CESifo WORKING PAPERS

11116
2024

May 2024

Bank's Risk-Taking Channel of Monetary Policy and TLTRO: Evidence from the Eurozone

António Afonso, Jorge Braga Ferreira

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: https://www.cesifo.org/en/wp

CESifo *Working Paper No. 11116*

Bank's Risk-Taking Channel of Monetary Policy and TLTRO: Evidence from the Eurozone

Abstract

Using a panel data approach with bank-fixed effects, we study the impact of Targeted Longer-Term Refinancing Operations (TLTRO) on banks' risk, given by their distance to default (DtD). The study aims to determine if the liquidity from TLTROs influences banks' risk-taking behaviour. For the period from 2012:Q1 to 2018:Q4, covering 90 listed banks from 16 Eurozone countries, our findings show that TLTRO is associated with an increase in banks' default risk. However, banks that participated in TLTRO experienced a positive effect on their default risk, indicating that they may have used liquidity to strengthen their financial position. Furthermore, we found no evidence that TLTRO liquidity encouraged banks to significantly increase lending or invest in riskier assets. Finally, our results also suggest that TLTRO's impact is consistent across banks of different sizes and that the competition within the banking sector does not influence how banks utilize TLTRO liquidity.

JEL-Codes: C230, E520, E580, G210, G320.

Keywords: ECB, TLTRO, unconventional monetary policy, bank risk, moral hazard, risk-taking channel.

António Afonso
ISEG – School of Economics and Management
University of Lisbon / Portugal
aafonso@iseg.lisboa.pt

Jorge Braga Ferreira
ISEG – School of Economics and Management
University of Lisbon / Portugal
jorge.ferreira@phd.iseg.ulisboa.pt

May 2024
The authors acknowledge financial support from FCT – Fundação para a Ciência e Tecnologia (Portugal), national funding through research grants UIDB/05069/2020 and UIDB/ 04521/2020. The opinions expressed herein are those of the authors and do not necessarily reflect those of the authors' employers. Any remaining errors are the authors' sole responsibility.

1. Introduction

The global financial crisis (GFC) of 2008-09 along with the European sovereign crisis, altered the operational framework of central banks in most developed countries. Prior to these crises, central banks operated primarily using short-term interest rates to influence financial conditions and the economy. However, in response to the financial turmoil, central banks reduced their policy interest rates to near-zero levels, limiting their ability to stabilize the financial system in the face of new shocks.

The ineffectiveness of conventional monetary policy tools in stimulating the economy due to limited flexibility prompted central banks to explore unconventional monetary policies. Initially implemented as emergency measures, these unconventional policies have become more common in the past decade. The European Central Bank (ECB) is among the central banks that have adopted unconventional monetary policies, such as the introduction of Target Longer-Term Refinancing Operations (TLTRO). Launched in 2014, TLTROs provided long-term financing at favourable terms to banks in the Eurozone, encouraging increased lending to businesses and consumers to boost economic activity. TLTROs played a crucial role in transmitting monetary policy to the real economy, aiding the ECB in achieving its primary goal of price stability.

The TLTRO offers banks longer and cheaper financing compared to other funding sources, making it more appealing to them. However, the amount that participating banks can borrow and the interest rate they pay depend on their outstanding loans to businesses and consumers. These specific program features can lead to an increase in moral hazard in the financial system since the attractive funding conditions can induce banks to make riskier decisions related to their assets, known as risk-taking channel of monetary policy. In this article, we assess the presence of the risk-taking channel by estimating the impact of TLTRO on the banks' level of risk. Through this analysis, we aim to determine if this type of unconventional monetary policy can introduce moral hazard into the European financial system. For our study, we use a sample of Eurozone banks that are participants in the TLTRO and estimate the impact of the program on their default indicator.

Using 90 listed banks from 16 Eurozone countries, for the period from 2012:Q1 to 2018:Q4, our main results, show that TLTRO are linked to an increase in banks' default risk. Still, banks that participated in TLTRO experienced a positive effect on their default risk. In addition, TLTRO's impact is consistent across banks of different sizes. Lastly,

competition in the banking sector does not seem to affect how banks utilize TLTRO liquidity.

The remainder of the paper is organised as follows. Section 2 briefly reviews the ECB's TLTRO developments. Section 3 provides a literature review. Section 4 describes the methodology. Section 5 presents our dataset. Section 6 provides the empirical analysis. Section 7 concludes.

2. ECB's TLTRO I and TLTRO II

In order to contextualise, as a response to the GFC, and after Draghi's "whatever it takes" speech, it was possible to uncover evidence of a new bond-pricing regime following the announcement of the Outright Monetary Transactions (OMT) programme in August 2012 (see Afonso et al., 2018).[1] Moreover, the Governing Council of the ECB decided to conduct a series of TLTROs in June 2014 to support bank lending to households and non-financial firms, thereby enhancing the monetary policy transmission (ECB/2014/34). By providing lower interest rate funding to banks, the ECB reduces the cost of borrowing for them. Consequently, banks have an incentive to increase the supply of loans to households and firms, stimulating the real economy through higher levels of consumption and investment. This is how the ECB can improve monetary policy transmission to the real economy and simultaneously achieve its inflation targets.

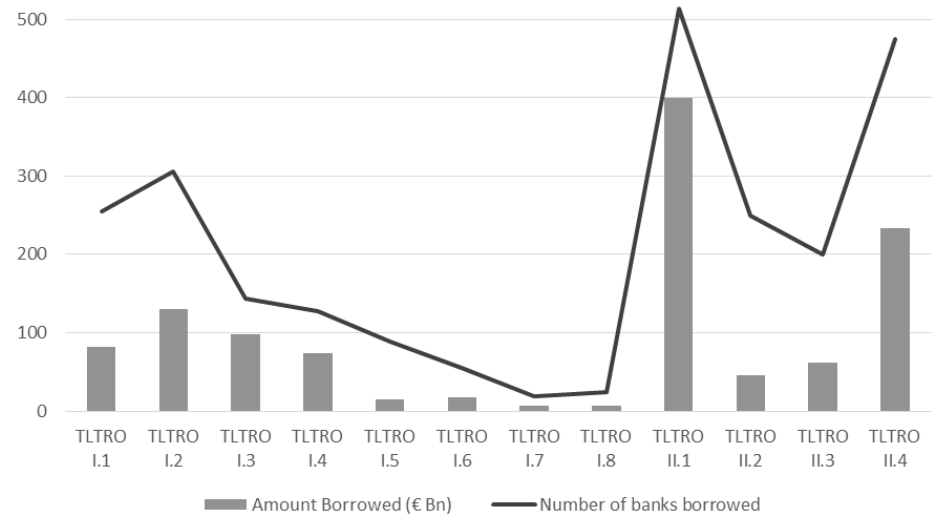
Following its decision, the ECB implemented the first TLTRO series, which covered eight quarterly operations starting in September 2014 and maturating in September 2018. In the first two operations of this series, banks were allowed to borrow up to 7% of the total amount of their loans to the non-financial private sector outstanding at the end of April 2014, excluding household loans for house purchases. In the subsequent six operations, banks could borrow if their outstanding amounts of their eligible loans exceeded a specified benchmark over a specific period. The interest rate on these operations was fixed over their life at the ECB refinancing rate prevailing at the time of acceptance, plus a spread of 10 basis points. As stated by Draghi (2014), the main concern of the ECB was to ensure that the funds support the real economy. In this sense, the ECB implemented several conditions related to the volume of banks' lending that allowed it to require the anticipated payment of the borrowings if they did not comply.

[1] The technical framework for the OMT was revealed on 6 September 2012.

The second series of TLTRO (TLTRO-II) was announced in March 2016 to strengthen the accommodative stance of the Eurosystem's monetary policy and incentivize lending (ECB/2016/10). TLTRO-II comprised four quarterly operations with a maturity of four years each. Under this series, banks were able to borrow up to 30% of their net lending to the private sector (excluding loans for house purchases) as of the end of January 2016. Although this new series is considered a continuation of the first program, it has a different approach to encouraging lending. TLTRO-II, instead of penalizing banks that do not reach the stipulated benchmark, provided lower interest rates for banks that exceeded it. Thus, the interest rate applicable to each operation in this series depended on the bank's net lending dynamics. This means that if a bank significantly increased its lending to the real economy, it would benefit from a lower interest rate. In this series, the interest rate could be lower than the deposit facility rate.

The total operations of TLTRO I and TLTRO II amounted to around €1.172 billion, with the second series concentrating a larger volume of financing and more participating banks than the first series (Fig. 1). Data from the second series indicates that the change in participation criteria may have been effective in attracting more banks and thus contributing to the ECB's main goal for this program, which is to encourage bank lending through cheaper funding.

Figure 1. Amount borrowed (€ Bn) and the number of banks that participated in each of the TLTRO I and II operations.



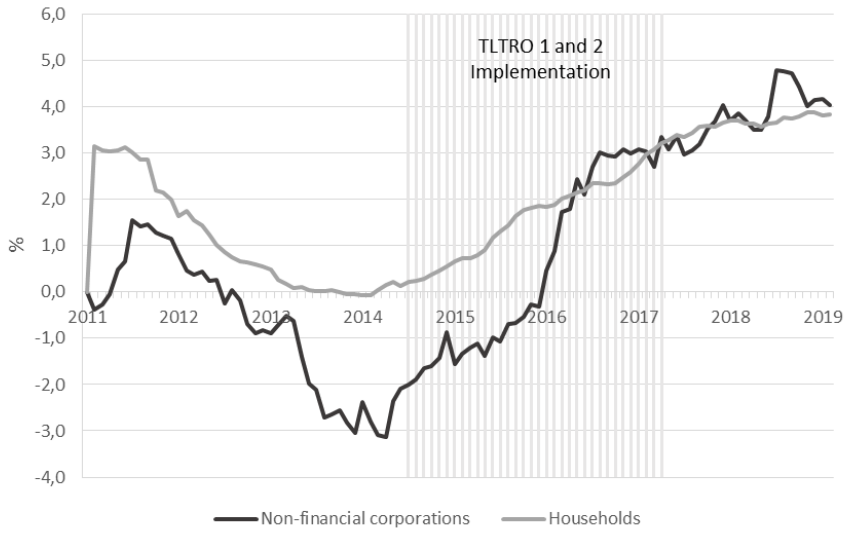
Source: ECB.

Examining the lending activity of Eurozone banks over the period 2011 to 2019 (Figure 2), we can see that lending to non-financial corporations and households started to decline

in 2012 but this trend seems to have stopped in 2014, coincidentally the year that TLTRO programs started. The growth in loans to the real economy recovered significantly from 2016, the year that TLTRO II started.

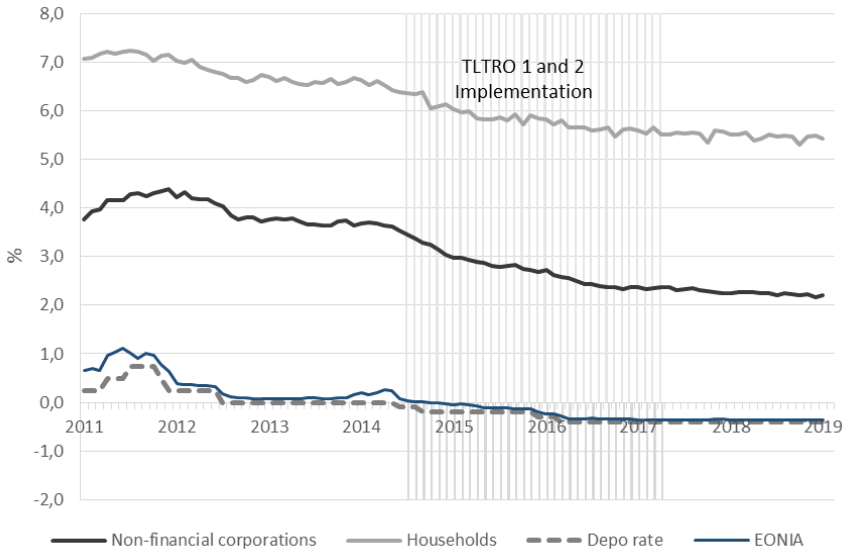
Additionally, it can be identified that the increase in loan volume was accompanied by a decrease in the average interest rate charged (Figure 3), especially in the period coinciding with the beginning of TLTRO-II, and by some easing of credit standards (Appendix Figure 1). Looking at the growth of bank assets, they registered some improvement in this period as well as the growth rate of the debt securities held (Appendix Figure 2), which provides a picture of the investment path of the banks' portfolio. These indicators can illustrate the contribution of the first two ECB TLTRO series to a change in the bank's attitude towards risk, while the programs seem to stimulate bank lending to the real economy.

Figure 2. Monthly growth rate of Eurozone bank's loans (including house purchase loans).



Source: ECB and authors' calculations.

Figure 3. Monthly average interest rate charged by Eurozone banks (excluding house purchase loans).

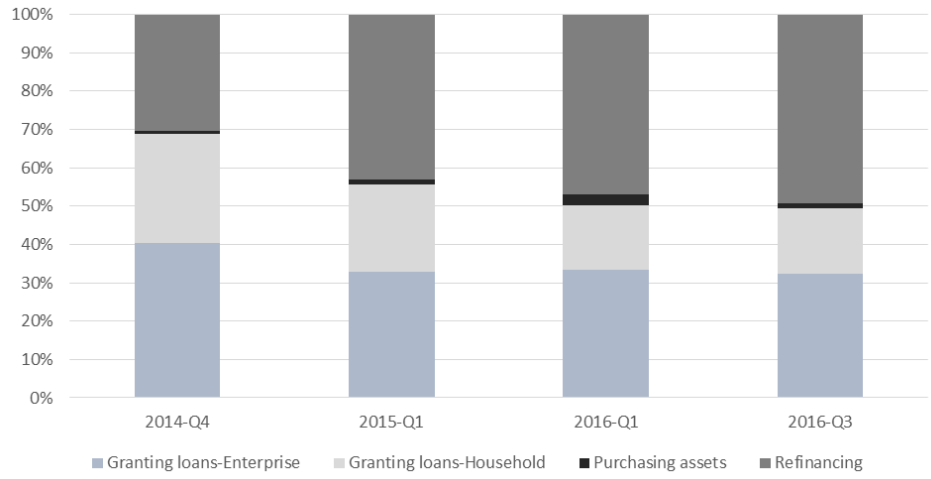


Source: ECB and authors' calculations

According to surveys conducted by the ECB between 2014 and 2016, it is observable that banks applied a significant portion of TLTRO funds to loans to households and businesses (Figure 4). However, it should be noted that banks have significantly increased their use of funds from TLTROs for refinancing purposes with the replacement of other Eurosystem liquidity operations, which does not result in funds directed to the real economy.

It is also important to analyse the reasons why banks participated in TLTROs. Additionally, during the period between 2014 and 2016, a significant percentage participated in these programs for profitability reasons with only a small percentage participating because they had insufficient demand for loans (Appendix Figure 3).

Figure 4. Bank's use of TLTRO funds (% of total banks). Based on ECB Surveys that include not only TLTRO I and TLTRO II but also past and future programs.



Source: ECB and authors' calculations.

3. Literature Overview

The TLTROs are relatively recent operations, so there is still not an extensive literature about their effects on banks and the real economy. Most of the existing studies focus on the effects of the TLTRO on the bank's lending activity to assess if the goal of expanding credit to the real economy is achieved through this program. Balfoussia and Gibson (2016) used a financial conditions index in a VAR framework to analyse the relationship between financial conditions and real economic activity in the Eurozone and Greece in particular. Based on their results, they found that financial conditions have significant effects on economic activity, and consequently, from the TLTROs, which are implemented to improve financial conditions.

Specifically, Altavilla et al. (2020) examined the pass-through of non-standard policies and found evidence that TLTRO lowered lending rates for both non-financial corporations and households, especially on participant banks. Dijk & Dubovik (2018) also noted that the TLTRO lowered interest rates on corporate loans. In turn, Benetton and Fantino (2018) studied Italy, where participant banks of the first two TLTROs lowered the average loan rate to the same firm by around 20 basis points compared to banks that did not participate in the program. Additionally, the authors found evidence that competition in the banking sector plays an important role in TLTRO pass-through on credit costs, with an increase in concentration leading to a reduction in the decline of the

cost. Andreeva and García-Posada (2019) found that TLTROs positively affect loan margins for safe borrowers without changes in credit standards. They also found that there is a positive impact on loan supply by non-bidders through an easing of credit standards due to the competitive environment. Furthermore, Afonso and Sousa-Leite (2020) used an OLS empirical regression to find a positive relationship between TLTRO and the amount of credit granted to the real economy in the Eurozone. However, in the case of Portugal, the authors did not find a statistically significant impact of the program on credit granted by banks.

Several studies on TLTROs have found evidence that these programs generally affect the volume and cost of loans granted to the real economy. Despite these effects being the main goal of TLTROs, this type of program, by providing funding at attractive conditions, can inadvertently incentivize banks to more take risks, the so-called risk-taking channel of monetary policy. When banks have access to larger and cheaper funding, they may be more willing to soften their credit policies to increase interest income and financial margins. Additionally, under TLTROs, banks can increase lending to the real economy to borrow more from the ECB at favourable interest rates. This can lead banks to increase credit to obtain cheaper liquidity for their operations. The risk-taking channel may also result in banks making riskier investments to enhance their balance sheet performance. Overall, with these incentives banks might take excessive risks, exacerbating the issue of moral hazard in the financial system.

Regarding the literature on risk-taking channels, Rajan (2005) was among the first to assess the impact of monetary policy on the increased incentive for intermediary managers to take excessive risks, driven by the "search for yield". The author suggests that "the low rates implicit in liquidity intervention could also create incentive distortions". Nicolò et al. (2010) generally support the idea that an accommodative monetary policy leads to increased risk-taking by banks in search of yield or through its effects on leverage. Additionally, Borio and Zhu (2012) emphasize the importance of evaluating the effects of changes in monetary policy on risk perceptions or risk tolerance, as liquidity and risk-taking are closely linked.

Most studies on the risk-taking channel of monetary policy primarily focus on the context of low interest rates, a situation that has been prevalent since the great financial crisis. Ioannidou, Ongena, and Peydró (2009) for Bolivia conducted one of the initial studies in the context of low US interest rates (as the Bolivian banking system is largely dollarized).

The authors found that banks not only increase the number of new risky loans but also lower the rates they charge to riskier borrowers. A similar study by Jiménez et al. (2009) found that Spanish banks tend to grant more risky loans and ease their lending standards by providing more credit to borrowers with poor credit histories. A study in Portugal by Bonfim and Soares (2018) also reached similar conclusions. In the case of the US, Dell'Ariccia, Laevaen and Suarez (2016) found evidence of the risk-taking channel of monetary policy in the country's banking system and observed that ex-ante risk-taking is inversely related to the increase in short-term interest rates. Paligorova and Santos (2017) also found that periods of monetary policy easing result in lower loan spreads for riskier firms in the US. Altunbas et al. (2010) took a broader approach by analysing the expected default frequencies of US and European banks and found that low interest rates contributed to an increase in banks' risk.

Despite the aforementioned conclusions regarding banks' risk-taking behaviour, it is important to note that bank's responses to changes in monetary policy are not uniform, and several factors can influence their reactions. Delis and Kouretas (2011) found that the negative relationship between interest rates and bank risk-taking in the euro area is more pronounced for banks with higher off-balance items and less significant for banks with higher levels of capitalization. Buch, Eickmeier, and Prieto (2014) provided evidence that in the US, small domestic banks increase their risk exposure following an expansionary monetary policy shock, while large domestic banks maintain their risk exposure. Dell'Ariccia, Laeven, and Suarez (2016) also found in the US that the effects of risk-taking depend on the level of bank capitalization, but the impact of interest rates on bank risk-taking is less pronounced for poorly capitalized banks. Additionally, Bonfim and Soares (2018) found that in Portugal the risk-taking channel is more prominent among smaller banks as they tend to lend more to non-financial firms with recent default or no credit history during periods of low interest rates.

Following the previously mentioned literature, we can deduce that TLTROs, by granting liquidity at very attractive interest rates, may have similar impacts on banks' risk perception and risk tolerance as found in the case of low policy rates. The relationship between the TLTROs and the presence of bank risk-taking is not directly addressed by the literature, with most of the research focusing on the effectiveness of those programs in increasing bank lending to the real economy as well as their impact on credit cost. However, the loans are only a part of the bank's assets and consequently, only a part in

which the presence of the risk-taking channel can be observed. The TLTROs can induce the banks to be more risk-on not only through their credit granted but also through their investment in securities, due to the "search for yield". Crosignani, Faria-e-Castro, and Fonseca (2020), by focusing on the ECB's three-year Longer-Term Refinancing Operations (LTROs) implemented in December 2011, found that the provision of longer-term funding incentives for the banks to purchase high-yield short-term securities. As the LTROs are considered the predecessors of the TLTROs, it is expected that these latter induce similar results.

Therefore, our work contributes to the growing strand of the literature that analyse the financial and economic impacts of the recent unconventional monetary policies pursued by several central banks. Our work focuses on the impact of the ECB's TLTRO on the banks' attitude towards risk, namely if these programs can induce the banks to be more risk-on by increasing their balance sheet risk level. We not only focus on the impact of TLTROs on banks' risk through changes in their lending policy perspective (Benetton and Fantino, 2018; Dijk & Dubovik, 2018) but from a general risk perspective as assumed by Altunbas et al. (2010) for the low-interest rate context. Since the ECB's TLTRO was implemented in the context of low interest rates in the Eurozone, our study also contributes to understanding if these programs exacerbate the presence of the bank's risk-taking channel in this context, thus contributing to this strand of literature (Jiménez et al., 2009; Bonfim and Soares, 2018; and Altunbas et al., 2010).

4. Methodology

In this study, the default risk is captured by a distance to default (DtD) measure that is computed according to a Merton (1974) type option-based model defined as follows:

$$DtD_t = \frac{\ln\left(\frac{V_A}{D_t}\right) + \left(r - \frac{1}{2}\sigma_A^2\right)(T-t)}{\sigma_A\sqrt{(T-t)}} \qquad (1)$$

where V_A denotes the current value of bank assets, D represents the face value of the bank's debt, σ_A denotes the volatility of the bank's assets, $T-t$ is the time to maturity and r is the expected rate of return on the bank's assets. The DtD is a market-based measure of corporate default risk and is widely used in the literature as a measure of bank default. This indicator is based on market prices which include the expectations of market

participants regarding the underlying, making it a potential comprehensive source of forward-looking information.

Despite the simple assumptions used to derive the DtD, this indicator has been proven as a strong predictor of default. Gropp, Vesala and Vulpes (2006) found evidence that DtD is a complete and unbiased estimator of bank fragility that displays lead times of 6-18 months in the case of EU banks. Singh, Gómez-Puig and Sosvilla-Rivero (2015) computed and analysed the DtD of a representative set of banks in the European Economic and Monetary Union (EMU) between 2004 and 2013 and found that this indicator has better predictive power than regulatory risk measures. In turn, Harada, Ito and Taka (2013) examined the movements of DtD for failed Japanese banks and found that this indicator has higher predictive power and quality than other measures. Also for EU banks, Koutsomanoli-Filippaki and Mamatzakis (2009) found evidence that the DtD indicator may act as a warning for both financial instability and inefficient operation.

The DtD measures the distance that a bank's market asset value is from its default point, scaled by the standard deviations of their assets, where a lower value indicates a higher probability of a bank's default in the perception of market investors. We calculate the DtD following the KMV method (Crosbie and Bohn, 2003), which is the standard method used in the literature. In this approach, the default point for a bank generally falls between its total liabilities and its short-term liabilities, rather than when bank's asset value equals the book value of its total liabilities. The amount of debt D_t is calculated as the sum of the bank's total short-term liabilities, including deposits, plus half of the long-term liabilities, assuming a maturity of one year $(T - t)$. The expected rate of return on the bank's assets, *r*, is assumed to be equal to the risk-free rate in the economy, which in our case is the one-year German government bond yield. The current value of the bank's assets, V_A, and the volatility of the bank's assets, σ_A, are not directly observed, so we need to calculate these unknown quantities. To estimate them, the KMV (Kealhofer-Merton-Vasicek) approach applies Merton's (1974) idea that the company's equity can be modelled as a call option on the company's assets. The bank's equity value, E_t, can be obtained using the Black and Scholes (1973) option pricing model, as shown in the following equation:

$$E_t = V_t N(d_1) - D_T e^{-r(T-t)} N(d_2), \quad (2)$$

where $d_1 = \frac{\ln\left(\frac{V_A}{D_t}\right)+\left(r+\frac{1}{2}\sigma_A^2\right)(T-t)}{\sigma_A\sqrt{(T}-t)}$, $d_2 = d_1 - \sigma_A\sqrt{T-t} = DtD_t$ and N(.) represents the cumulative distribution function of the standard normal distribution. The equity is directly observable on the stock market. We use the bank's debt data and the risk-free rate to calculate the unknown variables of the market value of assets and their volatility. To relate the observable data with those two variables, the KMV approach shows that equity and asset volatility are related by the following equation:

$$\sigma_E = \frac{V_A}{E_t} N(d_1)\, \sigma_A \tag{3}$$

Equity volatility can be estimated using historical data. This allow us to create an equation system with the last two equations, enabling us to calculate the unknown variables.[2]

5. Data

Our research covers the period from January 2012 to December 2018, examining an unbalanced panel dataset consisting of quarterly balance sheet data from 90 Eurozone banks. This information was obtained from Bloomberg, Moody's Analytics BankFocus and complemented with financial reports from the respective banks. Quarterly data is preferred as it is considered more appropriate for measuring the short-term impact of monetary policy changes over time.

The sample includes only listed banks from 16 Eurozone countries: Belgium (BE), Germany (DE), Estonia (EE), Ireland (IE), Spain (ES), France (FR), Italy (IT), Cyprus (CY), Lithuania (LT), Malta (MT), Netherlands (NL), Austria (AT), Portugal (PT), Slovenia (SI), Slovakia (SK) and Finland (FI). Listed banks are the only ones considered because they have more complete and reliable information available, allowing for a feasible calculation of DtD through the methodology described above. Hence, banks headquartered in these countries, actively listed on a stock exchange throughout the

[2] To solve the system of equations, we follow the framework used by Löffler and Posch (2007). We need to assign initial feasible value for both unknown variables, the asset value, and asset volatility. For the asset value, we assume the initial value as the sum of the market value of equity plus the book value of liabilities. As for the asset volatility, we assume an initial value based on equation (3) by solving it for σ_A and assuming $N(d_1) = 1$ which leads to the following expression: $\sigma_A = \frac{E_t}{A_t}\sigma_E$. The solution to the equation system is obtained when the difference between the model values and the observed values is zero, so we minimize the sum of squared differences between the model equity value and observed value: $(Model\ E_t/Observed\ E_t - 1)^2 + (Model\ \sigma_E/Observed\ \sigma_E - 1)^2$.

research period, and with available information are included. Additionally, banks that had subsequently merged or been acquired, but were independent entities during the period under analysis, were also included. Furthermore, only the parent firms were considered through their consolidated accounts, except for listed subsidiaries of non-Eurozone banks in the specified countries. For the analysis, only financially healthy banks were considered, defined as those with a positive DtD throughout the period under analysis. Table A1 and Table 2 provide an overview of the countries and banks included in our analysis.

The funding amounts received by banks through the TLTRO program are confidential and not publicly disclosed. To provide insight into this matter, we utilized available information from Bloomberg, which we believe offers a reasonable estimate of the actual TLTRO funding received by the banks, considering the confidentiality of such data. For the banks in our sample, their participation was cross-verified by consulting publicly available information, including financial reports. This verification process enhances the accuracy of our dataset by confirming that the identified banks participated in TLTRO transactions. Additionally, for banks not included in the Bloomberg sample, an investigation was conducted using public information to confirm their potential participation in the program, and in confirmed cases, the information was included. Based on the available TLTRO data, we calculate the outstanding amount borrowed for each bank at the end of each quarter, including amounts borrowed from the bank's subsidiaries in the Eurozone.

The DtD metric is used to assess a bank's default risk and is calculated quarterly following the methodology outlined in the methodological section. For this methodology, the bank's market capitalization and the book value of the bank's liabilities are sourced from Bloomberg, supplemented with data from the bank's financial reports. To determine the bank's equity volatility, a crucial parameter in this approach, we compute the annualized volatility using daily prices over the past 12 months. The pricing data used is sourced from Bloomberg, Refinitiv, and Moody's Analytics BankFocus, and selected based on data availability. The risk-free rate is assumed to be the one-year German government bond yield, also obtained from Bloomberg sources.

In our study, we control for several factors that influence individual banks' default risk at different levels. At the bank level, we consider balance sheet characteristics using the

CAMEL approach, which includes Capital adequacy, Asset quality, Management capability, Earnings and Liquidity indicators.[3] Additionally, we account for bank size by measuring the log of the total bank's market capitalization, as larger banks are typically associated with diversified assets that may reduce default risk.[4] We also address banking sector concentration by incorporating the Herfindahl-Hirschman Index (HHI), which reflects the distribution of market share within the sector[5]. Furthermore, we include variables representing Eurozone macroeconomic conditions, such as nominal GDP growth, inflation[6] and interbank interest rate. These factors influence default risk through their impact on loan defaults, profitability, borrower quality, and financing costs. We control for the interbank interest rate because its record low levels, may have contemporarily contributed to a change in default bank risk. Quarterly observations for the macroeconomic control variables were collected from various sources, including Bloomberg, the ECB Statistical Data Warehouse, and national statistics institutes. For the HHI index, it is important to note that only annual data are available. Therefore, in our analysis, we considered the annual values for each of the four quarters. In turn, the 3-month Euribor serves as a proxy for the interbank rate in our analysis.

As mentioned, our study only includes banks listed on stock exchanges to obtain feasible inputs for calculating the DtD metric. This limitation may influence the interpretation of our findings, as they might be representative only of listed Eurozone banks and not of the entire banking sector. However, it is crucial to acknowledge that listed banks are subject to greater transparency in their disclosures to the public through more detailed financial statement that can be used to obtain reliable bank-specific indicators (Eichler and Sobanski, 2016). Additionally, it is worth noting that most of the largest and systemic Eurozone banks are publicly listed, highlighting the significance of our study results.

[3] This approach provides useful information about the current conditions and performance of banks (Barker and Holdsworth, 1993; Hirtle and Lopez, 1999).

[4] Larger banks typically have a higher level of asset diversification, which may lead to a significant reduction in firm-specific risk (Demsetz and Strhan, 1997).

[5] According to the existing literature, competition can have an ambiguous impact on a bank's default risk (Caminal and Matutes, 2002; Boyd and De Nicoló, 2005). Greater competition can add pressure on the bank's margin which can induce them to take more risk (Keeley, 1990; Hellmann, Murdock and Stiglitz, 2000). On the other hand, we can assume that higher competition can lead to lower borrowing costs for entrepreneurs, which can boost their potential investment returns.

[6] Higher inflation levels negatively affect the bank's profitability (Boyd, Levine and Smith, 2001; Cetin, 2019) and can attract borrowers with lower quality (Boyd and Champ, 2006).

6. Empirical analysis

6.1. Baseline

To address unobserved heterogeneity among banks, we adopt a panel data approach that incorporates bank-fixed effects into the model. This decision is supported by the results of the Hausman test, which suggests a preference for fixed effects over random effects. Additionally, standard errors are clustered by bank to account for potential correlations within banks over time. The baseline model is expressed as:

$$DtD_{b,c,t} = \alpha DtD_{b,c,t-4} + \beta\left(Partic_b \times TLTRO_{b,t-1}\right) + TLTRO_{b,t-1} + \gamma X_{b,c,t} + \rho Z_{c,t} + \delta_b + \varepsilon_{b,c,t} \quad (4)$$

where $DtD_{b,c,t}$ represents the distance to default of bank *b* in country *c* in quarter *t*. The bank's distance to default is regressed on its value from four quarters ago to explore how past levels influence the current state, considering potential seasonality or temporal patterns in the data.

To comprehensively analyse the relationship between TLTRO and DtD while addressing potential endogeneity concerns, lagged TLTRO variables are applied. This approach ensures a robust analysis of the causal relationship between TLTRO and DtD, accounting for any contemporaneous correlations and potential endogeneity issues. The analysis includes a participation indicator ($Partic_b$), a dummy variable that equals 1 if the bank participated in the TLTRO program and 0 otherwise, to assess the impact on DtD and capture inherent differences in risk profiles and behaviours between participating and non-participating banks.

Furthermore, an independent TLTRO variable ($TLTRO_{b,t-1}$) is included to capture not only the direct effect of TLTRO on the banks' DtD, but also potential indirect effects, irrespective of individual bank participation. This inclusion helps to mitigate possible omitted variables bias by broadly capturing direct and indirect effects of TLTRO on bank's financial metrics and market dynamics.

The bank's DtD is also regressed on a vector of time-varying control variables at the level of individual bank *b*, country *c*, in quarter *t* ($\gamma X_{b,c,t}$) which includes the natural logarithm of market capitalization and five ratios' representative of the five elements of the CAMEL

approach[7]. Furthermore, DtD is regressed on the country's macroeconomic indicators ($\rho Z_{c,t}$) at quarter *t*, including the nominal inflation rate, interbank interest rate and nominal GDP growth rate. Bank-fixed effects, δ_b, are included to control for unobserved characteristics that may affect DtD. The error term in the model is represented by $\varepsilon_{b,c,t}$. Table A2 reports the summary statistics of the variables used in the baseline equation, as well as the variables used in the extensions described below.

The results of the baseline regression (4) are presented in column (I) of Table I. The results show a statistically significant negative impact of TLTRO on the banks' DtD. This finding suggests that the presence of TLTRO is associated with a decrease in the bank's DtD, indicating a potential weakening of their financial health. Although the exact mechanisms that determine this negative impact are not directly observed in this model, it is reasonable that factors related to TLTROs, such as changes in liquidity conditions, risk-taking behaviour, market dynamics or perception of markets about the banking system's stability, contribute to this effect. Most of those factors can have a more pronounced effect on listed banks, which is the focus of this study. In turn, the interaction term between dummy participation and TLTRO has a significant and positive impact on the bank's DtD, which indicates that the impact differs based on the bank's participation. The results suggest that banks that actively participate in TLTROs experience an improvement in their risk profile, an indication that those banks may have utilized TLTRO's liquidity to strengthen their financial position. Thus, bank participation in TLTROs appears to have a risk mitigation benefit.

The results also identify other factors influencing DtD, including market capitalization, liquidity, asset quality, and macroeconomic conditions. Larger banks tend to exhibit a higher DtD, possibly reflecting their asset diversification benefits (Demsetz and Strhan, 1997) but also the higher systemic risks (Laeven, Ratnovski, and Tong, 2016) that lead to more intense regulation and supervision by authorities. Banks with stronger liquidity positions can gain market confidence in their risk management (Calomiris et al. 2015), while conservative provisioning, which explicitly anticipates future loan losses, is associated with a higher level of risk-taking discipline (Bushman and Williams, 2012).

[7] The variables analyzed in the study are the common equity to total assets ratio (C), provisions for loan losses to total loans ratio (A), loan-to-deposits ratio (M), operating income to total assets ratio (E) and cash and securities to total deposits ratio (L).

Moreover, GDP growth, inflation, and interest rates have a positive and statistically significant impact on bank's DtD.

TABLE I. Regressions results for equations 1 to 5.

	(I)	(II)	(III)	(IV)	(V)
$DtD_{b,c,t-4}$	0.113**	0.121**	0.131**	0.123**	0.088
	(0.044)	(0.048)	(0.050)	(0.057)	(0.064)
$(Partic_b \times TLTRO_{b,t-1})$	2.839***				
	(0.318)				
$(Partic_b \times TLTRO_{b,t-1})$*Log Mark. Cap*		0.343			
		(0.285)			
$(Partic_b \times TLTRO_{b,t-1})$*LTA*			0.003		
			(0.006)		
$(Partic_b \times TLTRO_{b,t-1})$*STA*				0.004	
				(0.005)	
$(Partic_b \times TLTRO_{b,t-1})$*HHI*					0.001
					(0.000)
$TLTRO_{b,t-1}$	-1.747***	-0.242	0.830*	0.985***	0.595
	(0.267)	(1.014)	(0.455)	(0.321)	(0.482)
Market Cap (log)	2.077***	0.765	2.081***	1.824***	2.150***
	(0.464)	(1.178)	(0.473)	(0.465)	(0.505)
Common equity to total assets	0.014	0.011	0.008	0.022	0.018
	(0.031)	(0.030)	(0.035)	(0.031)	(0.033)
Provisions for loan losses to total loans	0.104**	0.090*	0.098*	0.082	0.104*
	(0.049)	(0.049)	(0.054)	(0.050)	(0.054)
Total Loans to total deposits	-0.005	-0.005*	-0.006*	-0.007**	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Operating income to total assets	0.070	0.064	0.082	0.004	0.038
	(0.085)	(0.094)	(0.081)	(0.109)	(0.095)
Cash and securities to total deposits	0.022**	0.022**	0.024**	0.020*	0.022**
	(0.009)	(0.009)	(0.010)	(0.011)	(0.009)
Inflation	0.241**	0.237**	0.245**	0.346***	0.135
	(0.099)	(0.102)	(0.098)	(0.100)	(0.124)
Interest rate	1.529***	1.555***	1.597***	1.968***	1.459**
	(0.563)	(0.562)	(0.566)	(0.499)	(0.569)
GDP growth	0.199***	0.194***	0.198***	0.195**	0.199**
	(0.065)	(0.066)	(0.065)	(0.093)	(0.074)
Constant	-8.650***	-3.843	-8.742***	-7.684***	-8.833***
	(2.184)	(4.309)	(2.116)	(2.221)	(2.254)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	470	470	470	421	470
R^2	0.0240	0.0601	0.0614	0.1711	0.1312
Within R^2	0.3089	0.3078	0.3043	0.3262	0.3261

Clustered (banks) standard-erros in parentheses
(* 0.1 ** 0.05 *** 0.01)

In the first extension of the baseline equation (4) we introduce an interaction of the natural logarithm of market capitalization, $LogMarkCap_{b,c,t}$. This interaction was introduced based on the understanding that the size of banks can play a crucial role in their strategies and attitudes towards risk. The inclusion of this variable aims to capture the possible influence of bank size on their decisions regarding the use of surplus liquidity:

$$DtD_{b,c,t} = \alpha DtD_{b,c,t-4} + \beta\left(Partic_b \times TLTRO_{b,t-1}\right)LogMarkCap_{b,c,t} + TLTRO_{b,t-1} + \gamma X_{b,c,t} + \rho Z_{c,t} + \delta_b + \varepsilon_{b,c,t} \quad (5)$$

This extension resulted in some changes in the significance of certain variables, as observed in column II of Table I. The interaction term with $LogMarkCap_{b,c,t}$ was found to be not statistically significant, suggesting that the impact of TLTRO participation is consistent across banks of different sizes. The TLTRO and market capitalization individual variables lose their significance in this extension, which corroborates a uniform response to the program in terms of default risk, independently from the bank's market capitalization. Regarding the other control variables, it is worth highlighting the loan-to-deposit ratio, an approximate measure of management quality, now exhibited a slight negative significance in influencing DtD.

To further explore the potential effects of TLTRO on banks' lending and investment behaviour, we introduced other interaction terms in the baseline equation (4). To account for possible impacts on a bank's lending behaviour, we included an interaction term, $LTA_{b,c,t-1}$ (equation 6), that represents the banks' total loans to asset ratio. This analysis provides insights on how liquidity from TLTROs may influence the allocation of funds within banks, namely towards an increase of lending activities that can potentially increase their risk exposure.

$$DtD_{b,c,t} = \alpha DtD_{b,c,t-4} + \beta\left(Partic_b \times TLTRO_{b,t-1}\right)LTA_{b,c,t} + TLTRO_{b,t-1} + \gamma X_{b,c,t} + \rho Z_{c,t} + \delta_b + \varepsilon_{b,c,t} \quad (6)$$

As demonstrated by column III of Table I, the interaction term added in equation 6 is non-significant, which may indicate that the bank's participation in TLTRO did not significantly influence the banks' lending behaviour, as captured by the total loans to asset ratio. This could imply that banks did not make extensive use of the funds from TLTROs to expand their lending activities during the period observed. This also

corroborates our findings on the baseline equation that banks may use the TLTRO funds to strengthen their financial situation and liquidity by avoiding excessive risk-taking activities. In contrast to the baseline model's finding, the presence of TLTRO was associated with a slight positive impact on the bank's DtD in this extension. Again, while the exact mechanisms that can drive this positive effect are not directly observed in the model, factors such as improved lending activities may contribute to this effect.

In another extension, we introduced the interaction term, $STA_{b,c,t}$ (equation 7), which represents the bank's ratio of total trading securities to total assets, to assess the potential effects of TLTRO on the bank's investment behaviour. Trading securities are, in general, the riskiest among the other categories of securities assets, since they are often bought and sold for short-term gains, and their value can be highly volatile. The inclusion of this interaction term allows for an examination of how TLTRO may influence banks' risk appetite and investment decisions, namely in allocating funds to assets with higher volatility and shorter investment horizons.

$$DtD_{b,c,t} = \alpha DD_{b,c,t-4} + \beta\left(Partic_b \times TLTRO_{b,t-1}\right)STA_{b,c,t} + TLTRO_{b,t-1} + \gamma X_{b,c,t} + \rho Z_{c,t} + \delta_b + \varepsilon_{b,c,t} \quad (7)$$

In this extension, the interaction term is also not significant (column IV of Table I), which indicates that TLTRO participation does not appear to influence banks' allocation of funds towards assets with higher volatility and shorter investment horizons. This result implies that banks may opt to use TLTRO funds in more conservative investment strategies to strengthen their financial position. Similarly, in the previous extension, TLTRO was associated with an improvement in banks' DtD, contrasting with the findings of the baseline model.

Finally, to identify how the level of competition in the banking sector affects banks' attitude towards risk in the presence of TLTRO, we introduced another interaction term in Equation (4):

$$DtD_{b,c,t} = \alpha DD_{b,c,t-4} + \beta\left(Partic_b \times TLTRO_{b,t-1}\right)HHI_{c,t} + TLTRO_{b,t-1} + \gamma X_{b,c,t} + \rho Z_{c,t} + \delta_b + \varepsilon_{b,c,t} \quad (8)$$

where $HHI_{c,t}$ is the Herfindahl-Hirschman Index (HHI) for the banking sector in country c. The inclusion of this interaction aims to assess whether TLTRO, through its provision of additional liquidity, may affect the bank's competitive behaviour namely in a more aggressive stance to increase its market share. According to the results presented in column V of Table I, the interaction term is not significant in this extension. This finding indicates that competitiveness in the banking sector does not play a significant role in determining how banks utilized the liquidity provided by TLTRO. These results are consistent with earlier findings suggesting that banks adopted a more conservative approach to TLTRO liquidity, prioritizing financial stability.

6.2. Robustness checks

In this section, we conducted robustness checks to ensure the reliability of our results. More specifically, we assess the implications of the varied model specifications on the baseline results. The first robustness analysis was based on introducing an exclusion rule by removing countries with just one or two banks from our initial sample (as shown in Table A1). This analysis was implemented with the aim of verifying the accuracy of our results in the presence of possible outliers and minimizing the impact of idiosyncratic factors associated with smaller banking systems. This analysis consistently supported the conclusions regarding the TLTRO (see Table A5).

In the baseline analysis, we excluded banks that had financial difficulties during the period under analysis (as shown in Table A3). To test the robustness of our results, we conducted an analysis that included these distressed banks. Specifically, we identified nine distressed banks, with five banks from Greece and one each from Ireland, Portugal, Belgium and Spain. The purpose of this analysis is to assess the influence of distressed banks on the results of the baseline model, particularly regarding TLTRO. The initial findings remained consistent with the inclusion of distressed banks (see Table II), except for extension III, where TLTRO appear to be not significant, and the interaction term with $LTA_{b,c,t}$ became marginally significant. This suggests that the presence of distressed banks can also affect the relationship between these variables, which justifies additional research into the potential mechanisms leading to this effect.

TABLE II. Robustness check: Inclusion of distressed banks in the sample.

	(I)	(II)	(III)	(IV)	(V)
$DtD_{b,c,t-4}$	0.088**	0.087**	0.091**	0.088*	0.071
	(0.039)	(0.041)	(0.045)	(0.045)	(0.052)
$(Partic_b \times TLTRO_{b,t-1})$	2.513***				
	(0.320)				
$(Partic_b \times TLTRO_{b,t-1})$*Log Mark. Cap*		0.391			
		(0.280)			
$(Partic_b \times TLTRO_{b,t-1})$*LTA*			0.009*		
			(0.005)		
$(Partic_b \times TLTRO_{b,t-1})$*STA*				0.006	
				(0.004)	
$(Partic_b \times TLTRO_{b,t-1})$*HHI*					0.000
					(0.000)
$TLTRO_{b,t-1}$	-1.663***	-0.648	0.212	0.778**	0.357
	(0.265)	(1.030)	(0.419)	(0.301)	(0.484)
Market Cap (log)	1.593***	0.148	1.643***	1.392***	1.612***
	(0.383)	(1.099)	(0.379)	(0.374)	(0.417)
Common equity to total assets	0.009	0.010	-0.008	0.009	0.011
	(0.031)	(0.030)	(0.037)	(0.030)	(0.034)
Provisions for loan losses to total loans	-0.048	-0.053	-0.024	-0.062	-0.040
	(0.075)	(0.072)	(0.053)	(0.075)	(0.070)
Total Loans to total deposits	-0.011***	-0.011***	-0.012***	-0.013***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Operating income to total assets	0.111	0.096	0.134	0.035	0.098
	(0.100)	(0.096)	(0.095)	(0.112)	(0.101)
Cash and securities to total deposits	0.023**	0.022**	0.027**	0.021*	0.023**
	(0.010)	(0.010)	(0.010)	(0.011)	(0.009)
Inflation	0.280***	0.276***	0.269***	0.363***	0.199**
	(0.079)	(0.080)	(0.075)	(0.061)	(0.091)
Interest rate	1.804***	1.820***	1.894***	2.210***	1.791***
	(0.494)	(0.492)	(0.510)	(0.453)	(0.507)
GDP growth	0.207***	0.204***	0.193***	0.188***	0.217***
	(0.041)	(0.042)	(0.041)	(0.047)	(0.049)
Constant	-5.269**	0.044	-5.253**	-4.312**	-5.324**
	(2.075)	(4.116)	(2.046)	(2.090)	(2.265)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	552	552	552	503	552
R^2	0.0819	0.1650	0.1482	0.3351	0.1361
Within R^2	0.3255	0.3272	0.3326	0.3532	0.3398

Clustered (banks) standard-erros in parentheses
(* 0.1 ** 0.05 *** 0.01)

Additionally, we extended the study period to the year 2019 to cover the announcement and initial implementation of TLTRO III, a program with more flexible conditions. Regarding TLTRO participation, the results from this extension are in line with those of

the primary analysis (see Table A6), except for the interaction with the HHI index, which became slightly significant. This, along with some other variations in the significance of certain variables, suggests potential influences of TLTRO III that were not directly examined in this study.

Furthermore, we conducted robustness checks by examining various lags for the TLTRO variable. We explored a TLTRO variable with no lag and with a lag of 2 periods to capture immediate effects or more persistent delayed responses. When analysing TLTRO without any lag, the results align with our main analysis concerning the bank's participation in TLTRO and its liquidity utilization (see Table A7). While there are slight variations in the sign and significance of the TLTRO variable, as previously noted, these could be attributed to factors not directly addressed in this study. Introducing a lag of 2 periods for the TLTRO variable in our robustness checks showed that the primary analysis findings regarding TLTRO remain valid (see Table A8), with only a minor change in the significance of one interaction term, particularly with STA, which becomes slightly positive significant. This could indicate a delayed impact on the utilization of TLTRO liquidity in banking lending activities. Further research may be essential to understand the reasons behind these variations, as changes in market conditions, regulatory frameworks, or bank-specific factors over time can also play a role in these discrepancies.

In summary, the robustness checks carried out in this section confirm the consistency of the relationship between the TLTRO and the bank's DtD observed in our main analysis. Specifically, the results regarding TLTRO participation are consistently aligned with the primary analysis. The results remained robust despite some variations in the significance of certain variables. These variations may imply the presence of distinct dynamics, which could be explored in future research to uncover potential underlying mechanisms.

7. Conclusion

This study analyses the impact of TLTROs on the bank's default risk, thus assessing the bank's risk-taking channel of this unconventional monetary policy. Using panel data with bank-fixed effects for 90 listed banks from 16 Eurozone countries during the period from 2012: Q1 to 2018: Q4, we found that while TLTRO was associated with an increase in the bank's default risk, participating in the program actually reduced default risk. The

results suggest that banks used the liquidity from TLTRO to strengthen and consolidate their financial position.

We extended the baseline model to assess the influence of bank size and operational ratios on the impact of TLTRO. Our findings suggest that the effects of TLTRO are consistent across banks of different sizes. Furthermore, we observed that banks did not use TLTRO funds to significantly increase lending or invest in short-term high-volatility assets. Additionally, we explored the competitive dynamics within the banking sector and found that competition did not affect how banks utilized liquidity TLTRO liquidity. As a robustness check, we included banks that faced financial distress during the study period, and the results remained consistent.

Our findings indicate that TLTRO programs, by providing additional liquidity at a more favourable cost, contribute to strengthening the stability of the Eurozone banking sector without encouraging excessive risk-taking. The conclusions of this study add to the empirical literature that studies the effectiveness and impacts of unconventional monetary policies. Future studies could explore additional dimensions, such as the inclusion of unlisted banks, temporal dynamics, underlying mechanisms and broader macro-financial implications to provide a more comprehensive analysis of the effects of TLTROs and their role in banking sector resilience and stability.

References

Andreeva, D.C. and García-Posada, M. (2019). "The impact of the ECB's Targeted Long-Term Refinancing Operations on banks' lending policies: the role of competition". Banco de Espana Working Paper, 1903.

Afonso, A., Arghyrou, M., Gadea, M., Kontonikas, A. (2018). ""Whatever it takes" to resolve the European sovereign debt crisis? Bond pricing regime switches and monetary policy effects", *Journal of International Money and Finance*, 86, 1-30.

Afonso, A., Leite, J. (2020). "The Transmission of Unconventional Monetary Policy to Bank Credit Supply: Evidence from the TLTRO", *The Manchester School*, 88 (S1), 151-171.

Altavilla, C., Canova, F. and Ciccarelli, M. (2020). "Mending the broken link: Heterogeneous bank lending rates and monetary policy pass-through". *Journal of Monetary Economics*, 110, 81-98.

Altunbas, Y, Gambacorta, L. and Marqués-Ibáñez, D. “Does Monetary Policy Affect Bank RiskTaking?”. ECB Working Paper Series nº 1166.

Balfoussia, H. and Gibson, H.D. (2016). “Financial conditions and economic activity: the potential impact of the targeted long-term refinancing operations (TLTROs)”. *Applied Economics Letters*, 23 (6), 449-456.

Barker, D., and Holdsworth. D. (1993). “The Causes of Bank Failures in the 1980s.” Research Paper No. 9325, Federal Reserve Bank of New York.

Benetton, M. and Fantino, D. (2018). “Competition and the pass-through of unconventional monetary policy: evidence from TLTROs”. Banco di Italia Working Paper, 1187.

Black, F. and Scholes, M. (1973). “The pricing of options and corporate liabilities”. *Journal of Political Economy*. 81 (3), 637–654.

Borio, C. and Zhu, H. (2012). “Capital regulation, risk-taking and monetary policy: A missing link in the transmission mechanism?”. *Journal of Financial Stability*, 8 (4), 236-251.

Bonfim, D. and Soares, C. (2018). “The Risk-Taking Channel of Monetary Policy: Exploring All Avenues”. *Journal of Money, Credit and Banking*, 50 (7), 1507-1541.

Boyd, J.H., Levine, R. and Smith, B. D. (2001). “The impact of inflation on financial sector performance”. *Journal of Monetary Economics*, 47(2), 221-248.

Boyd, J.H. and De Nicoló, G. (2005). “The Theory of Bank Risk Taking and Competition Revisited”. *The Journal of Finance*, 60 (3), 1329-1343.

Boyd, J H., and Champ, B. (2006). "Inflation, banking, and economic growth." Federal Reserve Bank of Cleveland, 1-4.

Buch, C.M., Eickmeier, S. and Prieto, E. (2014). “In search for yield? Survey-based evidence on bank risk taking”. *Journal of Economic Dynamics and Control*, 43, 12-30.

Bushman, R.M. and Williams, C.D. (2012). “Accounting discretion, loan loss provisioning, and discipline of Banks’ risk-taking”. *Journal of Accounting and Economics*, 54(1), 1-18.

Caminal, R. and Matutes, C. (2002). “Market power and Banking failures”. *International Journal of Industrial Organization*, 20 (9), 1341-1361.

Cetin, H. (2019). “Inflation and Bank Profitability: G20 Countries Banks Panel Data Analysis”. In Proceedings of the 2019 International Conference on Management Science and Industrial Engineering (MSIE 2019), 168–172.

Calomiris, C.W., Heider, F. and Hoerova, M. (2015). “A Theory of Bank Liquidity Requirements”. Columbia Business School Research Paper No. 14-39

Crosbie, P., Bohn, J. (2003). “Modeling Default Risk: Modeling Methodology”. KMV Corporation, San Francisco.

Crosignani, M., Faria-e-Castro, M. and Fonseca, L. “The (Unintended?) consequences of the largest liquidity injection ever”. *Journal of Monetary Economics*, 112, 97-112.

Decision of the European Central Bank of 29 July 2014 on measures relating to targeted longer-term refinancing operations (ECB/2014/34).

Decision (EU) 2016/810 of the European Central Bank of 28 April 2016 on a second series of targeted longer-term refinancing operations (ECB/2016/10).

Delis, M. D. and Kouretas, G. P. (2011). “Interest rates and bank risk-taking”. *Journal of Banking & Finance,* 35 (4), 840-855.

Dell’Ariccia, G., Laevan, L. and Suarez, G.A. (2016). “Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States”. *The Journal of Finance*, 72 (2), 613-654.

Demsetz, R. and Strahan, P. (1997) “Diversification, size, and risk at bank holding companies”. *Journal of Money, Credit and Banking*, 300-313.

Dijk, M. van and Dubovik, A. (2018). “Effects of Unconventional Monetary Policy on European Corporate Credit”. CPB Discussion Paper, 372.

Draghi, M. (2014). Introductory statement to the press conference (with Q&A). Frankfurt am Main, Germany. June 5.

Draghi, M. (2014). Monetary policy communication in turbulent times. Speech by Mario Draghi, President of the ECB, at the Conference De Nederlandsche Bank 200 years: Central banking in the next two decades. Amsterdam, Netherlands, April 24.

Eichler, S. and Sobnski, K. (2016). “National politics and bank default risk in the eurozone”. *Journal of Financial Stability,* 26, 247-256.

Gropp. R., Vesala, J. and Vulpes, G. (2006). “Equity and Bond Market Signals as Leading Indicators of Bank Fragility”. *Journal of Money, Credit and Banking,* 38 (2), 399-428.

Harada, K., Ito, T. and Takahashi, S. (2013). “Is the Distance to Default a good measure in predicting bank failures? A case study of Japanese major banks”. *Japan and the World Economy,* 27, 70-82.

Hellmann, T.F., Murdock, K.C. and Stiglitz, J. E. (2000). "Liberalization, Moral Hazard in Banking, and Prudential Regulation: Are Capital Requirements Enough?". *American Economic Review*, 90 (1), 147-165.

Hirtle, B.J., and Lopez, J.A. (1999). "Supervisory Information and the Frequency of Bank Examinations." *Federal Reserve Bank of New York Economic Policy Review,* 5, 1-20.

Ioannidou, V., Ongena, S. and Peydrò, J. (2009). "Monetary policy and subprime lending: a tall tale of low federal funds rates, hazardous loans and reduced loan spreads", European Banking Centre Discussion Paper, no 2009–04S.

Jiménez, G., Ongena, S., Peydrò, J. and Saurina, J. (2009). "Hazardous times for monetary policy: what do twenty-three million bank loans say about the effects of monetary policy on credit risktaking?", Bank of Spain, Working Papers nº 833.

Laeven, L., Ratnovski, L. and Tong, H. (2016). "Bank size, capital, and systemic risk: Some international evidence". *Journal of Banking & Finance* 69 (1), S25-S34.

Löffler, G. and Posch, P.N. *Credit Risk Modeling Using Excel and VBA*. Wiley, 2007.

Merton, R C. (1974). "On the pricing of corporate debt: the risk structure of interest rates". *Journal of Finance* 29, 449–70.

Nicolò, G., Dell'Ariccia, G., Laevan, L. and Valencia, F. (2010). "Monetary Policy and Bank Risk Taking", IMF Staff Position Note, SPN/10/09, July 27.

Paligorova, T. and Santos, J.A.C. (2017). "Monetary policy and bank risk-taking: Evidence from the corporate loan market". *Journal of Financial Intermediation,* 30, 35-49.

Keely, M. C. (1990). "Deposit Insurance, Risk, and Market Power in Banking". *The American Economic Review*, 80 (5), 1183-1200.

Koutsomanoli-Filippaki, A. and Mamatzakis, E. (2009). "Performance and Merton-type default risk of listed banks in the EU: A panel VAR approach". *Journal of Banking & Finance,* 33 (11), 2050-2061.

Rajan, R. (2005). "Has financial development made the world riskier?" Proceedings of the Economic Policy Forum of the Federal Reserve Bank of Kansas City, August 313369.

Singh, M.K., Gómez-Puig, M. and Sosvilla-Rivero, S. (2015). "Bank risk behavior and connectedness in EMU countries". *Journal of International Money and Finance,* 57, 161-184.

Appendix: Figures and tables

Table A1. Distribution of banks in the sample by country.

Country	Nr. of banks	Country	Nr. of banks
Austria	9	Ireland	2
Belgium	1	Italy	24
Cyprus	2	Lithuania	1
Germany	17	Malta	4
Estonia	1	Netherland	6
Spain	9	Portugal	3
Finland	4	Slovenia	1
France	5	Slovakia	1
		Total	**90**

Table A2. List of banks included in the sample.

Bank	Country	Bank	Country
Erste Group Bank AG	Austria	BPER Banca SPA	Italy
Raiffeisen Bank International AG	Austria	Mediobanca SPA	Italy
Oberbank AG	Austria	Banca Mediolanum SPA	Italy
Bank für Tirol und Vorarlberg AG	Austria	Credito Emiliano SPA	Italy
BKS Bank AG	Austria	Banca Popolare di Sondrio SPA	Italy
Volksbank Vorarlberg E.Gen.	Austria	FinecoBank SPA	Italy
Wiener Privatbank SE	Austria	Banca Carige SPA	Italy
BAWAG Group AG	Austria	Banco di Desio e Della Brianza SPA	Italy
Autobank AG	Austria	Banca Generali SPA	Italy
KBC Groep NV	Belgium	Banca Ifis SPA	Italy
Bank of Cyprus Holdings PLC	Cyprus	BFF Bank SPA	Italy
Hellenic Bank PLC	Cyprus	Banca Sistema SPA	Italy
LHV Group AS	Estonia	Banca Finnat Euramerica SPA	Italy
Aktia Bank Plc	Finland	Banca Profilo SPA	Italy
Alandsbanken PLC	Finland	Banca Intermobiliare di Investimenti e Gestioni SPA	Italy
Oma Saastopankki Oyj	Finland	Unipol Gruppo SPA	Italy
Fellow Pankki PLC	Finland	Dovalue SPA	Italy
BNP Paribas SA	France	Unione di Banche Italiane SPA	Italy
Crédit Agricole SA	France	Banca Piccolo Credito Valtellinese SPA	Italy
Societé Générale SA	France	Banca Popolare Dell'Etruria	Italy
Rothschild & Co	France	Siauliu Bankas AB	Lithuania
Natixis SA	France	Bank of Valletta PLC	Malta
Deutsche Bank AG	Germany	HSBC Bank Malta PLC	Malta
Commerzbank AG	Germany	Fimbank PLC	Malta
Deutsche Pfandbriefbank AG	Germany	Lombard Bank (Malta) PLC	Malta
Procredit Holding AG	Germany	ING Groep NV	Netherlands
Baader Bank AG	Germany	ABN AMRO Bank NV	Netherlands
Merkur Privatbank KGaA	Germany	Van Lanschot Kempen NV	Netherlands
Umweltbank AG	Germany	Aegon NV	Netherlands
Albis Leasing AG	Germany	NIBC Bank NV	Netherlands
Grenke AG	Germany	BinckBank NV	Netherlands
Wustenrot & Wurttembergische AG	Germany	Banco Comercial Português SA	Portugal
Aareal Bank AG	Germany	Banco BPI SA	Portugal
MLP SE	Germany	Caixa Económica Montepio Geral SA	Portugal
HSBC Trinkaus & Burkhardt AG	Germany	Tatra Banka as	Slovakia
IKB Deutsche Industriebank AG	Germany	Nova Ljubljanska Banka dd	Slovenia
Oldenburgische Landesbank AG	Germany	Banco Santander SA	Spain
Fidor Bank AG	Germany	CaixaBank SA	Spain
DVB Bank SE	Germany	Banco Bilbao Vizcaya Argentaria SA	Spain
Bank of Ireland Group PLC	Ireland	Banco Sabadell SA	Spain
AIB Group PLC	Ireland	Unicaja Banco SA	Spain
Intesa Sanpaolo SPA	Italy	Bankinter SA	Spain
Unicredit SPA	Italy	Renta 4 Banco SA	Spain
Banco BPM SA	Italy	Banco Popular Español SA	Spain
Banca Monte dei Paschi di Siena SPA	Italy	Liberbank SA	Spain

Table A3. List of distressed banks included in the robustness check.

Bank	Country
National Bank of Greece SA	Greece
Piraerus Financial Holdings SA	Greece
Eurobank Ergasias Services and Holdings S.A.	Greece
Alpha Services and Holdings S.A.	Greece
Permanent TSB Group Holdings PLC	Ireland
Attica Bank SA	Greece
Bankia, SA	Spain
BANIF SA	Portugal
Dexia, SA	Belgium

Table A4. Summary statistics.

Variables	Obs	Mean	Median	Std.Dev.	Min	Max
Distance to Default (DtD)	1.867	5.95469	3.740865	7.190346	0.0003302	80.83521
Lag Distance to Default (4 quarters)	1.589	5.752151	3.524822	7.012374	0.0003302	80.83521
Market capitalization (log)	2.139	3.14345	3.162107	0.9210007	0.634185	4.994155
Total TLTRO (log)	722	3.26282	3.43602	0.9513803	0.0000	4.804725
Lag Total TLTRO (log) (1 quarter)	685	3.253965	3.414973	0.9577218	0.0000	4.804725
Common equity to total assets	2.030	8.068507	7.160363	4.336706	0.0997168	73.42668
Provisions for loan losses to total loans	1.362	0.1994464	0.1503997	1.450826	-38.69471	16.13354
Loan to deposits	1.587	115.3679	112.1317	60.66839	3.403752	519.8318
Operating income to total assets	1.748	0.1259686	0.1337333	0.4982351	-8.462463	7.243107
Cash and securities to total deposits	1.880	29.97032	17.70865	81.86329	0.0610479	2810.157
Inflation	2.520	1.123183	1.1	1.010763	-2.58	4.8
Interest Rate	2.520	-0.0161071	-0.027	0.3094155	-0.331	0.777
GDP growth	2.520	2.734377	2.7	3.258817	-8.8	38.22
Herfindahl-Hirschman Index (HHI)	623	833.8413	519	718.8264	245	3630
Trading securities to total assets (STA)	1.310	5.860341	2.422924	8.549824	0.00000233	44.69165
Loans to total assets (LTA)	1.577	56.88115	63.16272	20.99265	2.259883	91.05274

Table A5. Robustness check: Exclusion of countries with only one or two banks.

	(I)	(II)	(III)	(IV)	(V)
$DtD_{b,c,t-4}$	0.135**	0.142**	0.160**	0.148**	0.111
	(0.054)	(0.056)	(0.060)	(0.062)	(0.073)
$(Partic_b \times TLTRO_{b,t-1})$	2.470***				
	(0.376)				
$(Partic_b \times TLTRO_{b,t-1})$*Log Mark. Cap*		0.381			
		(0.284)			
$(Partic_b \times TLTRO_{b,t-1})$*LTA*			-0.001		
			(0.005)		
$(Partic_b \times TLTRO_{b,t-1})$*STA*				0.002	
				(0.004)	
$(Partic_b \times TLTRO_{b,t-1})$*HHI*					0.001
					(0.000)
$TLTRO_{b,t-1}$	-1.541***	-0.558	0.975**	0.941***	0.228
	(0.249)	(1.035)	(0.430)	(0.343)	(0.532)
Market Cap (log)	1.721***	0.245	1.692***	1.637***	1.726***
	(0.452)	(1.163)	(0.461)	(0.457)	(0.470)
Common equity to total assets	0.002	-0.001	0.001	0.011	0.000
	(0.033)	(0.032)	(0.035)	(0.033)	(0.036)
Provisions for loan losses to total loans	0.100**	0.083*	0.098*	0.096*	0.084*
	(0.047)	(0.046)	(0.050)	(0.048)	(0.049)
Total Loans to total deposits	-0.005	-0.005*	-0.005	-0.006**	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Operating income to total assets	0.069	0.060	0.086	0.020	0.049
	(0.096)	(0.106)	(0.092)	(0.110)	(0.102)
Cash and securities to total deposits	0.012	0.012	0.012	0.010	0.012
	(0.008)	(0.008)	(0.007)	(0.008)	(0.007)
Inflation	0.437***	0.438***	0.448**	0.446***	0.343**
	(0.101)	(0.102)	(0.098)	(0.102)	(0.133)
Interest rate	2.183***	2.201***	2.202***	2.276***	2.095***
	(0.534)	(0.540)	(0.542)	(0.544)	(0.546)
GDP growth	0.307***	0.311***	0.314***	0.276***	0.345***
	(0.086)	(0.085)	(0.085)	(0.084)	(0.078)
Constant	-6.948***	-1.461	-7.106***	-6.919***	-6.433***
	(2.197)	(4.287)	(2.205)	(2.288)	(2.185)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	434	434	434	398	434
R^2	0.0295	0.0788	0.0966	0.1846	0.1850
Within R^2	0.3624	0.3637	0.3578	0.3592	0.3856

Clustered (banks) standard-erros in parentheses
(* 0.1 ** 0.05 *** 0.01)

Table A6. Robustness check: Extension of analysis period to 2019

	(I)	(II)	(III)	(IV)	(V)
$DtD_{b,c,t-4}$	0.107**	0.115**	0.118**	0.101**	0.051
	(0.043)	(0.047)	(0.046)	(0.048)	(0.056)
$(Partic_b$ x $TLTRO_{b,t-1})$	2.986***				
	(0.049)				
$(Partic_b$ x $TLTRO_{b,t-1})$*Log Mark. Cap*		0.291			
		(0.272)			
$(Partic_b$ x $TLTRO_{b,t-1})$*LTA*			0.004		
			(0.005)		
$(Partic_b$ x $TLTRO_{b,t-1})$*STA*				0.004	
				(0.004)	
$(Partic_b$ x $TLTRO_{b,t-1})$*HHI*					0.001*
					(0.000)
$TLTRO_{b,t-1}$	-2.130***	-0.268	0.579	0.849**	0.197
	(0.318)	(-0.268)	(0.431)	(0.343)	(0.440)
Market Cap (log)	2.291***	1.193	2.277***	2.182***	2.351***
	(0.482)	(1.077)	(0.473)	(0.513)	(0.506)
Common equity to total assets	-0.011	-0.013	-0.015	0.004	0.000
	(0.038)	(0.037)	(0.041)	(0.034)	(0.037)
Provisions for loan losses to total loans	0.084	0.071	0.079	0.072	0.083
	(0.053)	(0.054)	(0.055)	(0.055)	(0.058)
Total Loans to total deposits	-0.007***	-0.007***	-0.008***	-0.009***	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Operating income to total assets	0.174**	0.173**	0.191***	0.108	0.091
	(0.069)	(0.070)	(0.065)	(0.091)	(0.086)
Cash and securities to total deposits	0.017**	0.017**	0.019**	0.017*	0.017**
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
Inflation	0.135*	0.134*	0.135*	0.185**	0.039
	(0.069)	(0.072)	(0.069)	(0.079)	(0.084)
Interest rate	0.250	0.298	0.333	0.531	0.565
	(0.461)	(0.463)	(0.468)	(0.479)	(0.553)
GDP growth	0.089	0.086	0.087	0.030	0.123**
	(0.056)	(0.054)	(0.054)	(0.065)	(0.058)
Constant	-7.700***	-3.843	-7.778***	-7.708***	-8.005***
	(2.077)	(4.309)	(2.069)	(2.363)	(2.152)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	577	577	577	518	577
R^2	0.0206	0.0582	0.0567	0.1353	0.1358
Within R^2	0.2640	0.2620	0.2604	0.2713	0.3071

Clustered (banks) standard-erros in parentheses
(* 0.1 ** 0.05 *** 0.01)

Table A7. Robustness check: Regressions with TLTRO variable without lag.

	(I)	(II)	(III)	(IV)	(V)
$DtD_{b,c,t-4}$	0.107**	0.110**	0.106**	0.092	0.074
	(0.048)	(0.048)	(0.049)	(0.055)	(0.060)
$(Partic_b \times TLTRO_{b,t})$	5.841**				
	(2.693)				
$(Partic_b \times TLTRO_{b,t})$*Log Mark. Cap*		0.045			
		(0.418)			
$(Partic_b \times TLTRO_{b,t})LTA$			0.006		
			(0.006)		
$(Partic_b \times TLTRO_{b,t})STA$				0.002	
				(0.004)	
$(Partic_b \times TLTRO_{b,t})HHI$					0.000
					(0.000)
$TLTRO_{b,t}$	-5.102*	0.574	0.347	0.777**	0.368
	(2.818)	(1.449)	(0.467)	(0.352)	(0.449)
Market Cap (log)	2.064***	1.892	2.104***	1.924***	2.133***
	(0.453)	(1.650)	(0.458)	(0.474)	(0.483)
Common equity to total assets	-0.001	-0.002	-0.007	0.006	-0.000
	(0.031)	(0.032)	(0.036)	(0.029)	(0.031)
Provisions for loan losses to total loans	0.068	0.068	0.062	0.052	0.075
	(0.045)	(0.045)	(0.049)	(0.051)	(0.048)
Total Loans to total deposits	-0.006**	-0.006**	-0.007***	-0.007**	-0.006**
	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
Operating income to total assets	0.109	0.110	0.108	0.062	0.066
	(0.090)	(0.095)	(0.088)	(0.107)	(0.099)
Cash and securities to total deposits	0.024**	0.024**	0.027**	0.023*	0.023**
	(0.010)	(0.010)	(0.010)	(0.012)	(0.009)
Inflation	0.225**	0.224**	0.221**	0.303***	0.138
	(0.094)	(0.095)	(0.092)	(0.089)	(0.118)
Interest rate	1.408**	1.418**	1.495**	1.785***	1.343**
	(0.545)	(0.541)	(0.555)	(0.541)	(0.557)
GDP growth	0.171***	0.170***	0.169***	0.134*	0.166***
	(0.049)	(0.048)	(0.048)	(0.078)	(0.053)
Constant	-6.673***	-6.731	-7.320***	-6.926***	-7.360**
	(2.272)	(5.869)	(2.078)	(2.311)	(2.148)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	492	492	492	439	492
R^2	0.0095	0.0789	0.0664	0.1770	0.1406
Within R^2	0.2778	0.2775	0.2821	0.2974	0.2941

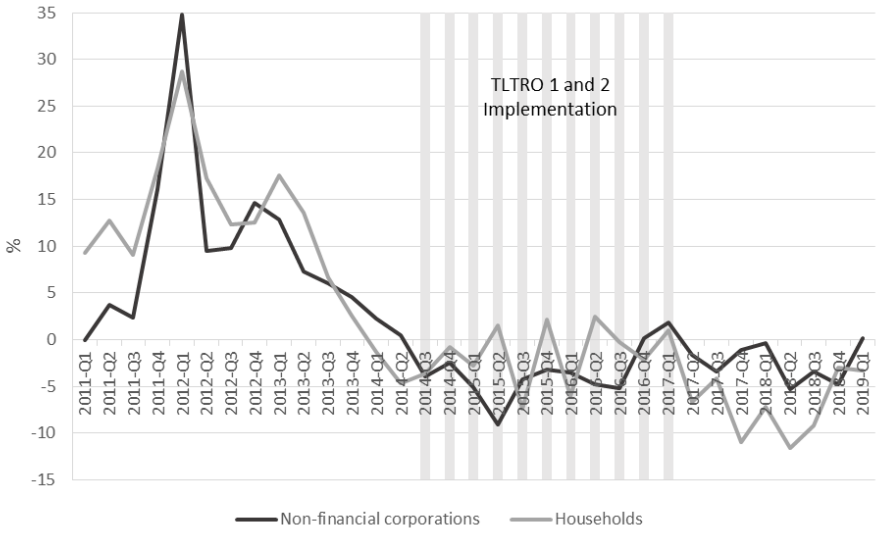
Clustered (banks) standard-erros in parentheses
(* 0.1 ** 0.05 *** 0.01)

Table A8. Robustness check: Regressions with TLTRO variable with a 2-lag period.

	(I)	(II)	(III)	(IV)	(V)
$DtD_{b,c,t-4}$	0.127**	0.131**	0.141**	0.134**	0.099
	(0.049)	(0.054)	(0.054)	(0.059)	(0.069)
$(Partic_b \times TLTRO_{b,t-2})$	3.192***				
	(0.415)				
$(Partic_b \times TLTRO_{b,t-2})$*Log Mark. Cap*		0.503*			
		(0.254)			
$(Partic_b \times TLTRO_{b,t-2})$*LTA*			0.006		
			(0.006)		
$(Partic_b \times TLTRO_{b,t-2})$*STA*				0.009*	
				(0.005)	
$(Partic_b \times TLTRO_{b,t-2})$*HHI*					0.001
					(0.000)
$TLTRO_{b,t-2}$	-1.893***	-0.642	0.818	1.292***	0.742
	(0.307)	(0.976)	(0.503)	(0.306)	(0.538)
Market Cap (log)	2.055***	0.211	2.054***	1.789***	2.122***
	(0.537)	(1.065)	(0.534)	(0.518)	(0.569)
Common equity to total assets	0.025	0.017	0.016	0.031	0.032
	(0.038)	(0.035)	(0.042)	(0.038)	(0.038)
Provisions for loan losses to total loans	0.074	0.059	0.057	0.076	0.087
	(0.052)	(0.052)	(0.064)	(0.058)	(0.056)
Total Loans to total deposits	-0.004	-0.004	-0.005*	-0.006	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Operating income to total assets	0.213	0.155	0.236	0.047	0.106
	(0.182)	(0.182)	(0.189)	(0.201)	(0.206)
Cash and securities to total deposits	0.025***	0.024**	0.027***	0.024**	0.025***
	(0.009)	(0.009)	(0.009)	(0.011)	(0.009)
Inflation	0.235**	0.226**	0.241**	0.339***	0.129
	(0.103)	(0.106)	(0.099)	(0.103)	(0.123)
Interest rate	1.623**	1.672**	1.703**	2.229***	1.592**
	(0.673)	(0.686)	(0.655)	(0.622)	(0.680)
GDP growth	0.232***	0.228***	0.227***	0.233**	0.233**
	(0.081)	(0.081)	(0.081)	(0.101)	(0.091)
Constant	-9.534***	-2.701	-9.411***	-9.047***	-9.640***
	(2.360)	(4.191)	(2.143)	(2.338)	(2.468)
Bank Fixed Effects	Yes	Yes	Yes	Yes	Yes
No. of observations	447	447	447	401	447
R^2	0.0213	0.0527	0.0556	0.1429	0.1245
Within R^2	0.3276	0.3302	0.3247	0.3488	0.3440

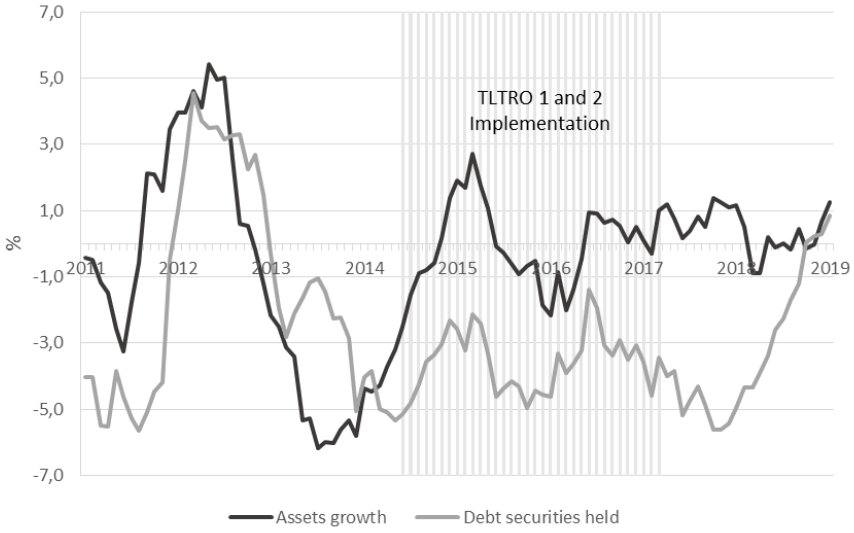
Clustered (banks) standard-erros in parentheses
(* 0.1 ** 0.05 *** 0.01)

Appendix Figure 1. Changes in credit standards for loans in the Eurozone (net percentages). (+) Net tightening/ (-) Net easing.



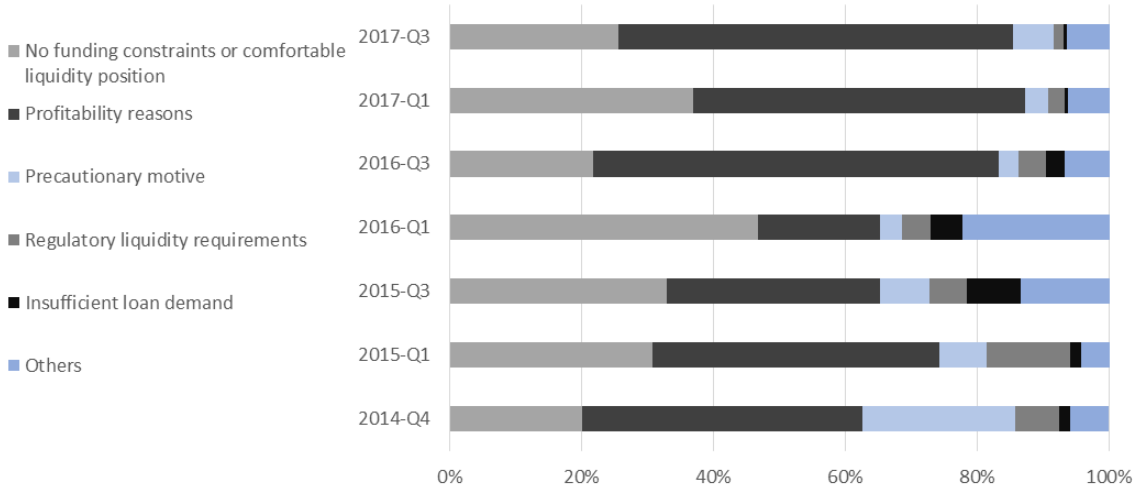
Source: ECB

Appendix Figure 2. Monthly growth rate of Eurozone banks' assets and debt securities held by them.



Source: ECB

Appendix Figure 3. Reasons for banks to participate in TLTROs (% of total banks). Based on ECB surveys that include not only TLTRO I and TLTRO II but also past and future programs.



Source: ECB and authors calculations