.391***	0.250***	0.320***
	(0.0928)	(0.0658)	(0.0585)	(0.119)	(0.0769)	(0.0694)
Eligible x Q3 2020	0.169**	0.125*	0.0824	0.274***	0.157**	0.187***
	(0.0757)	(0.0652)	(0.0523)	(0.0830)	(0.0635)	(0.0538)
Eligible x Q4 2020	0.0639	0.0573	0.0390	0.0406	0.0231	0.0392
	(0.0593)	(0.0592)	(0.0242)	(0.0720)	(0.0677)	(0.0399)
Bank x Time	Yes	Yes	Yes	Yes	Yes	Yes
Firm x Time	Yes	Yes	Yes	Yes	Yes	Yes
Maturity	Yes	No	No	Yes	No	No
Maturity x Country	No	Yes	No	No	Yes	No
Maturity x Bank	No	No	Yes	No	No	Yes
R^2	0.778	0.782	0.786	0.824	0.829	0.830
Observations	519263	519204	515915	215533	215463	213207

Standard errors in parentheses

Note: SE clustered at the bank-time level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Robustness - Time decomposition of the effect (multibanks only)

This table is the analogue of table 4 and reports the results when we restrict to firms with new loans granted by at least two different banks, in the spirit of Khwaja and Mian (2008). The dependent variable is the log amount of new loans, and controls and fixed effects are unchanged.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	No 2019 bid.	No 2019 bid.	No 2019 bid.
Eligible x Q1 2019	-0.207	-0.0624	-0.0245	-0.238	0.208	0.283
	(0.241)	(0.176)	(0.198)	(0.342)	(0.185)	(0.242)
Eligible x Q2 2019	-0.164	-0.00696	0.0183	-0.0639	0.189	0.404
	(0.211)	(0.185)	(0.245)	(0.340)	(0.266)	(0.298)
Eligible x Q3 2019	0.0652	0.0671	-0.104	0.0340	0.0685	0.0280
	(0.145)	(0.132)	(0.150)	(0.239)	(0.172)	(0.216)
Eligible x Q4 2019	0.0202	0.0289	-0.141	0.0663	0.0476	-0.0466
	(0.149)	(0.153)	(0.145)	(0.208)	(0.222)	(0.227)
Eligible x Q1 2020	-0.0268	0.0670	-0.0516	0.154	0.175	0.0717
	(0.128)	(0.128)	(0.156)	(0.195)	(0.180)	(0.240)
Eligible x Q2 2020	0.231**	0.177**	0.224***	0.455***	0.312***	0.340***
	(0.0983)	(0.0848)	(0.0677)	(0.143)	(0.110)	(0.108)
Eligible x Q3 2020	0.0736	0.0702	0.0793	0.320***	0.249**	0.273**
	(0.0916)	(0.0946)	(0.0821)	(0.119)	(0.116)	(0.111)
Eligible x Q4 2020	0.0649	0.0629	0.0637**	0.0475	0.0460	0.0695
	(0.0410)	(0.0412)	(0.0255)	(0.0835)	(0.0780)	(0.0481)
Bank x Time	Yes	Yes	Yes	Yes	Yes	Yes
Firm x Time	Yes	Yes	Yes	Yes	Yes	Yes
Maturity	Yes	No	No	Yes	No	No
Maturity x Country	No	Yes	No	No	Yes	No
Maturity x Bank	No	No	Yes	No	No	Yes
R^2	0.710	0.712	0.712	0.767	0.770	0.768
Observations	325073	325022	322561	128960	128889	127214

Standard errors in parentheses

Note: SE clustered at the bank-time level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Robustness - Time decomposition of the effect (all types of amortization)

This table is the analogue of table 4, extending our sample of loans to all types of amortization. The dependent variable is the log amount of new loans, and controls and fixed effects are unchanged.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	No 2019 bid.	No 2019 bid.	No 2019 bid.
Eligible x Q1 2019	0.244*	0.150	0.0492*	0.488**	0.235**	0.194***
	(0.131)	(0.0957)	(0.0295)	(0.231)	(0.105)	(0.0516)
Eligible x Q2 2019	0.208**	0.133*	0.0537*	0.337*	0.117	0.102*
	(0.0944)	(0.0797)	(0.0276)	(0.196)	(0.106)	(0.0617)
Eligible x Q3 2019	0.210**	0.138*	0.0737**	0.297	0.0799	0.102
	(0.0952)	(0.0787)	(0.0313)	(0.202)	(0.116)	(0.0640)
Eligible x Q4 2019	0.162*	0.0841	0.0189	0.314	0.0768	0.0807
	(0.0934)	(0.0754)	(0.0266)	(0.191)	(0.109)	(0.0623)
Eligible x Q1 2020	0.222**	0.128	0.0494	0.456**	0.218*	0.197***
	(0.105)	(0.0911)	(0.0346)	(0.215)	(0.131)	(0.0640)
Eligible x Q2 2020	0.539*	0.375**	0.180***	0.944**	0.421***	0.290***
	(0.289)	(0.170)	(0.0360)	(0.432)	(0.133)	(0.0752)
Eligible x Q3 2020	0.263***	0.214***	0.134***	0.427***	0.288***	0.238**
	(0.0817)	(0.0579)	(0.0462)	(0.143)	(0.0817)	(0.0952)
Eligible x Q4 2020	0.130**	0.100**	0.0721***	0.154	0.0988*	0.101***
	(0.0532)	(0.0433)	(0.0194)	(0.0968)	(0.0592)	(0.0316)
Bank x Time	Yes	Yes	Yes	Yes	Yes	Yes
Firm x Time	Yes	Yes	Yes	Yes	Yes	Yes
Maturity	Yes	No	No	Yes	No	No
Maturity x Country	No	Yes	No	No	Yes	No
Maturity x Bank	No	No	Yes	No	No	Yes
R^2	0.795	0.800	0.811	0.808	0.815	0.824
Observations	2215189	2215106	2204725	861454	861372	854691

Standard errors in parentheses

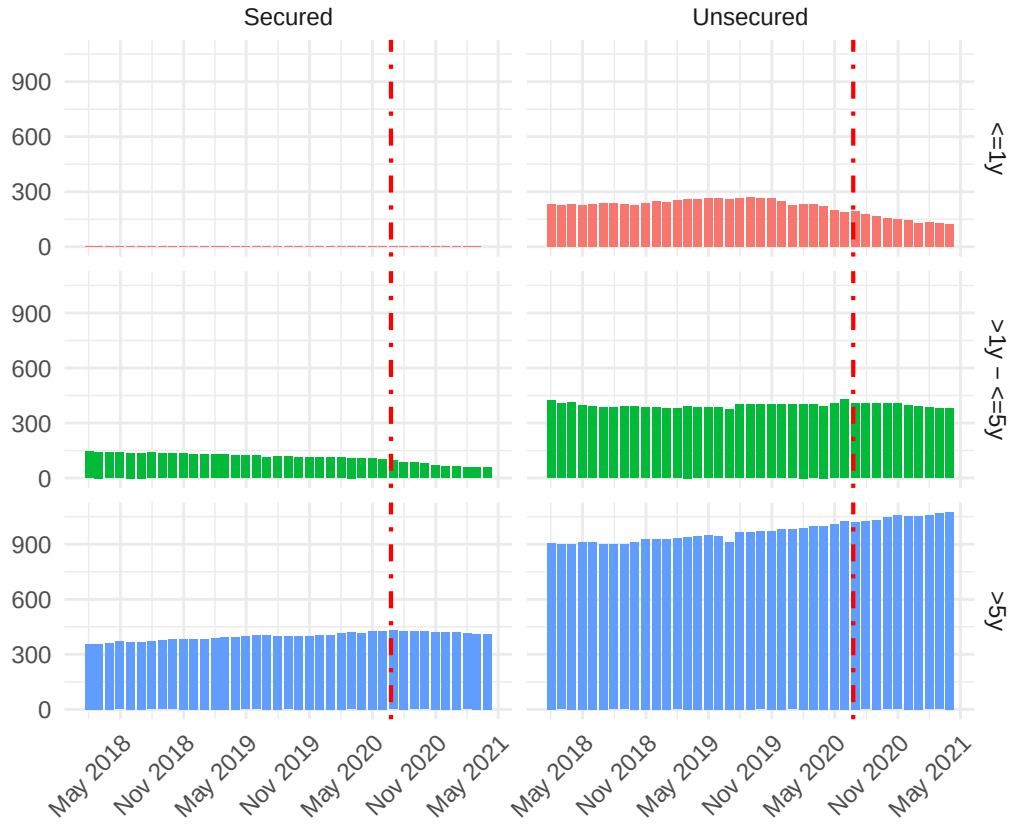
Note: SE clustered at the bank-time level

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B Appendix

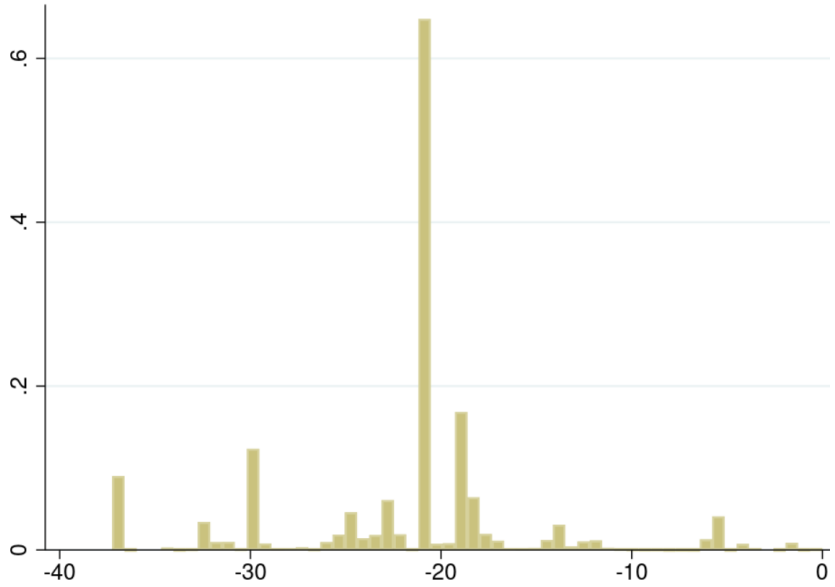
B.1 Additional graphs

Figure 13: Outstanding amount of bank debt, by initial maturity bucket and type (secured/unsecured), in Eur billion



Note: This figure shows the nominal amount outstanding of TLTRO III participating banks debts, secured and unsecured.Vertical red dotted line corresponds to the June 2020 takeup.

Figure 14: Distribution of projected loan portfolio decrease among TLTRO participating banks



Source: AnaCredit. This distribution shows the projected decline of the loans to non-financial corporations, in %, as of March 2020.

Figure 15: Lending performance proxy, according to IBSI data

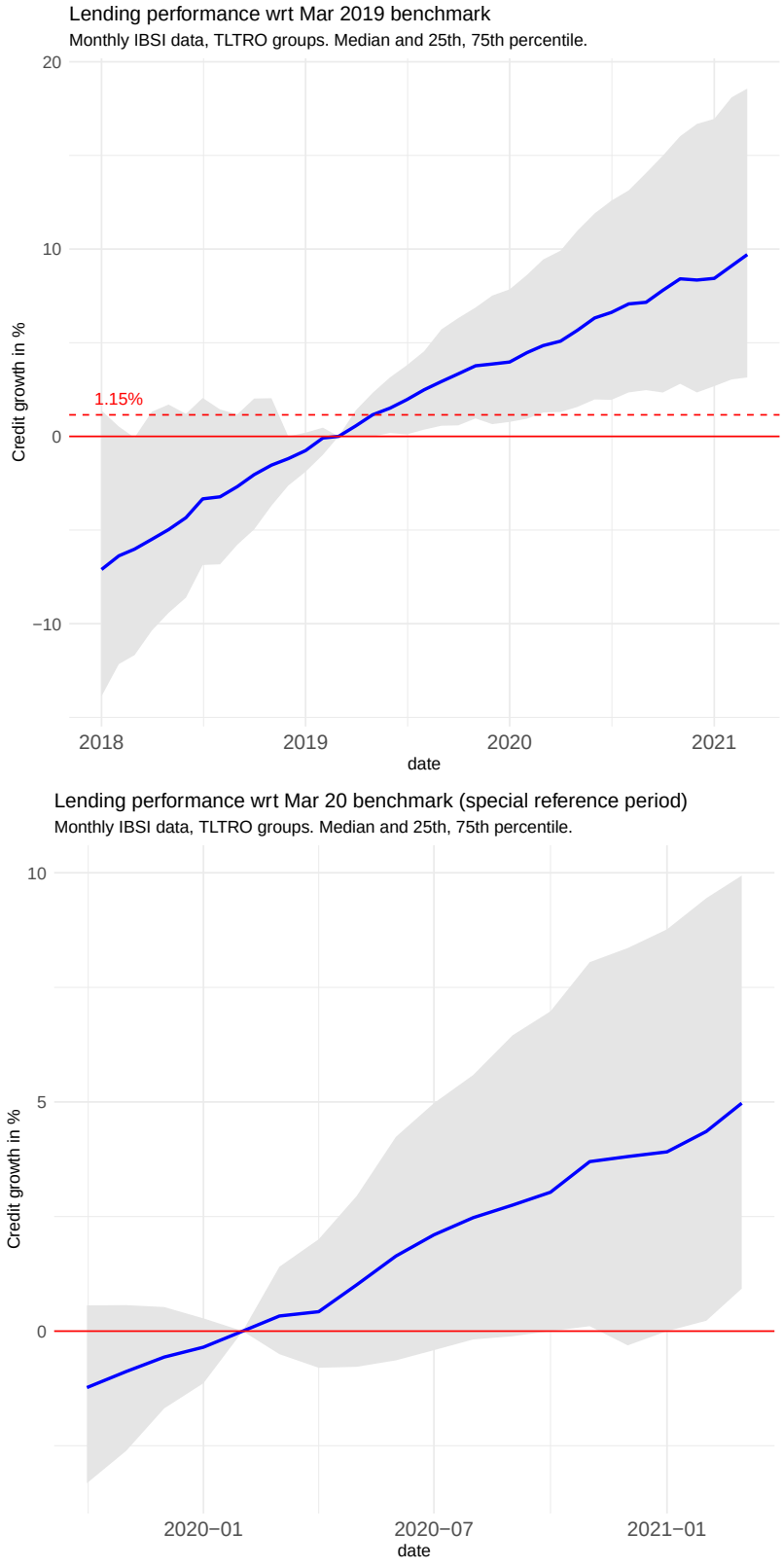
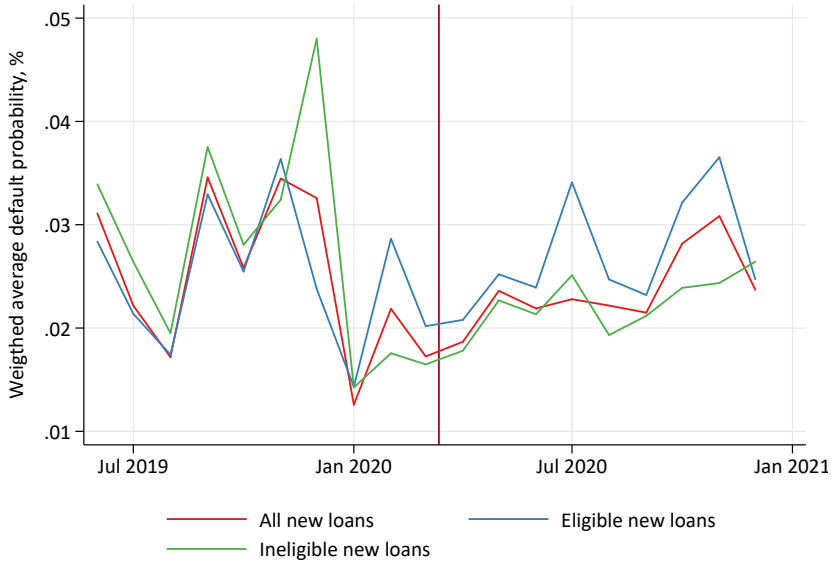


Figure 16: New loans default probability



Source: AnaCredit. This graph shows the volume-weighted average default probability of the debtors, for the new loans at each date of our data, split by eligibility status. Red vertical bar corresponds to March 2020.

B.2 Proofs of section 4

B.2.1 Case where g=0

If $g = 0$, the function $r_O(L^E)$ is never differrentiable, and we cannot use the Lagrangian to solve for L^E

Let's first look at the case where the supply of eligible loan exceeds the lending target, set by the central bank, i.e.:

$$\frac{r_E - r_M(1-\alpha) - \alpha r_D}{c} \equiv L^{E\prime} \geq \underline{\mathrm{L}} \tag{20}$$

Then the bank is not enticed to change it behavior and the solution is by:

$$\begin{cases} L^{I\star} = \frac{r_I - r_M(1-\alpha) - \alpha r_D}{c} \\ L^{E\star} = \frac{r_E - r_M(1-\alpha) - \alpha r_D}{c} \\ O^* = \bar{O} \\ D^* = \alpha(L^{E\star} + L^{I\star}) - \bar{O} \end{cases}$$

The solution remains unchanged if $L^{E\prime} < \underline{\mathrm{L}}$ and $\Pi(L^{E\prime}) > \Pi(\underline{\mathrm{L}})$ If $L^{E\prime} < \underline{\mathrm{L}}$ and $\Pi(L^{E\prime}) < \Pi(\underline{\mathrm{L}^E})$, the solution becomes:

$$\begin{cases} L^{I\star} = \frac{r_I - r_M(1-\alpha) - \alpha r_D}{c} \\ L^{E\star} = \underline{\mathrm{L}^E} \\ O^* = \bar{O} \\ D^* = \alpha(L^{E\prime} + L^{I\star}) - \bar{O} \end{cases}$$

Using the profit function one can derive the condition under which $\Pi(L^{E\prime}) < \Pi(\underline{\mathrm{L}})$:

$$\bar{O}(\bar{r_O} - \underline{\mathrm{r}_O}) > (\underline{\mathrm{L}^E} - L^{E\prime})^2 \tag{21}$$

This condition has a straightforward interpretation: in the case of a binary pricing structure ($g = 0$), and if the lending target set by the central bank is higher than the loans the bank would have supplied anyway ($\underline{\mathrm{L}^E} > L^{E\prime}$), lending is stimulated if the borrowing allowance $\bar{O}$ and the spread between the most favorable and the least favorable rate ($\bar{r_O} - \underline{\mathrm{r}_O}$) are large compared to the distance between the target set by the central bank and amount the bank would have lent in the absence of TLTRO $(\underline{\mathrm{L}^E} - L^{E\prime})^2$

B.2.2 Demand for central bank refinancing

First order conditions (FOCs) associated with equation (6) are as follows:

$$\begin{cases} L^E : r_E - O\frac{\partial r_O}{L^E} - \frac{C(L^E)}{L^E} = \lambda + \alpha\gamma \\ L^I : r_I - \frac{C(L^I)}{L^I} = \lambda + \alpha\gamma \\ M : \lambda = r_M \\ D : \lambda + \gamma = r_D \\ O : \lambda = r_O - \gamma + \delta \end{cases}$$

Combining the first FOC with the third and the fourth allows to derive equation (7). Combining the second FOC with the third and the fourth allows to derive equation (8). Combining the last three FOC, allows to derive the following condition:

$$r_D - r_O = \delta \tag{22}$$

From this condition, we can infer that:

$$r_D > r_O \iff \delta > 0 \iff O = \bar{O} \tag{23}$$

In words: as long as the interest rate from the central bank refinancing operation is larger than the interest on deposits, banks saturate their constraint.

The third and the fourth FOCs can be used similarly to show that:

$$r_D > r_M \iff \gamma > 0 \iff D + O = \alpha L \tag{24}$$

Given that $d_1 > 0$, equation (24) is always verified.

In the particular case when $r_D = r_O(L^{E\star})$, then the solution to the bank's problem is given by:

$$\begin{cases} L^{I\star} = \frac{r_I - r_M(1-\alpha) - \alpha r_D}{c} \\ L^{E\star} = r_O^{-1}(r_D) \\ O^* = \frac{gc}{r_{\bar{O}} - r_{\underline{O}}}(r_O^{-1}(r_D) - \frac{r_E - r_M(1-\alpha) - \alpha r_D}{c}) \\ D^* = \alpha(L^{E\star} + L^{I\star}) - O^* \end{cases}$$

When $r_D < r_O(L^{E\star})$, the demand for central bank refinancing drops to zero.

B.2.3 Profitability channel

Under the assumption that banks are competitive, an additional channel may kick in, that we call the profitability channel.

To see it, let's recall a couple of identities that may hold in our model. First, if we assume that all central bank asset purchase are conducted with non-banks, that in turn deposit their

liquidity with commercial banks, it must be the case that: $R = M + \bar{O}$.[35] Moreover, loans granted to the non-financial sector are settled in bank money, i.e. bank deposit, meaning that the sum of loans must equal the sum of deposits on aggregate (L=D).

The aggregate profit of the banking sector then writes:

$$r_E L^E + r_I L^I + r_R(M + O) - \bar{O}\underline{r}_O - r_D L - C(L^E) - C(L^I) = 0 \tag{25}$$

Taking the total derivative of equation (27), and using the fact that R and $\bar{O}$ are directly set by the central bank, and M is indirectly set by the central bank through its asset purchases toward non-banks allows to see how the banking sector adjusts to a decrease of r_O:

$$(r_E - r_D - cL^E)dL^E + (r_I - r_D - cL^I)dL^I = \bar{O}d\underline{r}_O \tag{26}$$

Using the equilibrium values of L^E and L^I, and $dL^E + dL^I = dL$ yields:

$$\frac{dL}{d\underline{r}_O} = \frac{\bar{O}}{(1-\alpha)(r_M - r_D)} \tag{27}$$

[35] To lighten notations, we neglect here the role of banknotes, coins and other "autonomous factor" that impact the amount of reserves R. The model can easily be extended to include them.

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