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TAF Effect on Liquidity Risk Exposure*

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Abstract

Using a unique bank-level dataset, we assess the impact of the Term Auction Facility program on bank liquidity risk. The change in the US housing price index at state levels between 2002:Q1 and 2006:Q3 is the exclusion restriction to control for potential selection bias. On average, TAF banks exhibit higher ex ante levels of liquidity risk and they drastically reduce funding liquidity risk in the periods after the first time they received TAF funds. TAF banks show larger reductions in liquidity and they are more likely to be headquartered in US states that experienced sharper housing price appreciation before 2007.

Keywords Term Auction Facility, Liquidity Risk, Financial Crisis, Unconventional Monetary Policies

JEL Classification E52, E58, G28

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1 Introduction

The bursting of the housing bubble in 2007 led to the most severe financial crisis since the Great Depression. As banks were forced to write down billions of dollars in bad loans, the interbank market for short-term funding froze, leaving several banks with severe liquidity problems. Although these banks were not able to roll over their short-term debt, they were also reluctant to use the Federal Reserve's traditional channel of the discount window (DW) credit programs. This aversion on the part of the banks was notably due to the fact that this strategy might have been interpreted by the market as a signal of being in financial trouble, which would intensify the pressure on the financial institution.

During the crisis the Federal Reserve carried out several extraordinary actions, including the creation of a number of new facilities. The Term Auction Facility (TAF) was based on auctioned short-term credit (with maturities between one and three months), with the general aim of supporting the financial sector and ensuring adequate access to liquidity for financial institutions. Among the programs promoted by the Federal Reserve, the TAF was the only that specifically addressed depository institutions. It was the most important with respect to the short-term credit provided and was available for the longest period. In fact, the Federal Reserve auctioned $3.81 trillion between December 2007 and April 2010 through TAF.[1].

According to the Federal Reserve, "[the TAF program] could help ensure that liquidity provisions can be disseminated efficiently even when the unsecured interbank markets are under stress"[2]. The Federal Reserve, through the TAF program, was injecting liquidity into the market, effectively substituting for the interbank credit market and thus trying to affect liquidity risk and spreads in the money markets.

The actions undertaken by the Federal Reserve and the Treasury are known as unconventional monetary policy measures. Their effects must still be clearly assessed and defined. As claimed by Gertler (2010) "We need to develop models that can trace the effects of these policies on the economy

[1]After the collapse of Lehman Brothers in October 2008, the US Treasury launched the Troubled Assets Relief Program (TARP). The main differences between TAF and TARP lie in the goals of the programs (liquidity provision versus encouraging lending) and the instruments (short-term loans versus equity infusions).

[2]See http://www.federalreserve.gov/monetarypolicy/files/TAFfaqs.pdf.

in the same manner we can trace out the effects of interest rate policies." Our paper contributes to the current debate (e.g. Taylor, 2009, 2010, 2012) on the appropriateness and effectiveness of these extraordinary measures and aims to analyse the main determinants that affected decisions to participate in the TAF program, assess bank liability and liquidity features depending on their participation in the TAF program, and quantitatively measure the effect of the TAF program on liquidity risk.

Using a unique bank-level dataset, constructed by merging TAF program information with bank balance sheet data, we provide a complementary point of view to the existing TAF literature. Instead of relying on aggregate price measures that proxy liquidity risk (see e.g. Taylor and Williams, 2009; McAndrews et al., 2008; Wu, 2008; In et al., 2012; Sarkar and Shrader, 2010), our study emphasises the importance of a maturity mismatch between bank assets and liabilities. Our main measure for liquidity risk is the logarithm of the ratio of short-term liabilities to short-term assets.[3] This choice is consistent with the Basel Committee of Banking Supervision's definition of liquidity, that is "the ability to fund increases in assets and meet obligations as they come due". Due to the fact that the participation in the TAF program is not random, we control for the potential selection bias by employing a treatment effects model and use as exclusion restriction the change in the US housing price index at the state level from 2002:Q1 to 2006:Q3.[4] This approach to controlling the selection bias is novel in the TAF literature. The housing price index at the state level from 2002:Q1 to 2006:Q3 helps explain the probability of participation in the TAF program. This measure is a proxy for bank exposure to the local real estate bubble, and therefore indicates of how difficult it was for the bank to access the interbank credit market during the crisis due to the reluctance of other banks to lend to counterparts potentially under stress. We compare the liquidity and liability features of banks that received TAF reserves with those that did not. We document the liquidity risk behaviour of banks that received the financial support before and after the period they received the TAF funds for the first time. Finally, we assess the impact of the TAF program on liquidity risk changes, measured by the difference of the liquidity risk before and after the TAF program.

[3]Maturities of less than one year are defined as short-term.

[4]We choose these dates because 2002:Q1 marks the end of the recession following the dot-com bubble, while 2006:Q3 quarter is the fourth quarter before the beginning of the TAF program.

Our main findings are the following:

- Banks that benefited from the TAF program exhibited ex ante higher levels of liquidity risk. High liquidity risk measures indicate that banks had more severe maturity mismatches and were therefore more exposed to the freezing of the interbank market since they were unable to roll over their short-term liabilities during the crisis. As a consequence, they were more likely to participate in the TAF program.

- Normalizing the first time when banks benefited from the TAF reserves, liquidity risk decreased in the following periods. During the period 2007:Q3–2010:Q3, all banks reduced liquidity risk, but TAF support implied a larger contraction. The larger the amount of reserves received, the bigger the reduction in liquidity risk. In other words, TAF banks were able to more quickly adjust the structure of their debt maturity. The TAF program provided banks with the extra time needed to improve their balance sheets.

- Banks headquartered in states that experienced a significant appreciation of housing prices between 2002:Q1 and 2006:Q3 were more likely to receive TAF support. These findings are consistent with Doms et al. (2007). The probability of participating in the TAF program also increases when a bank shows higher ex ante levels of liquidity risk and illiquid collateral, such as asset-backed securities (ABSs) and mortgage-backed securities (MBSs). These findings provide empirical support for Acharya et al. (2011).

Importantly, our findings highlight that banks that had significant liquidity mismatches and received TAF funds decreased liquidity risk faster than the rest of the banks. They were thus able to alleviate their short-term financing exposure. The TAF program provided the depository institutions with liquidity during the liquidity distress, giving them the time to restructure the liability side of their balance sheets. In this sense, the Federal Reserve, through the TAF program, acted as a lender of last resort (LOLR), providing liquidity to distressed banks. From a policy-making perspective, our results strongly support the Federal Reserve's choice to intervene in the banking sector, through the implementation of extraordinary monetary measures, with the aim of providing depository institutions with liquidity (e.g. Rochet and Vives, 2004; Segura and Suarez, 2012) in the periods of financial

distress.

Our main results are robust to several different tests. Since TAF loans are also short-term liabilities, our findings could be driven by an accounting effect. We avoid this issue by computing the change in liquidity risk between 2007:Q3 and 2010:Q3, after all the TAF loans were repaid.

The findings could be unrelated to the TAF program and, instead, driven by other measures promoted by the monetary authorities and operating at the same time as the TAF. We control for this issue by excluding from the dataset the banks that participated in the TARP program.

The results could also be driven by specific events that occurred during the period when the TAF was operating. In particular, the collapse of Lehman Brothers represents a tipping point in the context of the financial crisis that started in 2007. We control for this event in several ways. In particular, as suggested by Ivashina and Scharfstein (2010), we exclude from the dataset banks that had a large fraction of their credit lines co-syndicated with Lehman Brothers. We thus create a sub-sample of banks that received TAF funds for the first time before the collapse of Lehman Brothers. Finally, we study the behaviour of the average liquidity risk measures for the TAF banks after normalizing the first period when the banks received TAF support.

The TAF banks show higher levels of liquidity distress. This might imply that, in case of distress, they are forced to decrease their exposure faster than others. If this is true, our results are not capturing the TAF effect but, rather, they reflect a feature of the TAF banks. To control for this potential issue, we match TAF and NO TAF banks using liquidity risk indicators (short term liabilities to short term assets, short-term liabilities to total liabilities, short-term net liabilities, short-term liabilities to risk-free assets, short term liabilities and short term assets) measured in 2007:Q3.

Due to the sample's heterogeneous composition, which includes only a small fraction of TAF banks (3.49%), our results could reflect a sample feature instead of the effect of the TAF program. We control for this potential issue in different ways. On the one hand, we match TAF and NO TAF banks by using a set of control variables and the level of short term liabilities to short term assets measured in 2007:Q3. On the other hand, we run a bootstrap exercise. In each iteration, the sample includes all TAF banks and a randomly chosen subset of NO TAF banks, for a total of 1000 observations. We repeat the estimation 1000 times with different subsamples.

The results could also be driven by the sample period. To control for this potential issue we employ the difference in liquidity risk between 2006:Q3 and 2010:Q3 as dependent variable. We check whether our results hold for alternative measures of liquidity distress. In particular, we focus on short-term liabilities to total liabilities, short-term net liabilities, and short-term liabilities to risk-free assets.

A potential source of attenuation bias for our findings is the fact that, during the crisis, some banks were not allowed to fail, due to their systemic relevance. To control for this effect on the impact of the TAF program on liquidity risk, we focus on banks belonging to the 75th, 90th and 95th percentiles in terms of size.

It could be that banks participated in the TAF program because of solvency problems instead of maturity mismatches. We address this potential problem by focusing only on TAF banks with fundamentals[5] above larger the median of the fundamentals of the TAF banks that failed.

The results could be driven by the methodology employed. We provide evidence estimating the model using econometric techniques, such as ordinary least squares, two stage least squares and treatment effect model estimated in two-step.

Finally, we compute the impact of the TAF program looking at shorter horizons, in order to assess its short term effectiveness.

The literature reports mixed results on the effectiveness of the TAF program on liquidity risk, measured by the spread between the London Interbank Offered Rate (LIBOR) and the overnight indexed swap (OIS). Taylor and Williams (2009) and McAndrews et al. (2008) obtain different results from the same set of explanatory variables[6] but using as a dependent variable the level of liquidity risk and the first difference in liquidity risk, respectively. Specifically, the former study finds no impact of the TAF program, while the latter study finds the TAF program had a negative impact on the liquidity risk spread.

Wu (2008) expands the specification employed in previous contributions by adding a new set of explanatory variables and assuming that the TAF program had a permanent effect on LIBOR-OIS spreads. The author shows that the TAF program decreased liquidity risk spreads. However, these

[5]Fundamentals variables are capital buffer, portfolio risk, cash and short term liabilities over risk free assets

[6]The variables included refer to the asset-backed commercial paper spread, the credit default swaps for major banks, the Tibor-Libor spread, the Libor-Repo spread, and a TAF dummy variable, which is one on each of the TAF bid submission dates and zero elsewhere.

findings are subject to the criticisms of Taylor and Williams (2008), that the TAF program did not have a permanent effect on spreads.

In et al. (2012) distinguish between short and long-run TAF effects. They find that the LIBOR-OIS spread decreased when the TAF was announced, but the effect is not maintained over time. Moreover, according to their results, the TAF only affected three-month spreads. Sarkar and Shrader (2010) study the impact of TAF changes on three-month LIBOR-OIS spread changes by augmenting the specification employed in previous contributions on this topic. Their results show that changes in the TAF issuance volumes had a negative impact on the changes in the LIBOR-OIS spread. Moreover, the authors find that the spread changes depend on the amount of reserves provided.

Angelini et al. (2011) use the long-term interbank spread as dependent variable and distinguish between the period before and after the collapse of Lehman Brothers. They identify the unconventional monetary policy measure by using a dummy variable that takes the value of one on the day of the announcement of the extraordinary measure and zero otherwise. The authors find that the monetary policy measures decreased the spread by about 10 to 15 basis points, but only after Lehman's collapse.

Contrary to our results, the findings of previous contributions are not robust to the dependent variable chosen, the specification employed, or the distinction between short- and long-run effects associated with the TAF program.

Our study contributes to the literature in a number of ways. We use a unique bank-level data set that allows us to analyse the effect of the TAF program on liquidity distress from the individual bank's perspective. Indeed, we focus on bank *funding liquidity* instead of *market liquidity*,[7] specifically focusing on the effect of the TAF program on bank quantities instead of on liquidity risk spreads. The micro-level data have the additional advantage of mitigating any potential aggregation effects. We also avoid the criticism related to using the LIBOR spread as a measure of liquidity risk. More precisely, Michaud and Upper (2008) show that prices were also impacted by factors other than liquidity risk such as uncertainty and the higher dispersion of credit quality. Moreover, as stressed by Drehmann and Nikolaou (2012) "The spread between interest rates in the interbank market and a risk free rate is purely a price measure and it does not reveal anything about market access, which maybe severely

[7]For further details on funding versus market liquidity, see Brunnermeier and Pedersen (2009), Fontaine and Garcia (2012), and Allen et al. (2010).

impaired during crisis, nor the volume of net-liquidity demand [...]". Finally, Abrantes-Metz et al. (2012) document the suspicion that the LIBOR was misreported by banks during the crisis such that its informative power was severely diminished.[8]

Since we exploit the cross section instead of the time series dimension, we do not incur the criticism of Taylor and Williams (2008) about the assumption of the long-run effect of the TAF program adopted by Wu (2008).

In our approach, we distinguish between banks that at some point received the reserves provided by the TAF program and the other banks and we also take into account the amount of funds received by each bank. This perspective raises the question whether we are able to distinguish between the treatment effects model of the program and the selection effect of the banks. We control for this potential source of bias by using a treatment model to estimate the model. The pre-crisis (2002:Q1–2006:Q3) percentage change in housing prices is the exogenous determinant of the probability of asking for TAF support. This variable affects bank participation in the program without affecting the variation of the liquidity risk measures during the period 2007:Q3–2010:Q3[9].

The rest of the paper is organized as follows. Section 2 discusses the TAF program. Section 3 discusses the data set, while Section 4 describes the econometric model. Section 5 discusses the results and Section 6 concludes the paper.

2 How the Term Auction Facility program works

According to the Federal Reserve's definition, "The TAF is a credit facility that allows a depository institution to place a bid for an advance from its local Federal Reserve Bank at an interest rate that is determined as the result of an auction".[10] The aim of the TAF was to compensate for the collapse of the short-term funding market by ensuring liquidity provisions when the inter-bank credit market was under stress.

[8]Generally, it is important to note that the LIBOR is not a market interest rate, but rather the average of the answers of large banks to the question, "At what rate could you borrow funds, were you to do so by asking for and then accepting interbank offers in a reasonable market size just prior to 11 a.m.?" (see http://www.bbalibor.com/bbalibor-explained/the-basics).

[9]This intuition is supported by the empirical evidence, see column (6) of Table B.3 in Appendix B and by Figure 6.c.

[10]See http://www.federalreserve.gov/monetarypolicy/taffaq.htm

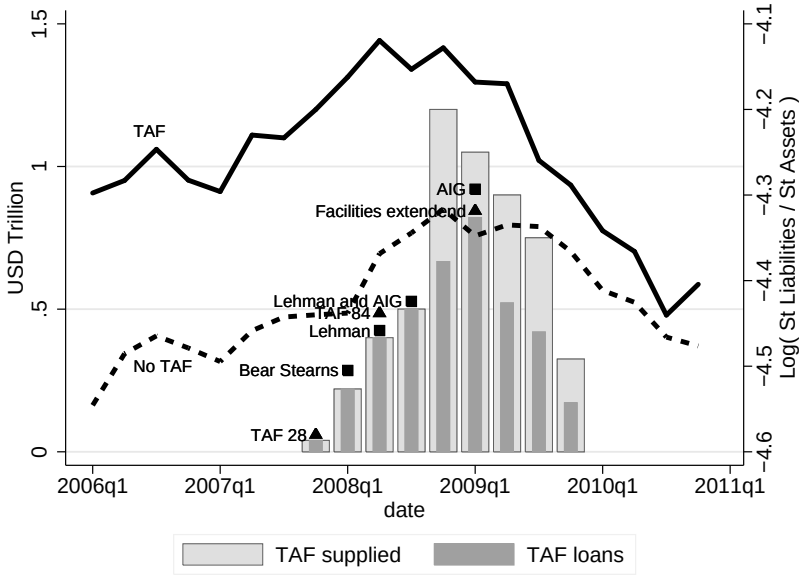
All banks eligible for the discount window credit programs at the moment of the auction and during the term of the TAF loans were also eligible for participation in TAF.[11] The reserves provided in the TAF program had a maturity of 28 days or 84 days, and had to be fully collateralized. Banks were allowed to have more than one loan at the same time so facilities with different maturities could overlap. The information about banks bidding and receiving funds was private. For each auction the Federal Reserve fixed the total amount to supply, the maximum amount an individual bank was allowed to obtain, and the minimum bid interest rate. For each auction, eligible banks had the possibility of making two rate amount offers. Specifically, the bid was characterized by the amount asked by the bank and a repayment interest rate. Bids were ordered according to the repayment interest rate bid. The Federal Reserve then began to accept bids, starting with the highest interest rate bids. It would continue to do so until the offered amount was reached; otherwise, all the bids were accepted. In the former case, the interest rate that had to be paid by all successful bidders was determined by the stop-out rate, that is, by the interest rate of the last accepted bid. If the supply exceeded the demand, the equilibrium interest rate would simply be equal to the minimum bid rate.

During the last financial crisis the normal instruments, such as the discount window credit programs, employed by the Federal Reserve to provide liquidity to depository institutions were less effective because of the so-called stigma effect. Depository institutions were concerned about the fact that the market would interpret benefiting from loans provided by the Federal Reserve by the normal discount window credit programs as a bad signal (stigma). Armantier et al. (2008) and Armantier et al. (2011) find that in the third quarter of 2008, banks preferred to pay, on average, at least 34 basis points more to borrow from the TAF program than from the DW. Ashcraft et al. (2010) confirm these findings. They show that after February 2008 depository institutions preferred to receive TAF support and pay a higher rate than to benefit from the discount window at a cheaper price. To avoid or minimize the stigma effect, the Federal Reserve decided to keep the information regarding the institutions that benefited from the loans in the TAF program framework confidential; at the same time, it adopted an auction mechanism to determine which institutions would obtain the reserves and to establish the repayment interest rate. An auction mechanism such as that described above

[11] To be eligible, banks had to be "in sound financial condition". The soundness of a particular bank had to be certified by its local reserve bank and depended on solvency, liquidity, and profitability.

has several important advantages in decreasing the potential stigma effect. First, the interest rate is determined through a market mechanism instead of being imposed by the authorities; second, banks approach the Federal Reserve collectively instead of individually.

Figure 1: TAF reserves, market events, policy measures and liquidity risk



Notes: The left-hand scale shows the reserves offered and effectively provided in the context of the TAF program. Moreover, the squares (triangles) refer to market (policy) events. The right-hand scale shows the average levels of short-term liabilities over short-term assets for the TAF and NO TAF bank groups. These features of the series hold when the quartiles (25th, 50th, and 75th) of the series for the two groups of banks are compared. These results are available upon request.

Figure 1 shows the reserves supplied by the Federal Reserve and those effectively provided to the depository institutions each quarter under the TAF program (left-hand scale). The graph highlights that before the collapse of Lehman Brothers, the auctions were competitive. Following the Lehman Brothers collapse, this was no longer the case for the auctions: All depository institutions that asked for TAF facilities obtained them, since the Federal Reserve doubled the amounts supplied.

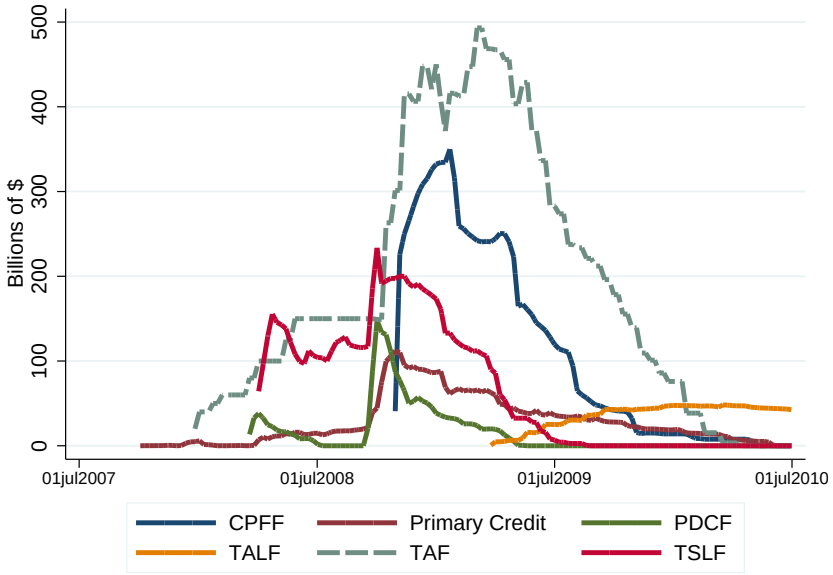
Figure 1 also reports several market events (squares) and policy measures related to the TAF program (triangles). The program was announced on December 12, 2007. The initial reserves had a maturity of 28 days. The amount provided was increased in the first quarter of 2008, after Fannie Mae and Freddie Mac requirements were eased to allow for increases in lending and Bear Stearns received emergency loans from the Federal Reserve. Reserves with longer maturities were established in 2008:Q2, after Lehman Brothers reported losses of $2.8bn. The amount of reserves provided kept rising after the

Lehman Brothers bankruptcy and the downgrade of AIG debt. The maximum amount was supplied during 2009:Q1, when Fannie Mae and Freddie Mac reckoned a need for $51bn to continue operations and AIG announced large losses. From 2009:Q2 on, new facilities decreased to a level that persisted until March 8, 2010, when the last auction took place.

The graph (right-hand scale) also shows the average level of short-term liabilities over short-term assets for two groups of banks: TAF banks, that is, banks that received reserves at least once, and NO TAF banks, which did not. Before the beginning of the TAF program the two groups of banks showed similar (increasing) patterns, although TAF banks had higher levels of liquidity risk. Just after the collapse of Lehman Brothers, both groups started decreasing their liquidity exposure. However, the graph shows that TAF banks adjusted their exposure faster, to such an extent that these differences were no longer significant once the TAF program was over.

During the last financial crisis, apart from the TAF program, the Federal Reserve and the US Treasury put in place other facilities for auctioning short-term credit, with the general aim of supporting the financial sector and ensuring adequate access to liquidity for financial institutions. Figure 2 shows the Federal Reserve's weekly outstanding lending to financial institutions through the different programs. The graph highlights the importance of the TAF program in the context of the measures launched by the Federal Reserve during the financial crisis, with respect to both the amounts employed and the duration of program operation.

Figure 2: Federal Reserve lending during the financial crisis



Notes: This figure shows the Federal Reserve's weekly outstanding lending to financial institutions through the different programs operating during the last financial crisis. Commercial Paper Funding Facility (CPFF), Term Asset-Backed Securities Loan Facility (TALF), Primary Dealer Credit Facility (PDCF), and Term Securities Lending Facility (TSLF).

3 Data and descriptive analysis

In this section we carry out a detailed analysis of the dataset employed in this study and summarise our main results.

3.1 Data

We create a unique dataset by merging several different sources. The data concerning bank balance sheets is a combination of the Report of Condition and Income (generally referred to as the Call Report) and the Uniform Bank Performance Report (UBPR). US banks are required to submit these reports to the Federal Financial Institutions Examination Council (FFIEC). The specific reporting requirements depend on the size of the bank and whether it has foreign offices. We accessed the Call Report data through the Federal Reserve of Chicago website and the UBPR data through the FFIEC website.[12] The period in question runs from 2006:Q3 to 2010:Q3. The data on the TAF auctions are from the Federal Reserve Board. The sample covers the period from 2007:Q4 to 2010:Q1. Although

[12] A known issue of the Call Report data we cannot control for is the so-called window dressing effect: The day before the report, banks adopt virtuous behavior so that their balance sheets look particularly good on the day of the report.

information regarding the TAF was kept private during the financial crisis, it had to be disclosed in December 2010, after Bloomberg won a federal lawsuit. Finally, the House Price Index (HPI) dataset was obtained from the Federal Housing Finance Agency website. The period covered is from 1991:Q1 to 2012:Q3 and the information is reported at the state level. We merged the datasets and transformed them into a cross-sectional dataset. The dependent variables are generated by taking the difference of the liquidity risk measures between 2007:Q3 and 2010:Q3, while the control variables are measured in 2007:Q3 and between 2002:Q1 and 2006:Q3, depending on the case.

Our final sample includes 7591 banks. Among them, 265 banks obtained TAF program reserves at least once. These banks represent approximately 3.49% of the banks in the sample.[13] We exclude all US branches of foreign banks and agencies of foreign banks from the final sample that were initially included in the TAF dataset because we have no comparable balance sheet data for these banks. Moreover, the sample includes failed, acquired, and surviving banks, so the results do not suffer from a survivorship bias.[14] Specifically, 804 banks disappeared (we consider them failed or acquired) before 2010:Q3. Among them, 27 obtained TAF program reserves.

3.2 Description of the variables

Since we are interested in the TAF program's effect on the change of banking funding liquidity risk, we distinguish between banks that obtained reserves through the TAF program at least once and those that did not. The dummy variable labelled TAF takes on the value of one if a bank received TAF reserves at least once and zero otherwise. We also focus on funds received by each bank through the TAF program. Specifically, we define $TAF\ AMOUNT\ 1$ as the log of one plus the overall amount of TAF funds received by each bank and $TAF\ AMOUNT\ 2$ as the log of one plus the ratio of the overall amount of TAF funds received by each bank and the total loans measured in 2007:Q3. Finally, $AVG\ TAF\ AMOUNT$ is defined as the log of one plus the ratio of the overall amount of TAF funds

[13] In the robustness checks, we control for the fact that the dataset is characterized by an uneven distribution of banks between the two groups.

[14] A survivor bias could arise if the sample included only surviving banks, disregarding those that failed or were acquired while the program was operated by the Federal Reserve. If this were the case, the results would not take into account the information associated with failed institutions, leading to biased results.

received by each bank to the corresponding number of times the bank received TAF reserves.[15]

In the baseline analysis, we approximate the liquidity risk of funding by the log of the short-term liabilities over short-term assets ($ST\,LIAB/ST\,ASS$). Larger values of this ratio imply a higher level of funding liquidity risk.

In the robustness checks we employ different measures of liquidity risk, such as the ratio of short-term liabilities to total liabilities ($ST\,LIAB/\,TLIAB$), the ratio of the log of short-term liabilities to risk-free assets ($ST\,LIAB/PF\,RISK\,0$), and the short-term net liabilities ($ST\,NET\,LIAB$). These proxies show how important short-term liabilities are with respect to different measures of liquid assets or with respect to the total volume of liabilities.

Control variables include bank liquidity capacity, portfolio composition, loan structure, loan losses, different types of collateral assets, capital capacity, profitability, and features of the US state where the bank has its headquarters. As a proxy for liquidity capacity, we employ two alternative measures: $LIQUIDITY$ is defined as the sum of total trading assets, total securities available for sale, and total securities held to maturity over total as- sets, while $CASH$ is determined by cash and balances due from depository institutions over total assets.

We also consider bank features regarding capital capacity and profitability as controls. Specifically, $CAPBUFFER$ is obtained by taking the difference between the tier 1 capital ratio and the minimum requirement established by the banking authorities,[16] return on assets (ROA) is equal to the ratio of income before taxes and extraordinary items and other adjustments to total assets, $SIZE$ is measured by the log of total assets, the ratio of non-performing loans to total loans (NPL) is defined as loans past due at least 30 days or that are on a non-accrual basis, and provisions for non-performing loans ($PROV$) equal the ratio of loan loss provisions to total loans.

To account for the portfolio composition of bank assets, we calculate the ratio of risk-weighted assets to total assets ($PF\ RISK$).[17] This measure can be interpreted as a proxy for the portfolio risk:

[15]The impact of the amounts received on liquidity risk should be studied at the margin. That is, by considering bank liquidity needs at the moment of receiving the funds. Unfortunately, the dataset precludes this type of analysis. In the cross-sectional context, we think that the alternative measures proposed above are the best approximation to capture the effect of TAF amounts on liquidity risk.

[16]In the period under analysis the minimum capital requirement was equal to 6%.

[17]The weights (0%, 20%, 50%, and 100%) are ascribed according to Basel I. On- and off-balance sheet items are summed when total assets are computed.

The higher this ratio, the higher the fraction of assets considered risky by the regulatory authorities. Another set of control variables includes the fraction of each asset risk category, according to Basel I.

For explanatory variables, we also take into account measures of bank loans. We consider total loans to total assets ($TLOANS$), as well as the ratio of different loan types over total loans. Specifically, we focus on commercial and industrial, real estate, individual, and agricultural loans ($CI\ LOANS$, $REST\ LOANS$, $INDIV\ LOANS$, and $AGRI\ LOANS$, respectively). The percentage variation of the housing price index during the crisis is included among the explanatory variables of the change in liquidity risk.

We add variables that serve as proxies for the amount of illiquid collateral. The quality of the collateral may have affected the likelihood of participation in the TAF program. More precisely, we take into account the Asset-Backed Securities and other types of Mortgage-Backed securities. They are defined as the ratio of asset-backed securities to total assets (ABS) and the ratio of other types of mortgage-backed securities to total assets ($MBS\ OTHER$). These measures assume that securities are held to maturity or are available-for-sale at their fair value. As a determinant of bank participation in the TAF program, we also include the percentage change in housing prices, at the US state level, during the period between the end of the dot-com bubble (2002:Q1) and the four quarters before the beginning of the TAF program (2006:Q3). The value ascribed to each bank refers to that of the US state where the bank is headquartered. A detailed analysis of the sources and definitions of the variables are reported in Table B.11 in Appendix B.

3.3 Descriptive statistics

Table B.1 reports the descriptive statistics before (in 2007:Q3) and after (in 2010:Q3) the TAF program. Within each sub-period, we also provide separate descriptive statistics for the sub-sample of banks that received TAF support and for those that did not. With a focus on liquidity risk measures, the main findings highlight that before the beginning of the program (2007:Q3), TAF banks reported higher levels of funding liquidity risk than those of other banks (column (3) vs. column (1)) and that these differences decreased once the program is over (column (9) vs. column (7)). Liquidity risk volatility was higher for TAF banks than for the other banks. This is true for the two periods

analysed. Focusing on the components of the baseline measure of liquidity risk,[18] we find TAF banks had larger values before and after they received TAF funds. Moreover, these banks increased short-term assets and decreased their exposure in short-term liabilities after the end of the program compared to before. Once the program was over, NO TAF banks experienced a decrease in $ST\ ASS$ and an increase in $ST\ LIAB$. The other relevant result is that although all banks lowered their funding liquidity exposure, TAF banks did so to a greater extent. The only measure that does not follow this pattern is $CASH$. Specifically, banks that did not receive reserves under the TAF program increased $CASH$ more than the other banks. A plausible explanation for this result is that NO TAF banks would have employed cash as a substitute for TAF reserves. To meet their liquidity needs, they would have increased their cash holdings, given that they chose not to benefit from alternative financial aid.

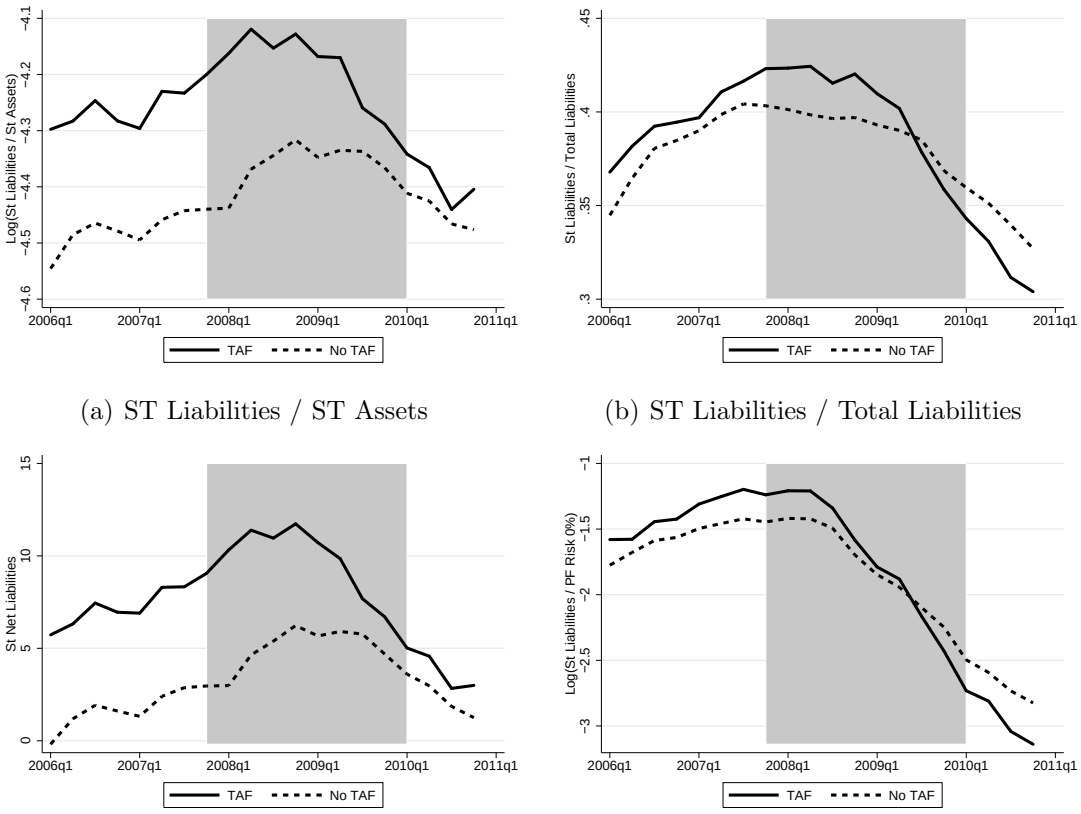
In Table B.2, we test whether, on average, there exist differences within groups across time and within time across groups. The results confirm previous intuitions: Ex ante, TAF banks exhibit higher levels of liquidity risk. Moreover, these differences decreased after the end of the program. Focusing on $ST\ LIAB$ and $ST\ ASS$, in both cases we find evidence that TAF banks compared to NO TAF banks show higher levels of the two variables both before and after they receive funds. Fixing the bank group, the results also highlight that there are no differences for the TAF banks across time, while NO TAF banks show a positive difference that is statistically significant. Finally, regarding liquidity measures, the results confirm that before and after the program TAF banks had less cash or liquidity than NO TAF banks, while the within-group analysis shows that only TAF banks experienced a significant increase in cash between the two periods.

The descriptive analysis highlights that both groups of banks adjusted the quantities that refer to liquidity risk, as indicated by liabilities and liquidity indicators. Moreover, in the majority of the cases, TAF banks changed these amounts more than the NO TAF banks. These changes also imply that the differences between the groups decreased or disappeared once the program was over. Previous patterns are illustrated in Figure 3. On average, bank liquidity risk levels between the groups were different just before the program began, while these differences decreased after the program ended.

[18] Specifically, $ST\ LIAB$ and $ST\ ASS$ are defined as the log of short-term liabilities and the log of short-term assets, respectively.

These results are confirmed by distinguishing bank quartiles (results available upon demand).

Figure 3: Bank average liquidity risk measures, by quarter



(a) ST Liabilities / ST Assets

(b) ST Liabilities / Total Liabilities

(c) ST Net Liabilities / Total Assets

(d) ST Liabilities / PF Risk 0%

Notes: We document the average behaviour of the following measures of liquidity risk, distinguished by bank group (TAF and NO TAF): ST LIAB/ST ASS, ST LIAB/TLIAB, ST NET LIAB, and ST LIAB/PF RISK ZERO. The period during which the TAF program was operating is in gray.

Figure 4 plots different measures of liquidity risk between 15 quarters before and 10 quarters after the first time banks received reserves under the TAF program. For all measures of liquidity risk, on average, the banks decreased their funding liquidity risk positions once they received the reserves. The graphical analysis suggests that the TAF program was effective and useful and that it especially improved the funding liquidity exposure of recipient banks.

One potential criticism could be that trends in previous graphs may be driven by the fact that banks received TAF support during a specific period. Therefore, if this is the case, it follows that what previous graphs are capturing does not refer to the effect of the TAF program but, rather, to other time-based events. Figure 5 shows the distribution of the quarters when banks received TAF support for the first time. The results highlight that about 50% of the TAF banks received the support

Figure 4: Average bank liquidity risk behaviour, by quarter

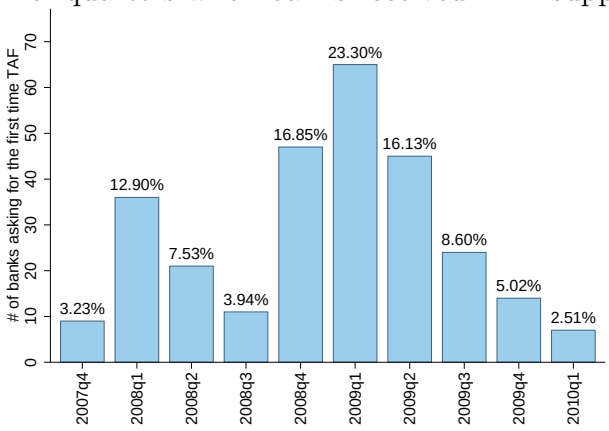
(a) ST Liabilities / ST Assets (b) ST Liabilities / Total Liabilities

(c) ST Net Liabilities / Total Assets (d) ST Liabilities / PF Risk 0%

Notes: For TAF banks only, we document the average behaviour of the following measures of liquidity risk from 15 quarters before to 10 quarters after the first time the banks obtained reserves: ST LIAB/ST ASS, ST LIAB/TLIAB, ST NET LIAB, and ST LIAB/PF RISK ZERO.

for the first time in the two quarters after the collapse of Lehman Brothers. The other 50% of the observations are spread around the rest of the quarters when the program was operating.

Figure 5: Distribution of quarters when banks received TAF support for the first time



Notes: This figure shows the distribution of the quarters when banks received TAF support for the first time. The vertical axis reports the frequencies. At the top of each bar is displayed the corresponding fraction of banks that received TAF support to the total number of TAF banks in a specific quarter.

To check whether the results summarized by Figure 4 are robust to this potential issue, we drop

from the sample banks that received TAF support for the first time in the two quarters after the collapse of Lehman Brothers. The findings (available upon request) do not change: The average liquidity risk per quarter decreases around the period zero. This is true for all the measures of liquidity risk employed.

4 Empirical strategy

4.1 Selection

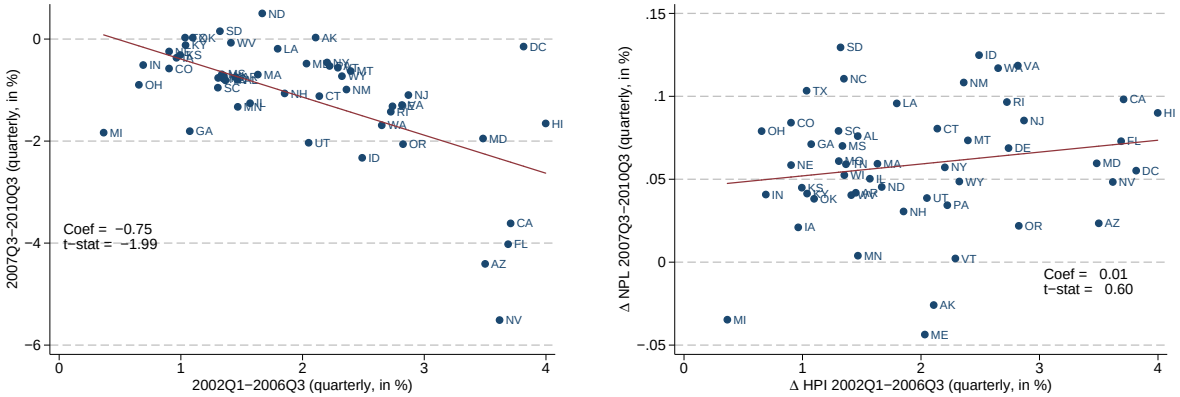
Participation in the TAF program was not random. Therefore, it is crucial to isolate the effect related to the voluntary choice of banks to ask for TAF funds, in order to assess the effect of the TAF program on the change in funding liquidity risk. We control for this selection issue by using the housing price index change at the US state level for the period 2002:Q1–2006:Q3 as an exogenous determinant of the probability to request TAF support.

More precisely, we claim that the 2002:Q1–2006:Q3 HPI percentage change is expected to positively affect participation in the TAF program. The reason is that US states that experienced a significant increase in housing prices for the period 2002:Q1–2006:Q3 were also those that, during the crisis, were hit by a relevant drop in housing prices (Figure 6.a) and a substantial increase in loan delinquency rates[19] (Figure 6.b). Therefore, banks headquartered in states where the HPI showed the patterns described above, were more likely to have suffered from the real estate collapse. These banks, in case of liquidity needs, could have found it more difficult to raise funds in the interbank credit market because of other banks' reluctance due to the risk related to the bursting of the real estate bubble. As a consequence, they should have been more likely to participate. It is important to note that the change in housing prices for the period 2002:Q1–2006:Q3 directly affects bank participation in the TAF program but does not affect bank strategy in changing liquidity risk during the period 2007:Q3–2010:Q3. Previous intuitions are supported by the results reported in column 6 of Table B.3 and by Figure 6.c.

Further information about the relationship between housing price changes and TAF participation

[19]The latter result is in line with those obtained by Doms et al. (2007).

Figure 6: Relation between changes in HPI and NPL before and during the crisis



(a)

(b)

(c)

Notes: In this figure, before the crisis (bc) is 2002:Q1–2006:Q3, and during the crisis (dc) is 2007:Q3–2010:Q3. Analysis at the state level (i). Figure 6.a: We document the relationship between the HPI percentage change before the crisis and that during the crisis. The line refers to the regression $\Delta\%HPI_{i,dc} = \alpha + \beta\Delta\%HPI_{i,bc} + \epsilon_i$. Figure 6.b: We document the relationship between the HPI percentage change before the crisis and the NPL percentage change during the crisis. The line refers to the regression $\Delta\%NPL_{i,dc} = \alpha + \beta\Delta\%HPI_{i,bc} + \epsilon_i$. Figure 6.c: We document the relationship between the HPI percentage change before the crisis and the change in liquidity risk ($ST\,LIAB/ST\,ASS$) during the crisis. The line refers to the regression $\Delta\%ST\,LIAB/ST\,ASS_{i,dc} = \alpha + \beta\Delta\%HPI_{i,bc} + \epsilon_i$.

is reported in Figure C.1 of Appendix D. More precisely, for each US state, we report the percentage change in housing prices during the period 2002:Q1–2006:Q3 (green), the size (by asset value) of the banks whose headquarters lie in a specific state (blue pie), and the fraction (by asset value) of banks that received TAF support (red). This figure highlights how the fraction of TAF banks is larger in US states that experienced greater appreciation of the housing price during the period 2002:Q1–2006:Q3.

4.2 Econometric model

To assess the impact of the TAF program on bank liquidity risk, we use a treatment effects model with a binary endogenous explanatory variable. This type of model is estimated simultaneously using maximum likelihood (ML) to provide consistent, efficient, and asymptotically normal estimators under the assumption that the error terms follow a bivariate normal distribution.[20]

We are interested in fitting the treatment effects model:

$$\begin{aligned}\Delta\, ST\,LIAB/ST\,ASS_i = {} & \alpha\, TAF_i + \beta_1\, LIQUIDITY_i + \beta_2\, CAPBUFFER_i + \beta_3\, ROA_i \\ & + \beta_4\, SIZE_i + \beta_5\, PFRISK\,0_i + \beta_6\, PFRISK\,20_i \\ & + \beta_7\, PFRISK50_i + \beta_8\, PFRISK100_i + \beta_9\, \Delta HPI_{i,\,2007:Q3-2010:Q3} + \xi_i \end{aligned} \quad (1)$$

$$TAF_i = \begin{cases} 1 & \text{if } TAF_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

where the unobserved latent variable follows the specification below:

$$\begin{aligned} TAF_i^* = {} & \pi_0 + \pi_1\, ST\,LIAB/ST\,ASS_i + \pi_2\, CASH_i \\ & + \pi_3\, MBS\,OTHER_i + \pi_4\, ABS_i + \pi_5\, \Delta HPI_{i,\,2002:Q1-2006:Q3} + \nu_i \end{aligned} \quad (3)$$

In the outcome equation (1), the change of funding liquidity risk, $\Delta\ LIQ\,RISK$, depends on a set of explanatory variables and on TAF, a binary endogenous covariate that captures the TAF program's impact on the dependent variable. Moreover, in equation (3) the latent variable determines the values of the binary variable TAF, according to equation (2). Equations (2) and (3) represent the participation part of the model. The TAF dummy can be interpreted as a participation indicator: It

[20] We test joint normality following Lee (1984), Pagan and Vella (1989), Bera et al. (1984), and Gallant and Nychka (1987). The null hypothesis of joint normality is never rejected at a reasonable significance level. The results are available upon request.

equals one if bank i received the funds at least once, and zero otherwise.

4.2.1 Outcome equation

All the variables included in equation (1), except the change in housing price index, are measured in 2007:Q3, prior to the beginning of the program. The dependent variable in equation (1) refers to the change in funding liquidity risk between 2007:Q3 and 2010:Q3. Once the selection bias is controlled for, the TAF variable is expected to negatively affect the change in funding liquidity risk. If this is the case, the TAF program is effective in the sense that it allows banks in funding liquidity distress to adjust and improve their funding liquidity exposure.

Several additional controls are added to equation (1). More precisely, we focus on $LIQUIDITY$, the level of $CAPBUFFER$, the $SIZE$ of the banks, and the ROA. The variable $LIQUIDITY$ captures potential liquidity distress associated with bank liquidity needs. The higher the liquidity level, the smaller the change in funding liquidity risk. The inclusion of $CAPBUFFER$ is useful for assessing the impact of capital cushions on the level of liquidity risk. More precisely, higher capital buffer implies that banks are prone to adopt more aggressive investment strategies, so we expect that capital buffer positively affects the change of funding liquidity risk. We explicitly take into account the $SIZE$ of the banks, because banks of different sizes have different abilities to manage liquidity risk. In particular, big banks can more easily adjust funding liquidity mismatches, so $SIZE$ is expected to have a negative impact on the change in liquidity risk. Finally, return on assets is a measure of investment returns. A higher return on assets implies that some banks invest more efficiently and therefore may easily reduce their funding liquidity exposure. We assess the effects of portfolio composition on the change in funding liquidity risk by including in the baseline specification the different types of assets held by banks[21]. We do not have an a priori expected sign for the effect of this second set of explanatory variables on the change in funding liquidity risk. Finally, the specification is completed by including the change of the housing price index, ΔHPI, for the period when the program was operating. We expect that more important drops in housing price at the US state level during the period 2007:Q3–2010:Q3 positively increased bank liquidity distress.

[21] The type of assets refers to their riskiness, consistent with Basel I.

The potential effect on liquidity risk of other Federal Reserve programs is not taken into account in the specifications. The reason is that the financial institutions that benefited from the other programs promoted by the Federal Reserve were not depository institutions. The only programs directly affecting depository institutions are the primary, secondary, and seasonal credit discount window, but, as previously mentioned, during the crisis these programs were less effective due to the fact that depository institutions were concerned about the stigma effect. Accordingly, the TAF program effects captured in our analysis appear unlikely to have been driven by other programs not explicitly taken into account in the specifications. This view is also supported by the information highlighted by Figure 2, which plots the Federal Reserve's weekly outstanding lending to financial institutions through the different programs operating during the last financial crisis. This figure shows the relevant role played by the TAF program in terms of the amounts provided, as well as the length of the period when the program was operated by the Federal Reserve.

4.2.2 Participation equation

Equations (2) and (3) capture the probability of obtaining the reserves. As previously mentioned, the key variable included among the covariates to explain a bank's probability to request TAF support is the percentage change in the housing price index between 2002:Q1 and 2006:Q3. The impact of this variable on bank participation is expected to be positive. Moreover, we include funding liquidity risk, cash, and illiquid collateral assets such as ABSs and MBSs, all measured in 2007:Q3. We expect that banks with higher levels of funding liquidity risk were more likely to participate in the program. The level of cash is expected to negatively affect the probability of receiving funds because banks with sufficient levels of cash were better able to manage liquidity distress. Banks showing high levels of illiquid collateral, reflecting greater maturity mismatch, are expected to be more likely to have participated in the TAF program, as predicted by Acharya et al. (2011).[22] These banks were solvent, but temporarily illiquid, because they were unable to increase liquidity by selling some of their assets.

[22]In a model of debt capacity, under specific assumptions about the tenor of the debt (shorter than that of assets), the frequency (high) of rolling over the debt; the liquidation cost (small) in case of default, and the probability (low) of finding potential borrowers in the market without short-term debt finance issues, Acharya et al. (2011) find sufficient conditions for a market freeze. A market freeze is more likely for banks holding important amounts of ABSs, assets with little trading liquidity.

Due to a lack of trust in the inter-bank credit market, these banks could not obtain liquidity from other banks, and only the Federal Reserve accepted their illiquid collateral assets in exchange for reserves.

5 Hypotheses and results

5.1 Participation effect on liquidity risk

Based on the findings of Section 3.3, our first hypothesis is that

H1: Banks that benefited from the TAF program decreased their liquidity risk exposures more quickly .

The results reported in Table B.3 confirm our hypothesis. The TAF dummy is always negative and statistically significant. This means that banks that received TAF reserves decreased funding liquidity exposure more quickly than those that did not. This effect is not only statistically significant but also economically substantial. Receiving TAF loans has an average extra effect on the quarterly growth rate of the funding liquidity exposure between -6.55 and -6.95 percentage points, depending on the case.[23] These results support the intuition that TAF reserves were crucial to reduce bank exposure and control for the funding liquidity risk of those banks with more severe maturity mismatches, which were most exposed to the freezing of the interbank market and unable to roll over their short-term liabilities during the crisis. This finding suggests that the TAF program provided banks with extra time to adjust the liability side of their balance sheets. A possible reason is that TAF banks might have considered themselves under scrutiny and might have reacted accordingly to look better when reassessed later on, although they were not subject to additional controls by the Federal Reserve.

The results hold regardless of the specification. More precisely, column (1) of Table B.3 reports the results of the baseline model. In column (2) we replace the different risk type shares by the weighted asset risk $PF\,RISK$. In column (3) we use the different types of loans instead of banks assets classified by risk category. In column (4) we estimate a reduced form of the baseline specification by dropping

[23]To interpret the dependent variable as a quarterly growth rate we have to divide the estimated coefficient of the dummy variable TAF by 12, the number of quarters between 2007:Q3 and 2010:Q3.

the different types of assets, while in column (5) we augment the previous specification by adding $PROV$ and NPL to capture the impact of expected future and current distress due to bad loans on liquidity risk.

The findings also confirm our intuition about the impact of the covariates, included in the different specifications, on liquidity risk change. Finally, the λ parameter is never statistically different from zero. We can therefore conclude that our results do not suffer from selection bias.[24]

5.2 Effect of reserves amount on liquidity risk

Another element affecting the change in liquidity funding is the amount of reserves that banks received within the TAF program framework. We expect that the larger the support received (proportional to the bank's size), the greater the effect on decreasing liquidity risk exposure. More precisely, we propose the following hypothesis.

H2: The larger the amount of reserves received, the higher the impact of the TAF program on liquidity risk change.

We employ three different measures of the total amount of reserves received by each bank. Specifically, we focus on the amount received, $TAF\,AMOUNT\,1$; the amount received weighted by the level of total loans measured in 2007:Q3, $TAF\,AMOUNT\,2$; and the average amounts received by each bank, $AVGTAF\,AMOUNT$, that is, the total amount divided by the number of successful bids.

Due to the nature of these alternative measures, specifically that they are continuous and left censored at zero, we modify the econometric model described in Section 4.2. More precisely, equations (2) and (3) are estimated using a Tobit model instead of a probit model. The explanatory variables used do not change with respect to the baseline model.

The results, reported in Table B.4, confirm our hypothesis. The findings highlight a negative relationship between the amount of reserves received and the adjustment of the funding liquidity risk. According to the results in column (1), a 1% increase in reserves received leads to a drop in the liquidity risk growth rate of 0.099%. The impact is reduced to about one-third if we focus on the

[24]The null hypothesis is no selection bias. In all cases, we reject the null hypothesis at the 1% significance level (see the corresponding χ^2 statistics).

fraction of amounts received with respect to the total loans the bank holds, as reported in column (2). Finally, as highlighted in column (3), an increase of 1% of the average amount of reserves received leads to a 0.147% decrease in the growth rate of the liquidity risk measure. This finding implies that the amount received through the TAF program matters in reducing exposure to liquidity risk. This holds regardless of the alternative measures of TAF benefits used, as documented by columns (1) to (3). Moreover, we test whether the results hold when an alternative dependent variable is employed. As shown in columns (4) to (6), the findings do not depend on the proxy for liquidity risk.

5.3 HPI change and the probability of receiving TAF support

As thoroughly discussed in Section 4.1, we employ the change in housing price index between 2002:Q1 and 2006:Q3 at the US state level as an exclusion restriction in the first-stage regression. More precisely, US states that experienced a huge increase in HPI during the period 2002:Q1–2006:Q3 are also those that showed a drastic drop in the same variable during the period 2007:Q3–2010:Q3. These states particularly suffered from the bust of the real estate boom. This variable can explain the difficulties banks located in these US states had in accessing to the interbank credit market due to the reluctance of the other banks to lend. Accordingly, we propose the following hypothesis.

H3: Banks with headquarters in US states that experienced a larger appreciation in HPI during the period 2002:Q1–2006:Q3 are more likely to have received TAF funds.

The results support our hypothesis. As highlighted in Table B.3, in the participation equation the change in HPI between 2002:Q2 and 2006:Q3 is always significant and positive. This result does not depend on the specification. In our opinion, this variable is crucial in fixing the selection effect, and therefore in isolating the effect of the TAF program. More precisely, the change in HPI from 2002:Q2 to 2006:Q3 affects the probability of receiving TAF support but does not directly affect the decision of the bank to decrease liquidity exposure during the period 2007:Q3–2010:Q3.

5.4 Illiquid collateral and the probability of receiving TAF support

The last hypothesis tested refers to the assessment of the impact of illiquid collateral on the probability of receiving TAF support. During the crisis, collateral such as MBSs or ABSs was revealed to be illiquid. Therefore, banks with important fractions of these types of collateral were more likely to be in need of liquidity. However, other banks were reluctant to lend them money because they thought that banks asking for funds were suffering from liquidity distress. Therefore, banks with higher fractions of MBSs and ABSs were more likely to have received TAF support. More precisely, we propose the following hypothesis.

H4: Banks with higher fractions of illiquid collateral such as MBSs and ABSs are more likely to have received TAF funds.

The results reported in Table B.3, confirm our hypothesis. This holds regardless of the specification. The results support the theoretical model by Acharya et al. (2011). The findings hold in several robustness checks, as documented in Tables B.7, B.5, and B.6.

5.5 Robustness

We perform several robustness tests and the results are reported in Tables B.5 to B.10.

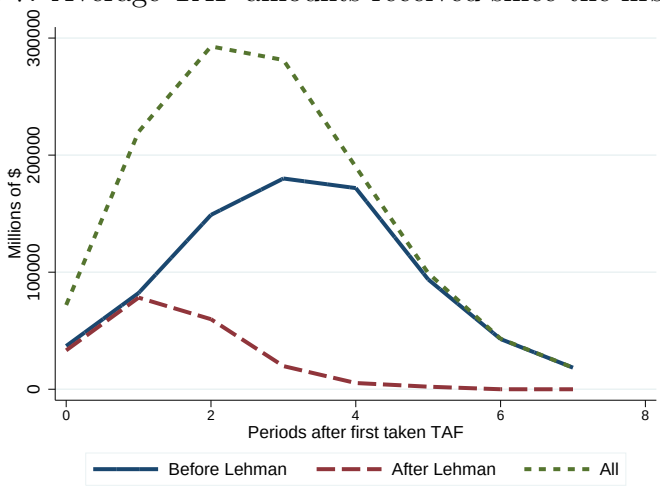
5.5.1 Competitive auctions and the pre-Lehman period

Our result could suffer from an omitted variable bias because other events occurred contemporaneously to the TAF program and were not explicitly taken into account.[25] One relevant episode was the failure of Lehman Brothers in 2008:Q3. We already controlled for the Lehman event by dropping all banks that had a large fraction of their credit lines co-syndicated with Lehman Brothers, as reported by Ivashina and Scharfstein (2010). For comparison reasons, the results of the baseline model are reported in column (1) of Table B.5. Moreover, in column (2) we verify the results by limiting our sample to the pre-September 2008 TAF auctions. The results show that the TAF coefficient is statistically different from zero and has the expected negative sign. The results of the competitive auctions are consistent

[25] As previously discussed, we do not control for the effect of the other extraordinary programs promoted by the Federal Reserve since depository institutions were not eligible for those programs.

with the baseline findings in terms of the direction of the effect (negative) of the TAF program and with respect to the size of the effect (4.68 percentage points in the competitive auctions versus 6.55 percentage points for the overall sample). Despite these common elements, we can capture differences in the amounts received by the two groups of TAF banks, those that benefited from the program for the first time before Lehmans collapse and those that benefited from the program afterward. Figure 7 shows the average amounts of reserves received by all the banks, by banks that received the reserves for the first time before the collapse of Lehman Brothers, and by banks that received the reserves for the first time after the collapse of Lehman Brothers. The majority of the funds were ascribed to depository institutions that received the facilities for the first time before the collapse of Lehman Brothers. Moreover, for these banks, the maximum average amount received was obtained after three periods, and they benefited from the program for a longer period than the depository institutions that obtained the reserves for the first time after the collapse of Lehman Brothers.

Figure 7: Average TAF amounts received since the first time



Notes: This figure shows the average amounts of reserves received by all banks, by banks that received the reserves for the first time before the collapse of Lehman Brothers, and by banks that received the reserves for the first time after the collapse of Lehman Brothers.

5.5.2 Controlling for TARP

Another event that could affect our results is the Troubled Asset Relief Program (TARP)[26] promoted by the US Treasury in October 2008. Among the banks in our sample, only seven received both TAF reserves and equity through the TARP program. However, we found that 89 banks received TAF and participated in the TARP program through their bank holding companies. To control for the TARP effect on liquidity risk, we exclude from the sample the 96 banks that participated in the TARP program. The results, reported in column (5) of Table B.5, remain unchanged. Therefore, we can conclude that our findings are not driven by the TARP program.

5.5.3 Higher levels of liquidity distress

The TAF banks display higher levels of liquidity risk. It follows that, in extreme cases, TAF banks should have adjusted their exposure more quickly. If this was the case, what the TAF dummy captures is not an effect of the TAF program but, rather, a feature of the TAF banks. We control for this potential issue by implementing propensity score matching with three neighbours and matching TAF and NO TAF banks with respect to liquidity risk measures such as short-term liabilities over short-term assets, short-term liabilities over total liabilities, short-term net liabilities, short-term liabilities over risk-free assets, short-term liabilities and short-term assets. We measure the variables in 2007:Q3. The results reported in column (7) of Table B.5 confirm the main findings: TAF participation is still significant and has the expected negative sign.

5.5.4 Sample heterogeneity

Since our sample includes all commercial banks that submitted Call Reports, and only a small fraction of those banks received TAF funding, we face a potential problem where the uneven distribution of the number of banks between the two groups could drive the main results. More precisely, only 265 out of 7591 banks (3.49%) received the TAF reserves. To alleviate this potential problem, we run a bootstrapping exercise, repeated 1000 times, to generate sub-samples of banks. The sub-samples

[26] In October 2008, the US Treasury launched the TARP. One part of it was the Capital Purchase Program (CPP), an equity infusion program created by the US Treasury in favour of credit institutes. Specifically, the US Treasury bought preferred non-voting stocks of U.S. financial institutions for a total value of $250 billion.

include all banks that participated in the program and a randomly chosen subset of banks that did not receive TAF funding. Each estimation is based on 1000 observations. In this way, it is possible to construct a distribution based on 1000 estimations for each estimate.[27] As column (6) of Table B.5 shows, the results are largely unchanged compared to our benchmark case, even if the TAF effect is now greater than in the results for the baseline model. Figure A.1 shows the distribution of the estimate of the TAF variable obtained from the bootstrapping exercise, as well as the bounds of the 95% confidence interval.

Alternatively, we balance the sample by employing a matching exercise. We use propensity score matching with three neighbours and match TAF and NO TAF banks with respect to $LIQ.\ RISK$, $CAPBUFFER$, $PF\ RISK$, ROA, $SIZE$, $CASH$ and $LIQUIDITY$. We estimate the model by including all TAF banks and 705 matched (with replacement) NO TAF banks. As shown in column (4) of Table B.5, the direction of the TAF effect is the same, even if the magnitude of the impact has increased.

5.5.5 Sample period and alternative dependent variables

To check whether the results are robust to the sample period chosen before the beginning of the program, in column (3) of Table B.5 we measure the variables in 2006:Q3 instead of in 2007:Q3, that is, two years before the beginning of the program. The results do not differ with respect to those of the baseline model: The larger value of the estimate is compensated by the longer period considered. Rescaling the estimate appropriately and dividing it by 16 periods we obtain a value of 5.46 percentage points, in line with the baseline results.

Throughout the paper we have used short-term liabilities over short-term assets as the measure for bank liquidity riskiness. The literature suggests other measures of liquidity risk, which include short-term net liabilities, short-term liabilities over total liabilities, and short-term liabilities over risk-free assets. Table B.7 compares the estimation results for different measures of liquidity risk. Column (1) reports the baseline results using the ratio of short-term liabilities to short-term assets as a proxy for liquidity risk, while columns (2) to (4) report the results referring to the above-mentioned measures

[27] More details about the bootstrapping exercise are provided in Appendix A.

of funding liquidity risk. The estimation results for the TAF dummy in the outcome equation are negative and statistically significant, confirming the baseline findings.

Since the main variable for measuring liquidity risk is a ratio, we are also interested in assessing the impact of the TAF program on short-term liabilities and short-term assets separately. Columns (5) and (6) of Table B.7 show that TAF affects negatively both short-term liabilities and short-term assets. However, the contraction is larger (more than double) for short-term liabilities.

5.5.6 Too big to fail and solvent banks

During the last financial crisis, systemically important commercial banks were not allowed to fail. Being too big to fail might lead to a moral hazard problem,[28] a potential source of attenuation bias in our findings. To assess the too big to fail effect on the impact of the TAF program on liquidity risk, we focus on the 75th, 90th and 95th percentiles in terms of size. The results of TAF program participation on the change in liquidity risk are confirmed. In particular, the larger the bank, the greater the TAF effect.

Finally, throughout the paper we focused on liquidity issues disregarding solvency aspects related to bank participation in the TAF program. In particular, it could be that banks participated in the TAF program because of solvency problems instead of maturity mismatches. We address this issue by adopting the following strategy. First, we calculate the median of the variables $CAPBUFFER$, $PF\ RISK$, $CASH$, and $ST\ LIAB/RISK\ FREE$ assets of those banks that participated in the TAF program, but failed nevertheless. Since these banks had access to liquidity, it is highly likely that these banks failed due to solvency problems. Second, we consider only banks that had better fundamentals by considering the aforementioned variables. The new sample includes 67 TAF banks and 3568 NO TAF banks. As reported in column (5) of Table B.6, the results are consistent with those of the benchmark.

[28] If banks internalize that they will always be bailed out with taxpayer money, they might adopt riskier strategies.

5.5.7 Alternative approaches

The previous results are based on the treatment effects model. Although the treatment effects model is well-suited to deal with the participation issue, we also provide the results based on two alternative estimation methods: ordinary least squares (OLS) and two-stage least squares (2SLS). Column (1) of Table B.8 reports the results of equation (1) estimated using OLS. In column (2) we augment the previous specification by adding the explanatory variables included in the participation equation (3). In column (3), we report the estimations using the two-step approach: we first estimate a probit model to compute the predicted participation to the TAF program, based on equation (3), then we replace in equation (1) the TAF variable by the predicted value. In column (4), we document the results using a treatment effect model estimated using a two-step procedure. In all cases, the TAF coefficient is statically significant and has the expected sign, even if depending on the estimation the magnitude of the impact of the TAF program is different. We can conclude that the main results are not driven by the econometric technique employed.

5.5.8 Shorter time horizons

The main results are based on measuring the impact of the TAF program on the change in liquidity distress before the beginning of the program and after its conclusion. As mentioned earlier this strategy allows us to neutralize any concern coming from an accounting effect. However, the TAF program was set up as an emergency measure with the aim of short-run effect. To measure the short-run effect of TAF on liquidity risk, we estimate the model on shorter time horizons. We compute the change in liquidity risk between the 'after' period and 2007:Q3 and estimate the model. In the columns in Table B.9 we choose 2008:Q3, 2009:Q1, 2009:Q3 and 2010:Q1 as different after periods. Since not all banks receive TAF at the same time, the number of TAF banks in the estimation changes (as indicated in the last row of Table B.9). In all cases, TAF has a negative and statistically significant impact. The point estimate of the effect of the TAF program on the change in liquidity risk is larger as the horizon increases. This is consistent with the observations in Figure 4.

5.5.9 Additional variables in participation equation

In Table B.10 we extend the set of variables included in the participation equation. We add ROA as a measure of profitability of the bank, $SIZE$ to identify potential scale effects, and PF_RISK and TOT_LOANS as measures for the asset side of the balance sheets. In columns (1)–(4) of Table B.10 we add these variables individually, and include them all together in column (5). Also with the extended set of variables in the participation equation, the results show that the coefficient on the TAF dummy remains negative and statistically significant. The estimation results from the participation equation highlight that banks with higher total assets and higher risk-weighted assets are more probable to participate to TAF.

6 Conclusion

During the last financial crisis the Federal Reserve promoted several extraordinary actions, including the creation of a number of new facilities for auctioning short-term credit, with the general aim of supporting the financial sector and ensuring that financial institutions had adequate access to liquidity. One of these programs was the Term Auction Facility (TAF). Using a unique dataset and taking an alternative perspective with respect to previous contributions on this topic, which focus on the impact of the TAF program on aggregate spreads, we concentrate on the impact of the TAF program on the specific behaviours of banks. More precisely, the goals of this paper are to assess which type of bank benefited from the program and to quantitatively determine whether banks that received TAF funds reduced their liquidity risk positions.

We show that banks in major funding liquidity distress benefited from the reserves auctioned in the context of the TAF program. Moreover, we find that the TAF program had an impact on the reduction of funding liquidity risk. The higher the amount of reserves received, the stronger the impact. A possible reason is that TAF funds allowed the banks to restructure their liability side of the balance sheet. In particular, the access to TAF funds relieves the immediate pressure to roll-over maturing debt. Although TAF was short-term, it was reasonable to assume for a bank to assume that it will be able to participate at later auctions again. Therefore, not only the immediate lack of

funding was resolved, but also the medium-term outlook improved. The fact that a bank has access to TAF was a positive signal to counterparties and the bank was able to find longer-term funding.

Moreover, we find that banks located in US states that experienced an important increase in housing prices during the period 2002:Q1–2006:Q3 are more likely to have participated in the program. This is due to the fact that, in these US states, the number of non-performing loans increased considerably during the crisis, and therefore banks located there were most exposed to the freezing of the interbank market and unable to roll over their short-term liabilities during the crisis. For these banks the TAF reserves were crucial to reduce their exposure and control their funding liquidity risk. Moreover, our findings support the opinion that TAF-like programs are appropriate during situations similar to the last crisis. In particular, our results support the view of those who consider the TAF program an additional countercyclical monetary policy instrument useful in mitigating bank liquidity concerns during economic busts (e.g. Rochet and Vives, 2004).

Our study stresses the importance of banking liability term structure as a source of banking soundness. From this perspective, our contribution provides empirical justification to those arguments in favour of the introduction of liquidity risk measures in international financial regulations. In particular, the new measures, implemented in Basel III, such as the liquidity coverage ratio and the net stable funding ratio, go in the right direction of focusing on liquidity management for the proper functioning of the banking sector and financial markets.

Finally, our results shed light on the behaviour of a particular group of banks. Specifically, we document that only banks in funding liquidity distress obtained loans through TAF. This was the case even if TAF loans were provided at favourable conditions (with the minimum bid rate below the primary credit discount rate and participation in TAF program kept private) and despite the fact that all bids were accepted after the Lehman Brothers collapse. This result raises the question of why the good banks decided not to participate in the TAF auctions. One potential explanation is that, even if the information about the participation was, at least theoretically, private, they were still concerned about the stigma effect.

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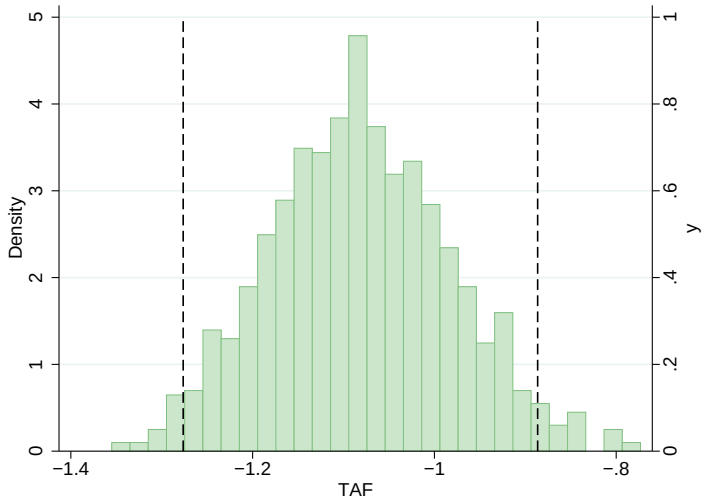
Appendices

A Bootstrapping approach

Figure A.1: TAF estimated coefficient obtained by a bootstrapping approach



To alleviate the potential problem of the uneven distribution of TAF and NO TAF banks, we run a bootstrapping exercise. In each iteration, the sample includes all TAF banks and a randomly chosen subset of NO TAF banks.

The graph in Figure A.1 shows the distribution of the estimate of TAF reserves as well as the bounds of the corresponding confidence interval at 95%, obtained by repeating the estimation 1000 times and by using a sample of around 1000 random observations. Before the estimation we check whether the mean of all the variables used of the chosen sub-sample are within a narrow band around the mean of the entire sample (we use 0.2 times the standard deviation as a threshold).

B Tables

Table B.1: Summary statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Before						After					
	No TAF		TAF		Total		No TAF		TAF		Total	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
ST LIAB / ST ASSET	-4.409	.751	-4.259	.856	-4.404	.755	-4.441	.682	-4.466	.812	-4.442	.687
NET ST LIAB	4.214	18.14	8.059	19.21	4.354	18.19	3.278	16.03	2.485	16.26	3.250	16.04
ST LIAB / PF RISK 0	-1.420	1.309	-1.192	1.634	-1.411	1.322	-2.636	1.398	-3.014	1.450	-2.650	1.401
ST LIAB / TLIAB	.404	.131	.411	.142	.404	.131	.349	.126	.317	.130	.348	.126
ST LIAB / LIQ	-3.862	1.105	-3.547	1.283	-3.850	1.114	-3.870	1.281	-3.849	1.177	-3.869	1.278
ST LIAB	6.164	1.330	8.281	2.140	6.241	1.423	6.180	1.256	8.216	1.961	6.253	1.342
ST ASSET	10.57	1.255	12.54	2.037	10.64	1.343	10.62	1.272	12.68	2.048	10.69	1.362
LIQUIDITY	.209	.139	.156	.118	.207	.139	.199	.143	.162	.120	.197	.143
CASH	.0379	.0398	.0281	.0345	.0375	.0397	.0834	.0790	.0675	.0716	.0829	.0788
CAPBUFFER	.0491	.0592	.0375	.0745	.0486	.0598	.0353	.0429	.0266	.0344	.0350	.0427
SIZE	11.90	1.250	14.06	2.152	11.97	1.355	12.05	1.238	14.23	2.081	12.13	1.341
ROA	.00559	.00716	.00677	.00660	.00564	.00715	.00145	.0120	-.00191	.0188	.00133	.0123
NPTL	.0238	.0245	.0162	.0144	.0236	.0242	.0512	.0594	.0621	.0545	.0516	.0593
PROV	.000972	.00274	.00126	.00200	.000982	.00272	.00368	.00793	.00834	.0115	.00385	.00814
TLOANS	.647	.151	.677	.146	.648	.150	.625	.147	.662	.138	.626	.147
RTESTLOANS	.684	.194	.702	.202	.685	.194	.712	.188	.722	.213	.712	.189
CILOANS	.148	.107	.177	.131	.149	.108	.134	.0951	.158	.124	.134	.0964
INDIVLOANS	.0771	.0907	.0705	.144	.0769	.0932	.0647	.0853	.0735	.175	.0651	.0901
AGRILOANS	.0740	.126	.0177	.0547	.0719	.125	.0715	.124	.0173	.0544	.0696	.123
PF RISK	.692	.125	.761	.115	.695	.126	.666	.119	.716	.111	.668	.119
PF RISK 0	.0259	.0483	.0249	.0620	.0259	.0489	.0732	.0820	.0859	.0926	.0737	.0825
PF RISK 20	.251	.143	.186	.117	.249	.143	.221	.142	.164	.103	.219	.141
PF RISK 50	.162	.120	.131	.0961	.160	.119	.169	.116	.133	.0856	.167	.115
PF RISK 100	.561	.170	.658	.153	.565	.170	.538	.160	.617	.138	.540	.160
Obs	7326		265		7591		7326		265		7591	

Notes: We can distinguish along two dimensions. On the one hand, columns (5) and (11) refer to the average values of the variables measured in 2007:Q3 (before), just before the beginning of the program, and in 2010:Q3, two quarters after the program's conclusion (after). On the other hand, columns (1), (3), (7), and (9) report the average values of the variables by distinguishing between banks that received TAF program reserves and the other banks in each of the two periods.

Table B.2: Average difference tests, before and after

Variable	Before	After	No TAF	TAF	Diff in Diff
ST LIAB / ST ASSET	0.203***	-0.018	-0.006	-0.227***	-0.221***
	(0.058)	(0.051)	(0.013)	(0.076)	(0.077)
NET ST LIAB	4.641***	-0.629	-0.344	-5.614***	-5.270***
	(1.211)	(1.017)	(0.298)	(1.553)	(1.581)
ST LIAB / PF RISK 0	0.228**	-0.377***	-1.217***	-1.822***	-0.605***
	(0.102)	(0.091)	(0.023)	(0.135)	(0.137)
ST LIAB / TLIAB	0.010	-0.033***	-0.054***	-0.097***	-0.043***
	(0.009)	(0.008)	(0.002)	(0.012)	(0.012)
ST LIAB / LIQ	0.323***	0.025	-0.007	-0.304***	-0.298***
	(0.080)	(0.074)	(0.020)	(0.107)	(0.109)
ST LIAB	2.148***	2.067***	0.063***	-0.018	-0.081
	(0.133)	(0.121)	(0.022)	(0.179)	(0.180)
ST ASSET	1.945***	2.085***	0.069***	0.210	0.140
	(0.129)	(0.127)	(0.021)	(0.179)	(0.180)
LIQUIDITY	-0.051***	-0.034***	-0.007***	0.009	0.017
	(0.007)	(0.008)	(0.002)	(0.010)	(0.011)
CASH	-0.008**	-0.017***	0.046***	0.037***	-0.009
	(0.004)	(0.005)	(0.001)	(0.006)	(0.006)

Notes: Columns (1) and (2) test whether, on average, a difference exists within groups across time (with 2007:Q3 as the before period and 2010:Q3 as the after period). Columns (3) and (4) test whether, on average, a difference exists within time across groups (TAF and NO TAF). Finally, column (5) tests whether there are differences in differences.

Table B.3: Baseline model

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome equation						
Dependent variable:			Δ ST LIAB ASS			
LIQUIDITY	-.771***	-.476***	-.191**	-1.063***	-.253***	-.771***
	(.154)	(.133)	(.075)	(.176)	(.072)	(.077)
CAPBUFFER	2.702***	3.015***	3.330***	2.475***	3.282***	2.702***
	(.286)	(.285)	(.289)	(.287)	(.306)	(.110)
ROA	-4.273**	-4.374**	-1.715	-4.093*	-2.804	-4.274***
	(2.107)	(2.050)	(2.884)	(2.151)	(3.134)	(.712)
SIZE	-.036***	-.037***	-.044***	-.045***	-.038***	-.036***
	(.008)	(.008)	(.011)	(.008)	(.008)	(.006)
PF RISK 0	1.116***					1.117***
	(.317)					(.176)
PF RISK 20	.995***					.995***
	(.172)					(.096)
PF RISK 50	-.042					-.042
	(.126)					(.089)
PF RISK 100	.297***					.297***
	(.106)					(.078)
HPI 2007:Q3–2010:Q3	-.050***	-.058***	-.046***	-.053***	-.054***	-.050***
	(.012)	(.012)	(.012)	(.011)	(.011)	(.013)
TAF	-.786***	-.834***	-.770***	-.828***	-.807***	-.785***
	(.111)	(.105)	(.106)	(.106)	(.104)	(.064)
PF RISK		-.439***				
		(.155)				
CILOANS			.996**			
			(.447)			
RTESTLOANS			.759*			
			(.417)			
INDIVLOANS			.615			
			(.492)			
AGRILOANS			.559			
			(.441)			
TLOANS				-1.013***		
				(.177)		
PROV					-5.262	
					(5.168)	
NPTL					.641**	
					(.318)	
HPI 2002:Q1–2006:Q3						-.001
						(.014)
Constant		.675***	-.391	1.269***	.309***	
		(.171)	(.486)	(.191)	(.103)	
Participation equation						
CASH	-.017	-.015	-.268	.194	-.268	-.017
	(1.547)	(1.493)	(1.541)	(1.466)	(1.517)	(.660)
ST LIAB / ST ASSET	.384***	.429***	.402***	.404***	.420***	.384***
	(.067)	(.068)	(.067)	(.066)	(.067)	(.037)
MBSO	2.322	2.125	2.372	2.345	2.158	2.323*
	(1.929)	(1.964)	(1.897)	(2.002)	(1.926)	(1.187)
ABS	17.270***	17.398***	17.294***	18.059***	17.556***	17.269***
	(3.280)	(3.156)	(3.192)	(3.354)	(3.182)	(2.884)
HPI 2002:Q1–2006:Q3	.115***	.104***	.111***	.108***	.107***	.115***
	(.034)	(.034)	(.034)	(.034)	(.034)	(.033)
Constant	-.302	-.073	-.205	-.204	-.115	-.302*
	(.315)	(.320)	(.320)	(.311)	(.319)	(.174)
Obs.	7591	7591	7570	7591	7570	7591
ρ	.480	.520	.481	.508	.505	.480
λ	.311	.342	.307	.331	.325	.311
	(.0473)	(.0454)	(.0447)	(.0455)	(.0440)	(.0238)
χ^2	36.53	45.52	40.21	43.32	45.04	61.34

Notes: This table shows the joint estimation of the treatment effects model with the binary dependent variable TAF, using ML. Robust standard errors are in parentheses. *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.

Table B.4: Different measures for capturing the TAF program effect

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome equation						
Dependent variable:	ΔST LIAB ASS	ΔST LIAB ASS	ΔST LIAB ASS	ΔST LIAB/TLIAB	ΔNET ST LIAB	ΔST LIAB/PF RISK 0
LIQUIDITY	-.798***	-.956***	-.800***	-.044***	-22.713***	.602***
	(.076)	(.078)	(.076)	(.013)	(1.777)	(.176)
CAPBUFFER	2.707***	2.766***	2.714***	.063***	53.304***	1.746***
	(.110)	(.115)	(.110)	(.019)	(2.559)	(.254)
ROA	-4.284***	-.852	-4.264***	.400***	-48.187***	2.499
	(.708)	(.905)	(.708)	(.120)	(16.601)	(2.005)
SIZE	-.033***	-.030***	-.031***	-.008***	-.725***	-.161***
	(.006)	(.006)	(.006)	(.001)	(.145)	(.014)
PF RISK 0	1.105***	.891***	1.082***	.134***	20.574***	8.873***
	(.176)	(.173)	(.176)	(.030)	(4.081)	(.379)
PF RISK 20	.975***	1.109***	.953***	.099***	24.593***	.515**
	(.097)	(.097)	(.097)	(.016)	(2.255)	(.216)
PF RISK 50	-.104	-.138	-.126	-.013	-5.923***	1.144***
	(.091)	(.088)	(.091)	(.016)	(2.106)	(.198)
PF RISK 100	.261***	.181**	.236***	.011	6.159***	.198
	(.080)	(.078)	(.080)	(.014)	(1.848)	(.174)
HPI 2007:Q3–2010:Q3	-.046***	-.050***	-.046***	-.015***	-1.914***	.230***
	(.009)	(.009)	(.009)	(.002)	(.215)	(.020)
TAF AMOUNT 1	-.099***			-.017***	-3.664***	-.072*
	(.012)			(.003)	(.232)	(.041)
TAF AMOUNT 2		-.035***				
		(.003)				
AVG TAF AMOUNT			-.147***			
			(.017)			
Participation equation						
LIQ. RISK MEASURE	3.377***	14.436***	2.332***	15.349***	.220***	1.017***
	(.469)	(1.719)	(.318)	(3.286)	(.021)	(.341)
CASH	-6.121	-6.673	-4.221	-16.091**	1.057	-18.333**
	(7.916)	(27.857)	(5.423)	(8.088)	(6.865)	(8.385)
MBSO	33.929**	107.776**	23.346**	44.136***	21.420*	51.736***
	(13.830)	(49.867)	(9.464)	(14.551)	(12.589)	(14.616)
ABS	179.655***	687.088***	124.212***	144.191***	177.779***	151.735***
	(34.676)	(125.693)	(23.672)	(35.237)	(32.638)	(36.426)
HPI 2002:Q1–2006:Q3	1.500***	5.092***	1.033***	1.548***	1.175***	1.533***
	(.376)	(1.382)	(.258)	(.384)	(.353)	(.383)
Constant	-7.986***	-20.044***	-5.408***	-29.289***	-22.507***	-21.581***
Obs.	7591	7570	7591	7591	7591	7310

Notes: This table shows the joint estimation of the treatment effects model with left-censored dependent variables ($TAF\ AMOUNT$ 1, $TAF\ AMOUNT$ 2, and $AVG\ TAF\ AMOUNT$) using ML. Robust standard errors are in parentheses. *** $= p < 0.01$, ** $= p < 0.05$, * $= p < 0.1$. The variable $TAF\ AMOUNT$ 1 is the log of one plus the overall amount of TAF reserves received; $TAF\ AMOUNT$ 2 is the log of one plus the ratio of the overall amount of TAF reserves received to total loans and $AVG\ TAF\ AMOUNT$ is the log of one plus the ratio of overall amount of TAF funds received by each bank to the number of times a bank received TAF funds.

Table B.5: Methodologies and sub-samples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome equation							
Dependent variable:	MLE	Lehman	Early	Matching I	W/out TARP	Bootstrap	Matching II
LIQUIDITY	-.771***	-.835***	-1.050***	-.867	-.931***	-.135	-.033
	(.154)	(.155)	(.148)	(.626)	(.131)	(.430)	(.302)
CAPBUFFER	2.702***	2.750***	2.408***	1.778	2.956***	2.021**	3.28***
	(.286)	(.285)	(.211)	(1.478)	(.287)	(.876)	(.8037)
ROA	-4.273**	-4.054*	-3.808**	-13.325	-5.495***	-6.975	5.58
	(2.107)	(2.076)	(1.832)	(8.375)	(1.717)	(8.426)	(5.518)
SIZE	-.036***	-.038***	-.033***	-.034	.002	-.029	-.052***
	(.008)	(.009)	(.008)	(.023)	(.009)	(.018)	(.013)
PF RISK 0	1.116***	1.123***	.865***	1.789***	.950***	1.150*	.92**
	(.317)	(.313)	(.247)	(.681)	(.330)	(.633)	(.416)
PF RISK 20	.995***	1.031***	1.247***	1.231	.700***	.707	.867*
	(.172)	(.173)	(.183)	(.755)	(.139)	(.475)	(.319)
PF RISK 50	-.042	-.075	-.025	.594	-.582***	.425	.463
	(.126)	(.129)	(.134)	(.403)	(.126)	(.315)	(.292)
PF RISK 100	.297***	.316***	.313***	.585*	-.172	.353	.645***
	(.106)	(.110)	(.105)	(.305)	(.113)	(.235)	(.192)
HPI 2007:Q3–2010:Q3	-.050***	-.042***	-.056***	-.038	-.050***	-.093***	-.067***
	(.012)	(.012)	(.012)	(.031)	(.012)	(.031)	(.025)
TAF	-.786***	-.562***	-.875***	-1.227***	-.604***	-1.081***	-.993***
	(.111)	(.137)	(.127)	(.138)	(.168)	(.149)	(.087)
Participation equation							
ST LIAB / ST ASSET	.384***	.237***	.365***	.478***	.275***	.575***	.47***
	(.067)	(.071)	(.059)	(.085)	(.098)	(.088)	(.091)
CASH	-.017	-8.271*	-5.825***	-.777	1.155	.777	-1.25
	(1.547)	(4.300)	(2.063)	(1.503)	(1.172)	(1.234)	(1.57)
MBSO	2.322	3.221	1.121	2.114	5.141***	4.864	2.29
	(1.929)	(2.140)	(2.416)	(3.265)	(1.845)	(3.351)	(3.33)
ABS	17.270***	17.172***	13.618***	28.832***	7.629**	31.407***	24.25***
	(3.280)	(3.779)	(3.086)	(10.923)	(3.445)	(11.320)	(6.16)
HPI 2002:Q1 - 2006:Q3	.115***	.122**	.133***	-.010	.143***	.085	-.036
	(.034)	(.054)	(.036)	(.044)	(.044)	(.052)	(.045)
Constant	-.302	-1.338***	-.197	1.523***	-1.139***	1.747***	1.62***
	(.315)	(.324)	(.293)	(.389)	(.439)	(.419)	(.399)
Obs.	7591	7388	7416	970	6646	1000	808
ρ	.480	.303	.514	.866	.295	.790	.800
λ	.311	.191	.347	.783	.181	.641	.596
	(.0473)	(.0411)	(.0564)	(.107)	(.0517)	(.097)	(.0565)
χ^2	36.53	19.70	29.70	90.09	11.49	59.419	115.88

Notes: This table shows the joint estimation of the treatment effects model with binary dependent variable TAF, using ML. Robust standard errors in parentheses. *** $= p < 0.01$, ** $= p < 0.05$, * $= p < 0.1$. Column (1) repeats the results of the baseline model using ML estimation. Columns (2) excludes TAF auctions after the collapse of Lehman Brothers; in column (3) the variables before the beginning of the program are measured in 2006:Q3 while in column (4) TAF banks are matched with NO TAF banks, with the variables measured in 2005:Q3. Column (5) excludes banks whose bank holding companies participated in the TARP program. Column (6) reports the result of the bootstrap exercise, while in column (7) we report the results of a matched sample. The matching is based on the different measures of liquidity distress, short-term liabilities and short-term assets, measured in 2007:Q3.

Table B.6: Too big to fail and solvency

	(1)	(2)	(3)	(4)	(5)
	Full	75% perc.	90% perc.	95% perc.	Solvent
Outcome equation			Δ ST LIAB ASS		
LIQUIDITY	-.773***	-.310	-.965	-1.356	-.804***
	(.156)	(.485)	(.751)	(1.145)	(.170)
CAPBUFFER	2.876***	2.993***	4.971***	5.629***	3.409***
	(.270)	(1.023)	(1.030)	(1.031)	(.436)
ROA	-4.571**	-11.130	-16.173	10.043	-3.137
	(2.098)	(8.952)	(12.970)	(9.812)	(4.964)
PF RISK 0	.646**	-.148	.163	.380	.430
	(.288)	(.326)	(.392)	(.524)	(.325)
PF RISK 20	.598***	.025	.639	1.295	.753***
	(.147)	(.473)	(.711)	(1.046)	(.169)
PF RISK 50	-.468***	-.422**	-.021	.309	-.571***
	(.069)	(.187)	(.363)	(.482)	(.148)
PF RISK 100	-.144***	.045	.102	-.203	-.017
	(.034)	(.108)	(.167)	(.191)	(.146)
HPI 2007:Q3–2010:Q3	-.040***	-.017	.016	.056	-.047**
	(.011)	(.020)	(.032)	(.044)	(.020)
TAF	-.873***	-1.139***	-1.372***	-1.513***	-.754***
	(.108)	(.128)	(.208)	(.216)	(.185)
SIZE					-.010
					(.011)
Participation equation					
ST LIAB / ST ASSET	.394***	.417***	.441***	.380***	.398***
	(.067)	(.087)	(.091)	(.087)	(.126)
CASH	-.054	-3.294	-.138	2.556	2.244*
	(1.577)	(2.653)	(2.409)	(1.965)	(1.220)
MBSO	2.511	-.123	1.744	1.951	5.417**
	(1.981)	(2.099)	(2.026)	(2.063)	(2.423)
ABS	17.697***	18.059***	13.115**	22.941***	14.375***
	(3.349)	(3.641)	(5.332)	(4.875)	(5.116)
HPI 2002:Q1–2006:Q3	.115***	-.040	-.094*	-.155***	.126*
	(.034)	(.042)	(.050)	(.055)	(.072)
Constant	-.252	.681*	1.156***	1.222***	-.630
	(.316)	(.385)	(.412)	(.371)	(.586)
Obs.	7591	1897	759	379	3635
TAF banks	265	183	140	108	67
ρ	.491	.735	.805	.894	.438
λ	.319	.549	.731	.978	.261
	(.0471)	(.0822)	(.148)	(.192)	(.0668)
χ^2	38.44	44.40	32.93	40.33	13.32

Notes: This table shows the joint estimation of the treatment effects model with binary dependent variable TAF, using ML. Robust standard errors are in parentheses. *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$. Column (1) repeats the results of the baseline model using ML estimation, excluding $SIZE$. Columns (2) to (4) consider only banks that are larger (in terms of $SIZE$ of all banks) than the 75th, 90th and 95th quantiles. Column (5) includes only banks with all fundamentals ($CAPBUFFER$, $PF\ RISK$, $CASH$, and $ST\ LIAB/RISK\ FREE\ ASSETS$) better than the median of the fundamentals of failed TAF banks.

Table B.7: Different dependent variables

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome equation						
Dependent variable:	Δ ST LIAB ASS	Δ ST LIAB TOT LIAB	Δ ST NET LIAB	Δ ST LIAB PF RISK O	Δ LN LIAB	Δ LN ASSET
LIQUIDITY	-.771***	-.042**	-22.063***	.658***	-.549***	.265**
	(.154)	(.018)	(2.573)	(.241)	(.123)	(.111)
CAPBUFFER	2.702***	.064*	52.480***	1.823***	4.126***	1.402***
	(.286)	(.035)	(3.983)	(.440)	(.267)	(.171)
ROA	-4.273**	.403*	-48.971	2.910	-8.079***	-3.854**
	(2.107)	(.216)	(37.746)	(3.100)	(1.850)	(1.962)
SIZE	-.036***	-.009***	-.878***	-.157***	.006	.040***
	(.008)	(.001)	(.159)	(.015)	(.006)	(.007)
PF RISK 0	1.116***	.138***	21.378***	8.628***	.123	-.960***
	(.317)	(.030)	(4.912)	(.698)	(.173)	(.260)
PF RISK 20	.995***	.107***	25.857***	.440	.213*	-.766***
	(.172)	(.020)	(2.875)	(.275)	(.127)	(.134)
PF RISK 50	-.042	-.001	-3.267	1.117***	-.382***	-.274***
	(.126)	(.016)	(2.302)	(.214)	(.086)	(.104)
PF RISK 100	.297***	.024	8.244***	.199	-.106	-.377***
	(.106)	(.015)	(2.077)	(.194)	(.083)	(.084)
HPI 2007:Q3–2010:Q3	-.050***	-.016***	-2.031***	.219***	-.004	.040***
	(.012)	(.002)	(.264)	(.023)	(.010)	(.009)
TAF	-.786***	-.146***	-27.306***	-1.575***	-.457***	-.244***
	(.111)	(.017)	(1.307)	(.216)	(.051)	(.086)
Participation equation						
LIQ. RISK MEASURE	.384***	1.970***	.026***	.169***	.379***	.367***
	(.067)	(.309)	(.002)	(.035)	(.021)	(.022)
CASH	-.017	-.817	.770	-1.580	1.779	.010
	(1.547)	(1.813)	(1.240)	(1.491)	(1.308)	(1.145)
MBSO	2.322	3.240**	1.140	4.069***	.711	2.225
	(1.929)	(1.453)	(1.487)	(1.484)	(1.389)	(1.435)
ABS	17.270***	12.570***	17.227***	14.378***	7.811**	1.197
	(3.280)	(3.759)	(3.065)	(3.600)	(3.130)	(3.877)
HPI 2002:Q1–2006:Q3	.115***	.103***	.060*	.098***	.020	.050
	(.034)	(.034)	(.034)	(.033)	(.035)	(.033)
Constant	-.302	-2.743***	-1.990***	-1.684***	-4.485***	-6.003***
	(.315)	(.150)	(.073)	(.095)	(.166)	(.254)
Obs.	7591	7591	7591	7305	7591	7591
ρ	.480	.499	.734	.480	.454	.308
λ	.311	.0551	11.38	.659	.227	.170
	(.0473)	(.00595)	(.478)	(.0842)	(.0201)	(.0282)
χ^2	36.53	67.78	277.0	47.74	140.1	30.29

Notes: This table shows the joint estimation of the treatment effects model with binary dependent variable TAF, using ML. Robust standard errors are in parentheses. *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.

Table B.8: Alternative econometric techniques

	(1)	(2)	(3)	(4)
Outcome equation				
Dependent variable:		Δ ST LIAB ASS		
Estimation technique:	OLS	OLS	2SLS	Treatreg
LIQUIDITY	-.813***	-.788***	-1.063***	-.749***
	(.156)	(.163)	(.319)	(.101)
CAPBUFFER	2.720***	2.744***	4.659***	2.647***
	(.286)	(.285)	(.750)	(.143)
ROA	-4.280**	-4.240**	-5.053*	-4.274***
	(2.092)	(2.110)	(2.676)	(.945)
SIZE	-.040***	-.036***	.455***	-.029***
	(.008)	(.009)	(.151)	(.008)
PF RISK 0	1.144***	1.134***	-4.445**	1.001***
	(.310)	(.311)	(1.872)	(.227)
PF RISK 20	1.037***	.995***	-4.559***	.894***
	(.175)	(.178)	(1.705)	(.124)
PF RISK 50	-.053	-.099	-6.103***	-.020
	(.126)	(.132)	(1.842)	(.114)
PF RISK 100	.338***	.298***	-4.926***	.325***
	(.107)	(.111)	(1.599)	(.099)
HPI 2007:Q3 - 2010:Q3	-.035***	-.042***	.021	-.059***
	(.009)	(.011)	(.032)	(.010)
TAF	-.107**	-.095*	-11.946***	-3.524***
	(.054)	(.053)	(3.685)	(.351)
MBSP		-.082		
		(.159)		
MBSO		.420		
		(.770)		
ABS		-9.059***		
		(2.476)		
HPI 2002:Q1 - 2006:Q3		-.011		
		(.014)		
Obs.	7591	7591	7591	7591

Notes: This table shows the estimation of the baseline model using different econometric techniques. More precisely, we use OLS in columns (1) and (2), in column (3) we employ a 2SLS (the instruments employed are the explanatory variable of equations (1) and (3)), while in column (4) we estimate the treatment effects model with binary dependent variable TAF, using a two-step approach (we report only the outcome equation results). Robust standard errors are in parentheses. *** $= p < 0.01$, ** $= p < 0.05$, * $= p < 0.1$.

Table B.9: Shorter time horizons

	(1)	(2)	(3)	(4)	(5)
Outcome equation					
Dependent variable:			Δ ST LIAB ASS		
After period:	2008q3	2009q1	2009q3	2010q1	2010q3
LIQUIDITY	-0.561***	-0.910***	-0.828***	-0.825***	-0.771***
	(0.120)	(0.112)	(0.127)	(0.138)	(0.154)
CAPBUFFER	2.610***	2.915***	2.833***	2.828***	2.702***
	(0.267)	(0.265)	(0.286)	(0.289)	(0.286)
ROA	-6.251***	-5.397***	-5.068**	-4.391**	-4.273**
	(1.782)	(1.937)	(2.013)	(2.068)	(2.107)
SIZE	0.020***	0.011	-0.006	-0.027***	-0.036***
	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)
PF RISK 0	0.466	0.326*	0.473**	1.014***	1.116***
	(0.334)	(0.195)	(0.211)	(0.324)	(0.317)
PF RISK 20	0.216*	0.533***	0.768***	0.928***	0.995***
	(0.124)	(0.118)	(0.136)	(0.150)	(0.172)
PF RISK 50	-0.346***	-0.432***	-0.188*	-0.071	-0.042
	(0.091)	(0.095)	(0.104)	(0.113)	(0.126)
PF RISK 100	-0.258***	-0.104	0.069	0.257**	0.297***
	(0.086)	(0.087)	(0.094)	(0.101)	(0.106)
HPI 2007:Q3 - **After**	-0.012***	-0.022***	-0.028***	-0.033***	-0.040***
	(0.004)	(0.005)	(0.007)	(0.008)	(0.009)
TAF	-0.343***	-0.440***	-0.643***	-0.682***	-0.786***
	(0.116)	(0.109)	(0.102)	(0.110)	(0.111)
Participation equation					
CASH	-7.422**	-0.961	-0.211	0.051	-0.017
	(3.101)	(2.298)	(1.778)	(1.612)	(1.547)
ST LIAB / ST ASSET	0.166**	0.288***	0.339***	0.374***	0.384***
	(0.068)	(0.070)	(0.063)	(0.069)	(0.067)
MBSO	5.513***	3.552*	4.461***	4.144***	2.322
	(1.386)	(1.962)	(1.466)	(1.436)	(1.929)
ABS	15.617***	14.163***	14.914***	14.867***	17.270***
	(4.711)	(5.009)	(4.435)	(4.056)	(3.280)
HPI 2002:Q1 - 2006:Q3	0.123**	0.102***	0.122***	0.111***	0.109***
	(0.049)	(0.037)	(0.033)	(0.032)	(0.032)
Constant	-1.669***	-0.873***	-0.575**	-0.361	-0.302
	(0.318)	(0.326)	(0.288)	(0.321)	(0.315)
Obs.	7591	7591	7591	7591	7591
No. of TAF banks	73	183	245	265	265
ρ	0.156	0.311	0.402	0.445	0.480
λ	0.0769	0.168	0.235	0.277	0.311
	(0.0220)	(0.0366)	(0.0416)	(0.0451)	(0.0473)
χ^2	11.45	19.77	27.39	30.96	36.53

Notes: This table shows the estimation of the baseline model using different shorter time horizons. In particular, we focus on the following "after periods": 2008:Q3, 2009:Q1, 2009:Q3 and 2010:Q1. The results are based on joint estimation of the treatment effects model with binary dependent variable TAF, using ML. Robust standard errors are in parentheses. *** = $p < 0.01$, ** = $p < 0.05$, * = $p < 0.1$.

Table B.10: Adding variables to the participation equation

	(1)	(2)	(3)	(4)	(5)
Outcome equation					
Dependent variable:			Δ ST LIAB ASS		
LIQUIDITY	-.826***	-.771***	-.777***	-.799***	-.819***
	(.156)	(.155)	(.155)	(.155)	(.157)
CAPBUFFER	2.736***	2.705***	2.737***	2.700***	2.765***
	(.287)	(.287)	(.289)	(.286)	(.289)
ROA	-4.285**	-4.083*	-4.090*	-4.229**	-4.394**
	(2.105)	(2.095)	(2.113)	(2.109)	(2.073)
SIZE	-.019**	-.036***	-.036***	-.037***	-.015*
	(.009)	(.008)	(.008)	(.008)	(.009)
PF RISK 0	.977***	1.113***	1.014***	1.114***	.858***
	(.311)	(.317)	(.318)	(.317)	(.314)
PF RISK 20	.832***	.992***	.928***	.992***	.750***
	(.174)	(.173)	(.174)	(.172)	(.176)
PF RISK 50	-.275**	-.046	-.071	-.008	-.339***
	(.131)	(.126)	(.125)	(.127)	(.132)
PF RISK 100	.096	.296***	.332***	.318***	.072
	(.118)	(.106)	(.105)	(.106)	(.113)
HPI 2007:Q3 - 2010:Q3	-.034***	-.040***	-.039***	-.040***	-.033***
	(.009)	(.009)	(.009)	(.009)	(.009)
TAF	-.606***	-.783***	-.909***	-.852***	-.732***
	(.109)	(.114)	(.088)	(.103)	(.096)
Participation equation					
CASH	1.679	.031	2.415*	1.021	3.415***
	(1.231)	(1.540)	(1.430)	(1.480)	(1.147)
ST LIAB / ST ASSET	.248***	.379***	.501***	.396***	.398***
	(.076)	(.068)	(.068)	(.066)	(.076)
MBSO	-.105	2.367	3.676	3.433	1.246
	(1.440)	(1.938)	(2.332)	(2.147)	(1.493)
ABS	10.151***	16.794***	17.978***	18.876***	11.796***
	(3.093)	(3.326)	(3.297)	(3.397)	(3.150)
HPI 2002:Q1 - 2006:Q3	.022	.113***	.031	.086**	-.031
	(.035)	(.033)	(.034)	(.034)	(.036)
SIZE	.347***				.327***
	(.023)				(.024)
ROA		5.129			-10.318
		(3.714)			(7.891)
PF RISK			2.825***		2.847***
			(.371)		(.408)
TLOANS				1.099***	-.478
				(.250)	(.336)
Constant	-5.190***	-.361	-1.767***	-.973***	-5.929***
	(.504)	(.314)	(.307)	(.301)	(.509)
Obs.	7591	7591	7591	7591	7591
ρ	.386	.478	.584	.530	.495
λ	.248	.310	.381	.345	.320
	(.0469)	(.0484)	(.0403)	(.0458)	(.0453)
χ^2	25.62	34.55	70.21	46.24	42.15

Notes: The different columns expand the set of variables added to the participation equation. Joint estimation of the treatment effects model with binary dependent variable TAF using ML. Robust standard errors are in parentheses. *** $= p < 0.01$, ** $= p < 0.05$, * $= p < 0.1$.

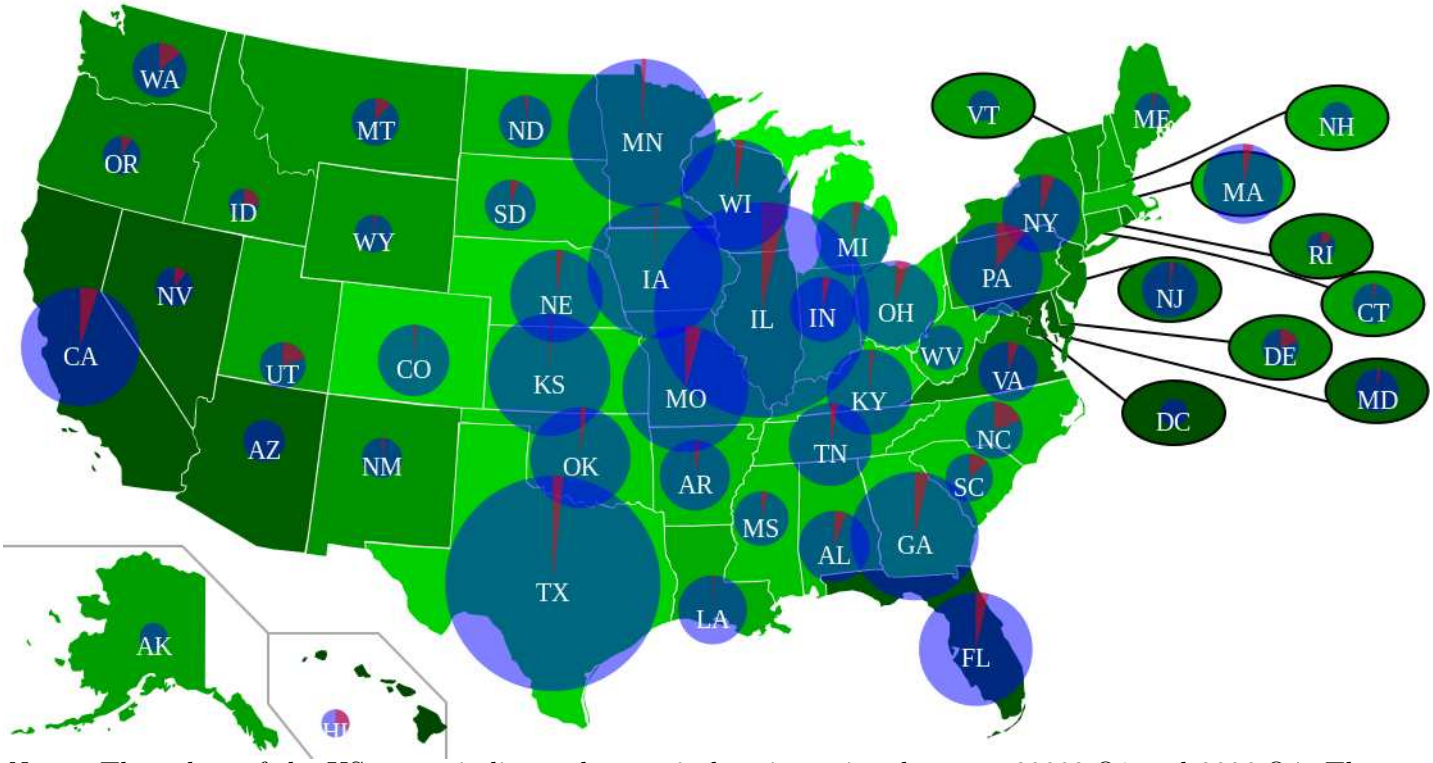
Table B.11: Sources and definitions of the variables

Variable Label	Variable definition	Chicago Fed Label	Source
TAF	Dummy variable. It takes value 1 if a bank received TAF reserves at least once, and 0 otherwise.		Federal Reserve Board
AMOUNT	Overall amount of TAF funds received by each bank.		Federal Reserve Board
NUM	Number of times a bank received TAF funds.		Federal Reserve Board
TAF AMOUNT 1	log of one plus the overall amount of TAF reserves received	log(1+AMOUNT)	Federal Reserve Board
TAF AMOUNT 2	log of one plus the ratio of the overall amount of TAF reserves received and the total loans	log[1+(AMOUNT/TLOANS)]	Federal Reserve Board
AVG TAF AMOUNT	log of one plus the ratio of the average amount received	log[1+(AMOUNT/NUM)]	Federal Reserve Board
ST ASS	log of Short term assets	log(UBPRE583)	U.S. Call Reports
TOTAL ASSETS	On- and Off-Balance Sheet assets	RCFDB644 + RCFDB696 + RCFDB697 + RCFDB698 + RCFDB699	U.S. Call Reports
TOT ASSETS S.T. RISK W	On- and Off-Balance Sheet assets, subject to risk-weighting	TOTAL ASSETS - RCFDB644	
ST ASS / ST LIAB	Short term assets over short term liabilities	UBPR598	U.S. Call Reports
TLIAB	Total liabilities	RCFD2950	U.S. Call Reports
ST LIAB	log of Short term liabilities	log(UBPRE583/UBPR898)	U.S. Call Reports
ST LIAB / ST ASS	log of Short term liabilities over short term assets	log(1/UBPR598)	U.S. Call Reports
ST LIAB / TLIAB	100 times Short term liabilities over total liabilities	100 × (ST LIAB/RCFD2950)	U.S. Call Reports
ST NET LIAB	Short term liabilities - Short tern assets over Total assets	UBPRE599	U.S. Call Reports
ST LIAB / PF RISK 0	log of Short term liabilities over Risk Free assets	log(ST LIAB /PF RISK 0)	U.S. Call Reports
LIQUIDITY	Liquid assets over total assets	(RCFD3545 + RCFD1773 + RCFD1754) /TOTAL ASSETS	U.S. Call Reports
CASH	Cash and balances due from depository institutions over total assets	RCFD0010/TOTAL ASSETS	U.S. Call Reports
PF RISK	Ratio of the risk-weighted assets to total assets subject to risk-weighting	RCFDA223/ TOTAL ASSETS S.T. RISK-W	U.S. Call Reports
PF RISK 0	Assets with a risk weight 0% over total assets subject to risk-weighting	RCFDB696 / TOTAL ASSETS S.T. RISK-W	U.S. Call Reports
PF RISK 20	Assets with a risk weight 20% over total assets subject to risk-weighting	RCFDB697 / TOTAL ASSETS S.T. RISK-W	U.S. Call Reports
PF RISK 50	Assets with a risk weight 50% over total assets subject to risk-weighting	RCFDB698 / TOTAL ASSETS S.T. RISK-W	U.S. Call Reports
PF RISK 100	Assets with a risk weight 100% over total assets subject to risk-weighting	RCFDB699 / TOT ASSETS S.T. RISK-W	U.S. Call Reports
TLOANS	Total loans and Leases, Gross over total assets	RCFD1400/TOTAL ASSETS	U.S. Call Reports
CI LOANS	Commercial and Industrial Loans over total loans	RCFD1766/RCFD1400	U.S. Call Reports
REST LOANS	Real Estate Loans over total loans	RCFD1410/RCFD1400	U.S. Call Reports
INDIV LOANS	Loans to Individuals over total loans	RCFD1975/RCFD1400	U.S. Call Reports
AGRI LOANS	Agricultural Loans over total loans	RCFD1590/RCFD1400	U.S. Call Reports
ABS	Ratio of Asset-Backed Securities* over Total Assets	(RCONC988+RCON027)/TOTAL ASSETS	U.S. Call Reports
MBS	Ratio of Mortgage* Backed (pass-through) over Total Assets	(RCON1699+RCON1702+RCON1705+RCON1707+ RCON1710+RCON1713)/TOTAL ASSETS	U.S. Call Reports
MBS OTHER	Ratio of other type of Mortgage* over Total assets	(RCON1734+RCON1736)/TOTAL ASSETS	U.S. Call Reports
CAPBUFFER	Tier 1 capital ratio minus 6%**	RCFD8274-.06	U.S. Call Reports
ROA	Ratio of the income before income taxes and extraordinary items and other adjustments over total assets	RIAD4301/TOTAL ASSETS	U.S. Call Reports
SIZE	Log of banks total asset	log(TOTAL ASSETS)	U.S. Call Reports
NPL	Loans that are past due at least 30 days or are on non-accrual basis over total loans	(RCFD1403 + RCFD1406 + RCFD1407)/RCFD1400	U.S. Call Reports
PROV	Ratio of loan loss provision over total loans	RIAD4230/RCFD1400	U.S. Call Reports
HPI	Quarterly percentage change in housing prices at state level		Federal Housing Finance Agency

Notes: * Securities held to maturity or available-for-sale at their fair value. ** The minimum requirement established by the banking authorities.

C Maps

Figure C.1: HPI change, banking sector size, and TAF participation



Notes: The colors of the US states indicate changes in housing prices between 20002:Q1 and 2006:Q4. The darker green an area, the more house prices increased. For example, Florida (FL) and California (CA) experienced high increases. The size of the pie shows the aggregate asset sizes of banks (with the main ZIP codes in the respective state). For the sake of clarity, some pies are shown larger than they actually are. The red part of the pie highlights the fraction of banks (in terms of size) that benefited from the TAF program.