The Impact of TARP Capital Infusion on Bank Liquidity Creation: Does Bank Size Matter?*

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This paper uses the Troubled Asset Relief Program (TARP) to examine whether the effect of capital support on bank liquidity creation differs depending upon bank size. We find that the relationship between TARP and liquidity creation is positive for small banks, but the relationship is insignificant for large banks. Further analysis shows that the positive and highly significant effect of TARP on small banks' liquidity creation may take longer to materialize, and that this increase in liquidity creation is experienced only by small TARP banks that did not repay early. We also find that the positive effect of TARP is driven mainly by the asset-side (on-balance-sheet) liquidity creation of small banks, and that this effect holds in most lending categories. These findings yield important policy implications for bank bailouts.

JEL Codes: G01, G21, G28.

1. Introduction

The financial turmoil that started in the summer of 2007 brought the U.S. financial system to the verge of collapse. In response to the worst economic downturn in the United States since the Great Depression, the Troubled Asset Relief Program (TARP), the largest government rescue program in U.S. history, was facilitated by the

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Emergency Economic Stabilization Act of 2008 (EESA) on October 3, 2008. TARP was created to stabilize the financial system by providing capital to viable financial institutions, and to increase the availability of credit to businesses and consumers in order to improve real economic conditions. The Capital Purchase Program (CPP), the largest bank investment program, is the cornerstone of TARP. It entailed the direct injection of up to $250 billion of TARP funds into qualifying financial institutions (QFIs). For simplicity, the term TARP is used henceforth to refer to CPP throughout the remainder of this paper.

An interesting question is how TARP recipients deployed their new capital during the crisis and post-crisis period. Would they use it to create additional loans, or retain it to improve their capital positions? To shed light on these questions, we investigate whether and how TARP capital injections affect bank liquidity creation. Liquidity creation is a major function of banks in the economy, and can be regarded as the best available measure of total bank output that includes all assets, liabilities, equity, and off-balance-sheet guarantees and derivatives. Our study is closely related to the line of research that investigates the impact of TARP on bank lending, which is one element of liquidity creation. However, previous empirical evidence regarding this strand of literature is mixed and inconclusive.[1]

[1]Some studies document the positive effects of TARP investments on bank loan supply. For example, Li (2013) uses political and regulatory connection variables as instruments for TARP participation and finds that the program increased bank loan supply by a large amount, $404 billion. Applying difference-in-difference methodology to loan-level data, Berger, Makaew, and Roman (2019) find that TARP resulted in more favorable loan contract terms in five dimensions—spread, amount, maturity, collateral, and covenants—for recipient banks' business customers. Puddu and Waelchli (2015) Chavaz and Rose (2019), and Chu, Zhang, and Zhao (2019) and also find evidence that TARP banks increased credit supply to business. However, other studies have found little increase in lending as a result of TARP capital support. For example, Duchin and Sosyura (2014) find that TARP investments have little effect on aggregate credit supply, despite using the similar political connection variable that was used by Li (2013) as an instrument for bailout approvals. Taliaferro (2009) argues that, because of severe capital losses of banks during the crisis, TARP banks used much of their TARP funds to shore up their capital ratios and repair their weak balance sheets, rather than to support new lending. Bassett, Demiralp, and Lloyd (2020) assess five government support programs, including TARP, and find no evidence of a change in credit supply.

There are two views of the impact of TARP on bank liquidity creation in the literature. The first view ("precautionary motive") predicts that government support, if intended to help strengthen banks through capitalization, can discourage banks from hoarding liquidity (Castiglionesi et al. 2014). This is because government capital support may provide banks with the assurance of safety and, thereby, reduce precautionary liquidity hoarding incentives so that banks would not have to hold as much liquidity for survival, and encourage bank liquidity creation. The second view ("moral hazard effect") argues that the expectation of financial safety nets (e.g., deposit insurance scheme, capital bailout, liquidity provision policies, loan guarantees, nationalizations, and many others) can create moral hazard in the form of excessive risk-taking behavior, which would, in turn, result in a higher likelihood of bank failure (Dam and Koetter 2012; Vazquez and Federico 2015). Banks with high insolvency risk may not have the ability and willingness to create liquidity for the public. Moreover, in response to the global financial crisis (GFC), one goal of post-crisis capital regulation reforms proposed in Basel III was to reduce the risk-taking incentives of banks by imposing stricter capital requirements. Therefore, it is likely that banks might use TARP funds to repair their weak balance sheets (e.g., capital losses) during the crisis period, and meet stringent capital requirements during the post-crisis period. In these scenarios, TARP capital injections may have insignificant effects on bank liquidity creation.

The research of Berger and Bouwman (2009), too, is related to our paper. Building on two strands of theories on the impact of bank capital on bank liquidity creation, i.e., the "financial fragility–crowding-out" and the "risk-absorption" theories,[2] Berger

[2]The theories on the role of capital yield conflicting predictions about how capital affects liquidity creation. According to the "financial fragility–crowding-out" hypothesis, capital has a negative effect on liquidity creation because a higher capital ratio is associated with less monitoring, which leads to less liquidity creation (Diamond and Rajan 2000, 2001) and a higher capital ratio may reduce liquidity creation through the crowding out of deposits (Gorton and Winton 2017). In contrast, the "risk-absorption" hypothesis implies that there is a positive effect of capital on liquidity creation because capital helps to absorb the illiquidity risks associated with liquidity creation, and expands the risk-bearing capacity of banks (Bhattacharya and Thakor 1993; Allen and Santomero 1997; Allen and

and Bouwman (2009) researched the relationship between bank capital and liquidity creation using a sample of U.S. commercial banks from 1993 to 2003, and found empirical support for both hypotheses. For large banks, which create by far most of the liquidity, they find a positive relationship, consistent with the "risk-absorption" effect, whereas for small banks, the relationship is negative, consistent with the "financial fragility–crowding-out" effect.

Our study is different from theirs in two important ways. First, Berger and Bouwman's (2009) two hypotheses are aimed at explaining bank capital adjustment needed for the normal business operations of banks during normal times. However, they may not be relevant in the context of government bailouts during crisis and post-crisis periods. This is not only because government capital support may come with specific goals (e.g., the twin goals of financial stability and economic growth of TARP) that are distinct from increases in capital buffer for the normal business operation of banks but also because banks may behave differently during the financial crisis and post-crisis periods. Hence, it may be worthwhile to consider theories that are closely related to how banks behaved during the financial crisis period. Specifically, we argue that the "precautionary motive" and "moral hazard effect" theories are more relevant and applicable under these circumstances, for the following two reasons. With respect to the "precautionary motive," it has been documented that a well-functioning interbank market during normal times provides effective liquidity coinsurance by channeling liquidity between banks with liquidity surpluses and shortages (Allen, Carletti, and Gale 2009) and this, in turn, minimizes the holding by banks of costly liquid assets for which the returns are low. However, there is ample evidence that banks stopped creating liquidity and started hoarding liquidity rapidly for precautionary purposes, after September 2008, following the collapse of Lehman Brothers (Afonso, Kovner, and Schoar 2011). As discussed in the third paragraph of this section, government capital support may provide banks with the assurance of safety and, thereby, reduce precautionary liquidity-hoarding incentives. Turning to the "moral hazard effect" view, as noted above,

Gale 2004; Repullo 2004; Von Thadden 2004; Coval and Thakor 2005). For an in-depth discussion of the "financial fragility–crowding-out" and "risk-absorption" theories, see Berger and Bouwman (2009).

moral hazard in the form of excessive risk-taking behavior may create huge capital losses for banks, which would, in turn, lead to a higher probability of bank failure during the crisis period. Hence, to meet the stringent capital requirements following the crisis, banks may use TARP funding to strengthen their solvency and repair their weak balance sheets (e.g., capital losses), resulting in little change in bank liquidity creation.

Second, bank size can moderate the relationship between bank capital and bank liquidity creation differently in a financial crisis. In Berger and Bouwman (2009), the reasons for the opposing effects of capital on liquidity creation by bank size include that, for example, large banks can access funding from national or international markets more easily than small banks; large banks are subject to tighter prudential supervision than small banks, etc. However, these may not hold true in the crisis period, since previous literature shows that banks of all sizes have restricted access to external funds, because of the interbank market breakdown (Ashcraft, McAndrews, and Skeie 2011), and bank supervisors are likely to relax strict regulations in support of large banks, because of their too-big-to-fail position (Laeven, Ratnovski, and Tong 2016).

Our study contributes to two strands of literature: bank liquidity creation and government capital support. First, while the literature has devoted extensive efforts to evaluating the impact of TARP on bank lending, which is only one component of asset-side liquidity creation, the effects of TARP on bank liquidity creation, which includes much more than lending, remain largely unanswered. The minimal attention to the impact of TARP on bank liquidity creation is unfortunate, though, because liquidity creation can be regarded as the best available measure of total bank output, and is found to have numerous positive economic effects (see, e.g., Berger and Sedunov 2017). The goal of this article is to fill this gap in the literature. Second, this is the first study that integrates bank size as a primary component in the analysis of the impact of government capital bailout on bank liquidity creation. The results clearly indicate that one size does not fit all when it comes to government bailout. We find that TARP has a positive and significant effect on small banks' liquidity creation, in line with the "precautionary motive" hypothesis, whereas TARP has an insignificant effect on large banks' liquidity creation, consistent with the "moral hazard effect" hypothesis.

Further investigation indicates that the positive effect of TARP on small banks' liquidity creation is driven mainly by on-balance-sheet, asset-side liquidity creation, and this effect holds in most lending categories. This suggests that, from the bank liquidity creation perspective, government capital injections should target a large fraction of small banks. However, it doesn't imply that government capital support is of no importance for large banks, as it can strengthen their capital position. Prior literature shows that the main design challenge of TARP was its conflicting goals for bank recapitalization and bank lending (e.g., Black and Hazelwood 2013). Therefore, to design more effective government bailout programs in the future, it is critically important to consider different sizes of banks.

The remainder of this paper is organized as follows: Section 2 discusses our research hypotheses. Section 3 presents the data, variables, composition of the sample, and preliminary results. Section 4 contains the econometric model, presents the empirical analysis with the main findings, and addresses the endogeneity concern, followed by a series of related additional analyses and robustness checks in Sections 5 and 6, respectively. Section 7 provides the conclusions.

2. Theoretical Motivation and Hypothesis Development

Building on two theories in the literature (i.e., the precautionary motive and the moral hazard effect), we test empirically the impact of TARP on bank liquidity creation, to understand which view finds empirical support. "Precautionary motive" refers to the hoarding of liquidity by banks for self-insurance purposes, such as insurance against counterparty risk and liquidity risk. Acharya and Merrouche (2013) find that large U.K. settlement banks started hoarding cash to cover their transactional needs immediately following the freeze of the money market. Similarly, studies about the precautionary motive suggest that during the recent financial crisis, banks hoarded liquidity to protect themselves against future liquidity shocks, i.e., credit line drawdowns and unexpected demand deposit withdrawals (Ashcraft, McAndrews, and Skeie 2011; Cornett et al. 2011), and in anticipation of future expected losses from security write-downs (Berrospide 2013).

However, precautionary liquidity-holding behavior may hamper a bank's ability to create liquidity. On the empirical side, Berrospide

(2013) finds that more than one-fourth of the reduction in bank lending during the crisis was attributable to the precautionary motive. According to Berger and Sedunov (2017), higher levels of liquidity holdings—for example, cash and marketable securities held by a bank—decrease liquidity creation, since the holding of it restrains the transfer of liquid assets to the public. On the theoretical side, Gale and Yorulmazer (2013) model the precautionary motive for holding cash, and show that liquidity-hoarding banks lend less than the maximum possible amount. They find that the inefficiency of liquidity hoarding caused by incomplete markets always occurs with positive probability in a laissez-faire equilibrium. The central bank, the lender of last resort, can implement a constrained-efficient liquidity allocation to restore efficiency. They argue that if the central bank intervenes very aggressively, it can discourage bankers from holding liquidity. Along the same line, Castiglionesi et al. (2014) explain that banks enter the interbank market to hedge away bank-specific risk. However, when the interbank market stops providing this function (as it did during the financial crisis), banks have two alternatives. One is issuing capital, which they argue is costly, and the other is liquidity hoarding. This theory predicts that government support, if intended to help strengthen banks through capitalization, can discourage banks from hoarding liquidity. We, therefore, hypothesize that government capital support may provide banks with the assurance of safety and, thereby, reduce precautionary liquidity holding incentives (i.e., banks would not have to hold as much liquidity for survival) and encourage bank liquidity creation.

With respect to the "moral hazard effect," previous studies suggest that government bailouts could either increase or decrease moral hazard in the form of excessive bank risk-taking behavior. One strand of research argues that bank bailouts may increase moral hazard incentives because of a perceived increased probability of future bailouts (Acharya and Yorulmazer 2007; Kashyap, Rajan, and Stein 2008). A government safety net could erode market discipline, so investors in the bailed-out banks have less incentive to monitor their banks' risk-taking when they anticipate the bailout (Gropp, Hakanes, and Schnabl 2011). Consistent with this line of argument, a number of studies find that government bailouts are associated with banks' risk-taking positively and significantly (e.g., Dam and Koetter 2012; Hryckiewicz 2014). More importantly, bank risk-taking behavior has an adverse effect on bank solvency. In this regard, Vazquez and Federico (2015) find that bank risk-taking increases the likelihood of individual bank failure. It is, thus, expected that a bank with elevated insolvency risk may have lost/reduced the ability and willingness to create liquidity for the public. Supporting this notion, Duchin and Sosyura (2014) find that TARP banks increased their portfolio risk significantly by approving riskier residential mortgages and corporate loans, but find no evidence of an increase in credit supply. In a similar vein, Berger and Roman (2015) imply that borrowers are more reluctant to take loans and loan commitments from TARP banks when these banks are more likely to fail or become financially distressed. Additionally, given that preferred equity has priority over common equity, bank bailouts like TARP could increase leverage risk, since TARP-preferred equity infusion may decrease the market value of common equity through lower equity market prices and/or less common equity issuance by making such equity more expensive to raise (Berger, Roman, and Sedunov 2020).[3] Increased leverage would in turn aggravate the risk-taking moral hazard at banks by inducing banks to engage in illiquid and risky lending that may result in the widespread failures of these institutions (Acharya and Thakor 2016). As noted earlier, banks with higher probability of insolvency may not be able to create liquidity for the nonbank public. Therefore, we expect the influence of TARP capital infusion on bank liquidity creation to be minimal and insignificant.

Yet another strand of related research has highlighted that bank bailouts may decrease moral hazard in the following ways. First, government bailouts may discourage excessive risk-taking because extra explicit or implicit government restrictions are imposed on the bailed-out banks, such as limits on executive compensation or capital requirements (Kashyap, Rajan, and Stein 2008; Acharya, Mehran, and Thakor 2016; Berger and Roman 2020).[4] Second, the

[3]Three mechanisms through which leverage risk may increase are discussed in Berger, Roman, and Sedunov (2020): (i) preferred equity holders must be paid dividends before common equity shareholders; (ii) the rate paid on the preferred equity may be a penalty rate; (iii) bailout might hurt confidence in the banks because of a stigma of being more likely to fail or become financially distressed.

[4]TARP participants were subject to compensation restrictions. The initial restrictions were outlined at the program inception in October 2008. For example,

extra capital from the TARP bailout may increase charter value for protected banks, because of lower refinancing costs. In turn, the higher charter value, which a bank would lose in the case of failure, deters risk-taking (Keeley 1990). The charter value proposition suggests that the bailouts may encourage banks to shift towards safer portfolios. Third, a larger capital buffer through TARP-preferred equity infusion could decrease leverage risk, since injected preferred equity may increase the market value of common equity and boost public confidence in the bailed-out banks (Berger, Roman, and Sedunov 2020).[5] In fact, Berger, Roman, and Sedunov (2020) provide empirical evidence suggesting that TARP resulted in significantly decreased market-based and accounting-based leverage risk relative to non-TARP banks. Anecdotal evidence suggests that, in August 2007, mortgage-backed securities started experiencing huge losses, and financial institutions eventually had to write down many of these losses, depleting their capital. Some banks were threatened with failure, as they were unable to raise needed capital in public markets (Bayazitova and Shivdasani 2012). Besides, in response to the GFC, one goal of the post-crisis capital regulations that were implemented in Basel III was to reduce the risk-taking incentives of banks by imposing stricter capital requirements. Considering that TARP was designed to improve the safety and soundness of the banking system through increased capitalization, we predict that banks might, after they receive TARP funds, retain/withhold TARP capital, both to strengthen their solvency and repair their weak balance sheet during the crisis period, and to meet higher capital requirements during the post-crisis period, rather than lend to consumers and businesses. In line with the view of decreased moral hazard we, thus, expect that

restrictions include limiting tax deductibility of compensation for senior executives to $500,000, requiring bonus clawbacks, and restricting golden parachute payments. In February, 2009, the American Recovery and Reinvestment Act (ARRA) became a law, imposing more stringent executive compensation restrictions on the TARP recipients. For example, ARRA further prohibited bonuses, retention awards, and incentive compensation other than long-term restricted stock awards that exceeded one-third of annual compensation.

[5]Three mechanisms through which reduced leverage risk may occur are explained in Berger, Roman, and Sedunov (2020): (i) reducing the risk and cost of bank debt by providing an extra layer of funds to absorb losses before debtholders; (ii) providing the preferred equity at a subsidized rate; (iii) boosting public confidence in the bank because of the government's backing or signaling of safety.

the TARP capital injection would have no significant impact on bank liquidity creation.

Furthermore, as discussed already, portfolio risk and leverage risk are the key risks through which moral hazard incentives and bailouts affect the ability of banks to create liquidity. It is worth mentioning that these two risks may cancel each other out under some circumstances, resulting in no overall effect of the TARP capital injection on bank liquidity creation. For example, one of the likely ways through which moral hazard may work could be via shifting into riskier portfolios (riskier loans and other investments) to offset potential reduction in leverage risk from the bailout.[6]

In summary, this discussion leads to the following empirical predictions:

HYPOTHESIS 1. *Consistent with the "precautionary motive" view in the literature, TARP capital injection has a positive and significant effect on bank liquidity creation.*

HYPOTHESIS 2. *Consistent with the "moral hazard effect" view in the literature, TARP capital injection has no significant effect on bank liquidity creation.*

Note that these hypotheses are not mutually exclusive. Each may apply to different sets of banks. Since liquidity creation differs considerably among different sizes of banks (Berger and Bouwman 2009), we test empirically which of these hypotheses dominates the other overall by splitting our sample into small banks, medium banks, and large banks.

3. Data Collection, Sample Construction, and Measurement of Variables

3.1 Bank Sample and TARP Data

TARP was initiated in October 2008 and terminated in December 2009. Data on TARP are publicly available on the website of the U.S. Treasury. The Treasury's TARP Transaction Report includes

[6] We are grateful to an anonymous reviewer for his/her constructive comments on the moral hazard hypothesis.

the identity and location of the institution, the date the institution received/repaid TARP funds, and the amount of the funds received/repaid. Because of concerns that investors may interpret the non-award of TARP capital as a negative signal that may trigger bank runs on such applicants, TARP did not publicly disclose identities of unsuccessful applicants. The bank sample was retrieved from the Statistics on Depository Institutions (SDI) database, maintained by the Federal Deposit Insurance Corporation (FDIC). The SDI repository includes all FDIC-insured institutions and it contains detailed on- and off-balance-sheet information for all banks.[7] According to industry definitions, we define small banks as those with total assets of less than $1 billion, medium banks as those with total assets between $1 billion and $3 billion, and large banks as those with total assets of more than $3 billion.[8]

We match the institutions listed on the TARP Transaction Report with the bank sample retrieved from the FDIC SDI database, by name and location. Our initial data set consists of 703 TARP recipients. However, six banks in the TARP Transaction Report are excluded because, owing to the lack of a specific TARP and/or SDI identity number, they cannot be matched with the banks in the SDI data set. Among the remaining 697 banks, 665 banks received one-off TARP funds, and 32 banks received a TARP capital injection twice. Of those 32 banks, two TARP investments received by

[7]Depending on their bank holding company (BHC) status, there are three types of banks in our data set, i.e., multibank holding company members, one-bank holding company members, and independent banks. In the case of a multibank holding company, we aggregate the SDI data of all subsidiary banks in the same BHC at the holding company level because TARP applications in the case of subsidiaries were conducted via the BHCs. If the bank is a one-bank holding company or an independent bank, we keep the data for the bank. Our sample includes 613 BHCs and 84 commercial banks.

[8]During the process of our research, we found a similar paper by Bowe, Kolokolova, and Michalski (2019) that shows that small TARP banks create a lower amount of liquidity than their non-TARP peers. Our conclusions are not directly comparable to Bowe, Kolokolova, and Michalski's (2019) findings in that we include banks with total assets of less than $1 billion whereas they remove such banks from their sample. It is important to consider these "community banks" since a large fraction of U.S. banking institutions consists of small banks. For example, in Berger and Bouwman (2009), small banks comprise 98 percent of the sample observations. Similarly, in our study, 89.7 percent of observations are small banks.

the same bank holding companies (BHCs) or independent banks are combined. With respect to the TARP repayment, our data set includes 636 banks that had repaid TARP funds by 2014:Q4. Of those 636 banks, the majority repaid TARP funds once (471 banks), whereas 125 banks made two repayments, 32 made three, 1 made four, 6 made five, and 1 made seven. As a last step, we exclude data if the bank failed before 2009:Q1 (i.e., before observation of TARP effects), and winsorize the extreme observations at the top and bottom 1 percent.

Figure 1 plots the patterns of TARP disbursements and repayments by bank size. This figure shows that the amounts that large banks received and repaid are far higher than those received and repaid by small banks (see graph A), but the numbers of TARP capital injections and redemptions are highly concentrated in small bank subsamples (see graph B). For timing, both graphs A and B illustrate that large banks received and repaid much earlier than did small banks. Specifically, 17 of the large banks made their first TARP repayment in 2009, 16 in 2010, 13 in 2011, 9 in 2012, 3 in 2013, and 1 in 2014. In contrast, 14 of the small banks made their first TARP repayment in 2009, 39 in 2010, 117 in 2011, 84 in 2012, 77 in 2013, and 38 in 2014. On average, the amount of TARP repayment made by large banks was \$8.6 billion, whereas that made by small banks was \$212 million.

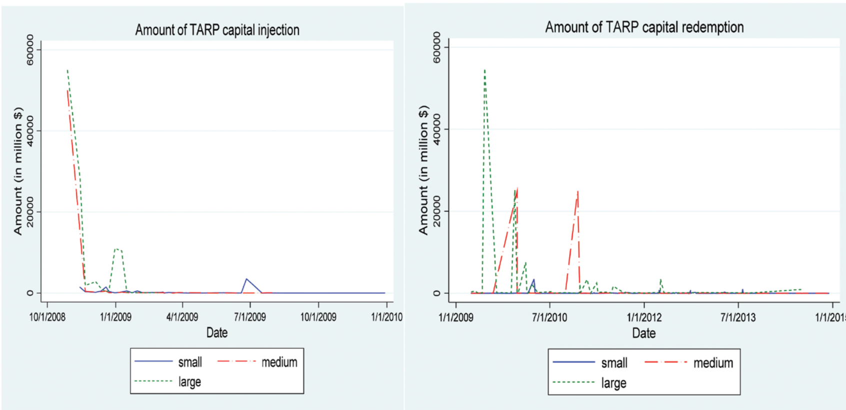
3.2 Variables

Bank liquidity creation is the dependent variable in our study. We use the measures proposed in the ground-breaking work of Berger and Bouwman (2009) (hereafter referred to as the BB measure).[9]

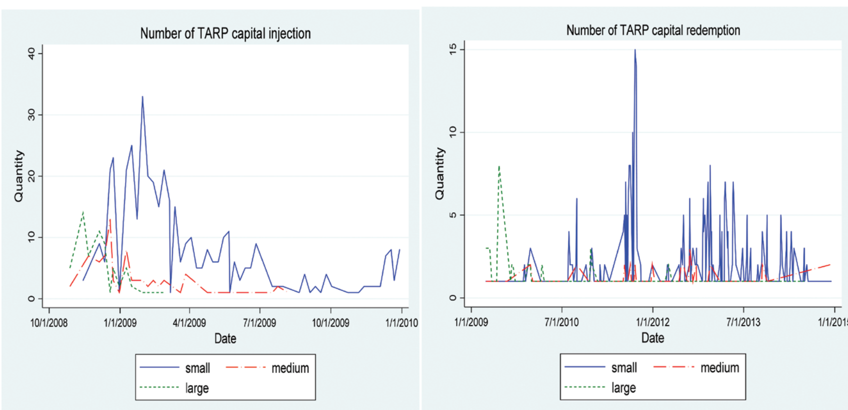
[9]We are grateful to Christa Bouwman for providing the bank liquidity creation data. It is downloadable from Christa Bouwman's personal website (https://sites.google.com/a/tamu.edu/bouwman/data). To summarize, the BB measure is the weighted sum of all assets, liabilities, equity, and off-balance-sheet activities. Since liquidity is created when banks finance illiquid assets (e.g., business loans) with liquid liabilities (e.g., transaction deposits), a positive weight of 1/2 is given to both illiquid assets and liquid liabilities. Thus, transforming \$1 of an illiquid commercial loan into \$1 of a liquid transaction deposit creates \$1 of liquidity for the public. Similarly, since banks destroy liquidity when they use illiquid liabilities (e.g., subordinated debt) or equity to finance liquid assets (e.g., cash, Treasury securities), a negative weight of –1/2 is given to liquid assets,

Figure 1. Amount and Number of TARP Capital Injection and Redemption

A. Amount of TARP Capital Injection and Redemption



B. Number of TARP Capital Injection and Redemption



Note: The data on banks' participation in TARP are obtained from transaction reports from the U.S. Department of the Treasury (https://www.treasury.gov/initiatives/financial-stability/TARP-Programs/Pages/default.aspx). For small banks (total assets up to $1 billion), medium banks (total assets $1 billion–$3 billion), and large banks (total assets exceeding $3 billion), panel A of Figure 1 displays the distribution of the amount of capital injection and redemption (in million $), and panel B displays the distribution of the number of capital injection and redemption.

Berger and Bouwman (2009) compute four measures of liquidity creation. The first two are based on loan categories (*cat*) with the inclusion (*fat*) or exclusion (*nonfat*) of off-balance-sheet activities. The third and fourth measures are based on maturities (*mat*) with the inclusion (*fat*) or exclusion (*nonfat*) of off-balance-sheet activities. They argue that the two liquidity creation measures based on categories (*catfat* and *catnonfat*) are preferable to those based on maturity (*matfat* and *matnonfat*), because they are better indicators of the ease, cost, and time for banks to dispose of their obligations to obtain liquid funds. Therefore, in our study, we use two of the BB measures: *catfat* and *catnonfat.* The measure *catfat* is the sum of on- and off-balance-sheet liquidity creation, and *catnonfat* measures liquidity created on the balance sheet only. The *catfat* and *catnonfat* measures are calculated as follows:

$$\begin{aligned} catfat = {} & 0.5 \times (illiquid\ assets + liquid\ liabilities \\ & + illiquid\ guarantees) + 0 \times (semiliquid\ assets \\ & + semiliquid\ liabilities + semiliquid\ guarantees) \\ & - 0.5 \times (liquid\ assets + illiquid\ liabilities + equity \\ & + liquid\ guarantees + liquid\ derivatives) \end{aligned} \tag{1}$$

$$\begin{aligned} catnonfat = {} & 0.5 \times (illiquid\ assets + liquid\ liabilities) \\ & + 0 \times (semiliquid\ assets + semiliquid\ liabilities) \\ & - 0.5 \times (liquid\ assets + illiquid\ liabilities + equity)\,. \end{aligned} \tag{2}$$

We use $TARP\ Recipient_i$ and the interaction term $Post\ TARP_t \times \text{TARP Recipient}_i$ as the key independent variables for our regression analysis. $TARP\ Recipient_i$ equals one for banks that were TARP recipients, and zero for banks that were not TARP recipients; $Post\ TARP_t$ equals one in the periods 2009:Q1 to 2014:Q4

illiquid liabilities, and equity. Thus, taking \$1 of liquid asset from the public and giving the public \$1 of illiquid subordinated debt or equity destroys \$1 of liquidity. All semi-liquid assets and liabilities (e.g., residential real estate loans) are assigned a neutral weight of zero. Off-balance-sheet activities are assigned weights consistent with those assigned to functionally similar on-balance-sheet activities.

after TARP initiation, and zero otherwise. See the appendix for their definitions and abbreviations.

3.3 Preliminary Results

Table 1 presents summary statistics for key variables used in our main analysis and univariate tests. Panel A shows that the mean value of total bank liquidity creation (*catfat_gta*) is 0.299, 0.423, and 0.447 for small, medium, and large banks, respectively. This finding is consistent with the earlier literature showing that most of the liquidity in the banking sector is created by large banks (e.g., Berger and Bouwman 2009). Furthermore, the mean values of the *TARP amount* variable are 0.801, 3.830, and 5.689 for small, medium, and large banks, respectively. This result is consistent with the view that large banks tend to enjoy "too-big-to-fail" subsidies and, hence, receive the most in TARP capital injections. The mean values of capital adequacy (*ca*) and asset quality (*aq*) suggest that, in our sample, small banks have stronger capital positions and higher-quality assets than medium and large banks. The univariate tests in panel B report the difference-in-means estimates to compare characteristics of TARP banks and non-TARP banks for small, medium, and large bank subsamples. As shown, TARP banks create more liquidity than non-TARP banks in all subsamples, although the difference magnitude is larger for small banks. For example, the mean *catfat_gta* for small, medium, and large TARP banks is 0.392, 0.438, and 0.480, respectively, but 0.290, 0.414, and 0.401 for non-TARP banks, respectively. We also find that the non-TARP banks, on average, tend to have high capital and less troubled assets, earn higher returns on equity, and are more sensitive to market risk than TARP banks. A two-tailed t-test for the difference between the two groups yields a p-value less than 0.001. Note that our initial small-, medium-, and large-bank sample consists of 251,416; 11,416; and 6,273 bank-quarter observations, respectively. Since all control variables are lagged by one period in our model, this leads to our final sample of 181,613; 7,972; and 4,378 bank-quarter observations for small, medium, and large banks, respectively, in the baseline estimation.

To get a preliminary idea about how TARP affected bank liquidity by bank size, Figure 2 maps the evolution of the average liquidity creation (*catfat_gta*) for TARP banks and non-TARP banks

Table 1. Descriptive Statistics

A. Summary Statistics by Bank Size								
	Small Banks							
Variables	**N (1)**	**Mean (2)**	**SD (3)**	**Min. (4)**	**p25 (5)**	**p50 (6)**	**p75 (7)**	**Max. (8)**
catfat_gta	251,416	0.299	0.175	−0.158	0.184	0.309	0.420	0.713
catnonfat_gta	251,416	0.246	0.154	−0.178	0.148	0.259	0.356	0.567
TARP dummy	251,416	0.082	0.274	0	0	0	0	1
TARP amount	251,416	0.801	2.684	0.000	0.000	0.000	0.000	9.802
ca	251,416	0.105	0.036	0.047	0.084	0.096	0.116	0.279
aq	251,416	0.003	0.005	−0.001	0.000	0.001	0.004	0.030
mq	251,416	74.920	42.580	7.326	30.560	85.560	110.100	151.600
roe	251,416	0.047	0.076	−0.362	0.021	0.046	0.083	0.228
liq	251,416	0.067	0.063	0.008	0.027	0.044	0.082	0.340
ltd	251,416	1.441	0.545	0.804	1.111	1.287	1.575	4.164
bhc	251,416	0.832	0.374	0	1	1	1	1
banksize	251,416	11.760	0.884	10.090	11.090	11.710	12.390	13.820
crerisk	251,416	0.684	0.131	0.343	0.599	0.693	0.777	0.974
llp	251,416	0.003	0.006	−0.002	0.000	0.001	0.003	0.037
dwtaf	251,416	0.197	0.398	0	0	0	0	1
spread	251,416	2.048	1.133	−0.512	1.529	2.249	2.875	3.578
lngdp	251,416	9.587	0.112	9.339	9.532	9.593	9.667	9.786
lnpop	251,317	11.100	1.788	7.715	9.821	10.690	12.270	16.090
lnpopden	243,983	4.525	1.809	0.503	3.330	4.220	5.747	9.364
ingr	243,983	4.244	4.956	−10.300	1.800	4.200	6.600	21.700
merger	251,416	0.018	0.133	0	0	0	0	1
hhi	251,416	722.600	545.500	173.800	386.800	636.300	844	3,653
crisisdummy	251,416	0.224	0.417	0	0	0	0	1

(*continued*)

Table 1. (Continued)

A. Summary Statistics by Bank Size								
	Medium Banks							
Variables	**N (1)**	**Mean (2)**	**SD (3)**	**Min. (4)**	**p25 (5)**	**p50 (6)**	**p75 (7)**	**Max. (8)**
catfat_gta	11,416	0.423	0.148	−0.158	0.325	0.430	0.525	0.713
catnonfat_gta	11,416	0.334	0.124	−0.178	0.259	0.347	0.420	0.567
TARP dummy	11,416	0.391	0.488	0	0	0	1	1
TARP amount	11,416	3.830	4.779	0.000	0.000	0.000	9.792	9.803
ca	11,416	0.091	0.022	0.047	0.079	0.088	0.098	0.279
aq	11,416	0.004	0.006	−0.001	0.001	0.002	0.004	0.030
mq	11,416	70.260	43.110	7.326	31.010	59.500	109.400	151.600
roe	11,416	0.048	0.084	−0.362	0.023	0.050	0.089	0.228
liq	11,416	0.054	0.053	0.008	0.022	0.035	0.063	0.340
ltd	11,416	1.249	0.359	0.804	1.047	1.168	1.346	4.164
bhc	11,416	0.964	0.187	0	1	1	1	1
banksize	11,416	14.260	0.312	13.820	13.990	14.220	14.510	14.910
crerisk	11,416	0.736	0.124	0.343	0.659	0.747	0.820	0.974
llp	11,416	0.004	0.007	−0.002	0.001	0.002	0.005	0.037
dwtaf	11,416	0.289	0.453	0	0	0	1	1
spread	11,416	2.109	1.081	−0.512	1.608	2.390	2.852	3.578
lngdp	11,416	9.612	0.106	9.339	9.571	9.605	9.694	9.786
lnpop	11,416	12.720	1.627	8.607	11.510	12.680	13.690	16.090
lnpopden	11,105	6.144	1.597	0.749	4.917	6.171	7.370	9.364
ingr	11,105	4.080	4.243	−10.300	2.100	4.300	6.400	21.700
merger	11,416	0.081	0.272	0	0	0	0	1
hhi	11,416	851.400	556	173.800	514.700	755.400	947.600	3,635
crisisdummy	11,416	0.227	0.419	0	0	0	0	1

(*continued*)

Table 1. (Continued)

A. Summary Statistics by Bank Size

Large Banks

Variables	N (1)	Mean (2)	SD (3)	Min. (4)	p25 (5)	p50 (6)	p75 (7)	Max. (8)
catfat_gta	6,273	0.447	0.177	−0.158	0.351	0.462	0.562	0.713
catnonfat_gta	6,273	0.295	0.158	−0.178	0.230	0.320	0.402	0.567
TARP dummy	6,273	0.581	0.493	0	0	1	1	1
TARP amount	6,273	5.689	4.831	0.000	0.000	9.789	9.791	9.796
ca	6,273	0.093	0.030	0.047	0.075	0.086	0.102	0.279
aq	6,273	0.006	0.008	−0.001	0.001	0.002	0.007	0.030
mq	6,273	83.640	49.670	7.351	33.810	86.810	134.100	151.600
roe	6,273	0.049	0.084	−0.362	0.022	0.048	0.087	0.228
liq	6,273	0.056	0.061	0.008	0.022	0.034	0.062	0.340
ltd	6,273	1.255	0.529	0.804	0.990	1.123	1.318	4.164
bhc	6,273	0.980	0.139	0	1	1	1	1
banksize	6,273	15.710	0.430	14.910	15.300	15.930	16.110	16.110
crerisk	6,273	0.737	0.138	0.343	0.659	0.748	0.829	0.974
llp	6,273	0.006	0.009	−0.002	0.001	0.002	0.006	0.037
dwtaf	6,273	0.544	0.498	0	0	1	1	1
spread	6,273	2.075	1.098	−0.512	1.608	2.249	2.829	3.578
lngdp	6,273	9.610	0.108	9.339	9.563	9.603	9.694	9.786
lnpop	6,273	13.290	1.313	9.398	12.320	13.360	14.260	16.090
lnpopden	5,984	6.750	1.486	1.154	5.663	6.954	7.723	9.364
ingr	5,984	3.961	4.257	−10.300	1.600	4.300	6.300	21.700
merger	6,273	0.152	0.359	0	0	0	0	1
hhi	6,273	1,045	686.900	188.800	655.600	847.500	1,174	3,635
crisisdummy	6,273	0.235	0.424	0	0	0	0	1

(continued)

Table 1. (Continued)

B. Univariate Tests By Bank Size			
	Small Banks		
Variables	**TARP Banks (1)**	**Non-TARP Banks (2)**	**Difference in Means (3)**
catfat_gta	0.392	0.290	0.102***
catnonfat_gta	0.320	0.239	0.081***
ca	0.096	0.106	–0.010***
aq	0.003	0.003	0.000***
mq	52.565	76.818	–23.253***
roe	0.030	0.048	–0.018***
liq	0.057	0.068	–0.011***
ltd	1.221	1.460	–0.239***
bhc	0.883	0.827	0.056***
banksize	12.420	11.698	0.722***
llp	0.004	0.003	0.001***
crerisk	0.743	0.678	0.065***
No. of Bank-Quarter Observations	20,549	230,867	—

(continued)

Table 1. (Continued)

B. Univariate Tests By Bank Size			
	Medium Banks		
Variables	**TARP Banks (1)**	**Non-TARP Banks (2)**	**Difference in Means (3)**
catfat_gta	0.438	0.414	0.024***
catnonfat_gta	0.345	0.327	0.018***
ca	0.090	0.091	–0.001***
aq	0.004	0.003	0.001***
mq	68.508	71.388	–2.880***
roe	0.041	0.052	–0.011***
liq	0.045	0.059	–0.014***
ltd	1.171	1.300	–0.129***
bhc	0.988	0.948	0.040***
banksize	14.291	14.246	0.045***
llp	0.005	0.004	0.001***
crerisk	0.754	0.725	–0.029***
No. of Bank-Quarter Observations	4,465	6,951	—

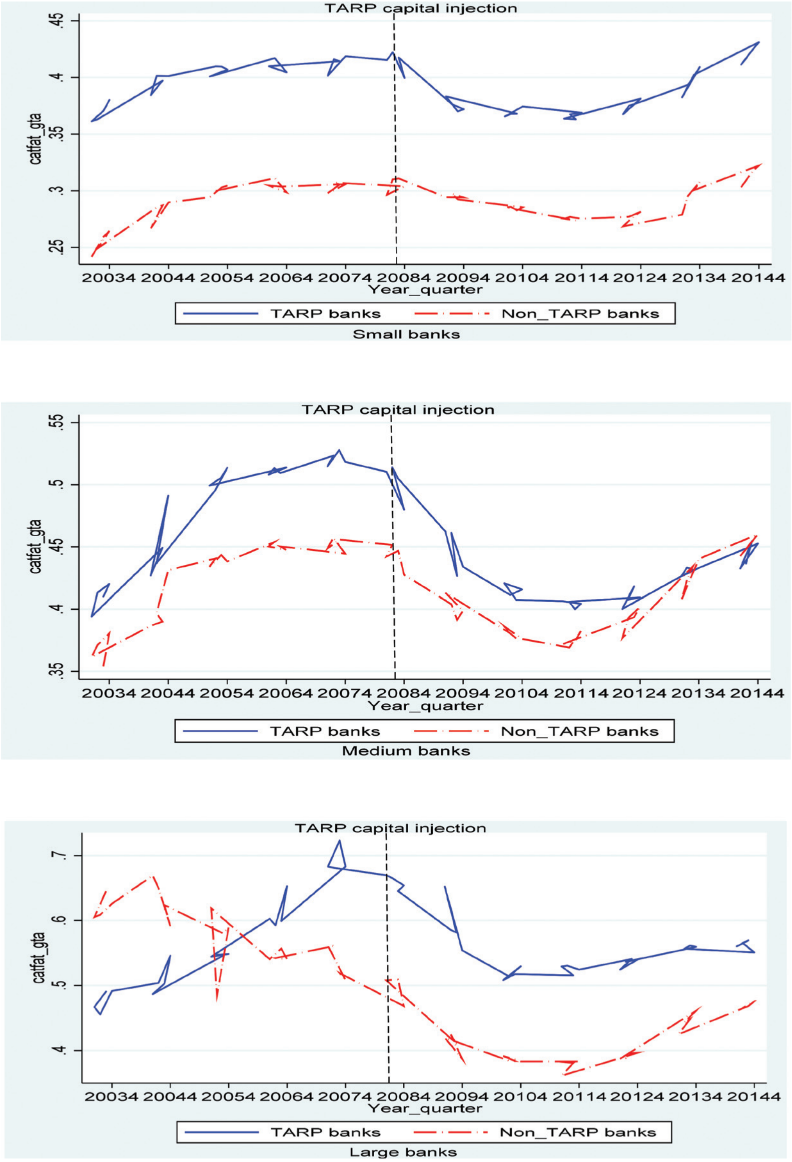
(*continued*)

Table 1. (Continued)

B. Univariate Tests By Bank Size			
	Large Banks		
Variables	**TARP Banks (1)**	**Non-TARP Banks (2)**	**Difference in Means (3)**
catfat_gta	0.480	0.401	0.079***
catnonfat_gta	0.321	0.260	0.061***
ca	0.091	0.095	–0.004***
aq	0.007	0.004	0.003***
mq	88.679	76.654	12.025***
roe	0.053	0.044	0.009***
liq	0.050	0.065	–0.015***
ltd	1.184	1.353	–0.169***
bhc	0.983	0.976	0.007***
banksize	15.773	15.630	0.143***
llp	0.006	0.005	0.001***
crerisk	0.755	0.711	0.044***
No. of Bank-Quarter Observations	3,645	2,628	—

Note: This table reports statistics that describe the sample. Panel A shows the summary statistics of key variables in the baseline model. Panel B reports the difference-in-means estimates to compare characteristics of TARP banks and non-TARP banks. See the appendix table for variable definitions. *, **, and *** denote 10 percent, 5 percent, and 1 percent significance levels for the difference between TARP and non-TARP banks, respectively.

Figure 2. Liquidity Creation over Time



Note: This figure shows the average bank liquidity creation (*catfat_gta*) for TARP bank and non-TARP banks over 2003:Q1 to 2014:Q4 by small banks (total assets up to \$1 billion), medium banks (total assets \$1 billion–\$3 billion), and large banks (total assets exceeding \$3 billion).

over 2003:Q1 to 2014:Q4. Several observations are clear from these graphs. First, consistent with prior study, we find that most of the liquidity in the banking sector was created by large banks. Second, the liquidity creation of small TARP banks was much more than that of non-TARP banks, but this pattern did not hold for medium and large banks over the same time frame. As shown, the liquidity creation of medium non-TARP banks has exceeded that of medium TARP banks by the end of the period, while large non-TARP banks created much more liquidity than did large TARP banks at the beginning of the period. Third, after TARP started, for different sizes of banks, both TARP and non-TARP banks had lower average liquidity creation before 2010:Q4, and they experienced non-monotonic increases in average liquidity creation afterwards. However, by the end of our sample period, only small banks had exceeded their pre-crisis liquidity creation levels, with medium and large banks having average liquidity creation substantially lower than that in their pre-crisis level. Overall, the preliminary evidence is consistent with our expectations that the impact of TARP capital injection on bank liquidity creation may vary with bank size.

4. Empirical Methodology and Results

4.1 Main Results

We use a difference-in-difference (DID) regression model to examine the effects of government capital support (TARP) on the liquidity creation of banks over the period from 2003:Q1 to 2014:Q4. The 2003 to 2014 time period is unique in that it contains data before, during, and after the largest financial crisis in recent history. It starts five years before the GFC and ends five years after the GFC, to allow for the long-term effect of this exogenous shock on the relation between TARP and bank liquidity creation. The first difference is from before to after TARP, and the second difference is between TARP recipients and non-TARP recipients. A DID estimator allows the comparison of banks that received TARP funds (a treatment group) with a set of banks that did not receive any TARP funds (a control group) before and after TARP funding (treatment) was provided. Following Berger and Roman (2015), the DID regression model, applied over the sample period of 2003:Q1 to 2014:Q4, is specified as follows:

$$\begin{aligned}&\mathit{Bank\ Liquidity\ Creation}_{i,t}\\&\quad = \beta_0 + \beta_1 \mathit{TARP\ Recipient}_i + \beta_2 \mathit{Post\ TARP}_t\\&\qquad \times \mathit{TARP\ Recipient}_i + \beta_3 X_{i,t-1} + \beta_4 \mathit{Time}_t + \varepsilon_{i,t}. \qquad (3)\end{aligned}$$

In equation (3), the dependent variable $\mathit{Bank\ Liquidity\ Creation}_{i,t}$ denotes the liquidity creation of bank i at time t. $\mathit{TARP\ Recipient}_i$ is a dummy variable that is equal to one if the bank received TARP funding and zero otherwise. $\mathit{Post\ TARP}_t$ is a dummy variable that is equal to one in 2009:Q1–2014:Q4, the period after TARP initiation, and zero otherwise. $\mathit{Post\ TARP}_t \times \mathit{TARP\ Recipient}_i$ is the DID term and captures any shift of liquidity creation specific to TARP recipients induced by the implementation of TARP. The term $\mathit{Post\ TARP}_t$ is not included in the model by itself, because it is subsumed by the time fixed effects. $X_{i,t-1}$ are control variables, Time_t represents year and quarter fixed effects, and $\varepsilon_{i,t}$ represents a white-noise error term. The key independent variable of interest is the interaction term $\mathit{Post\ TARP}_t \times \mathit{TARP\ Recipient}_i$. It shows the marginal effect of TARP on liquidity creation of the TARP recipients relative to non-TARP recipients.

We include a broad set of bank-specific characteristics, and macroeconomic and local economic conditions as control variables. The first set of control variables includes proxies for CAMELS-type variables because the CAMELS rating is often used by U.S. regulators to evaluate the safety and soundness of commercial banks, and a bank's overall financial condition will affect its ability to create liquidity. The values of CAMELS ratings are confidential and not available for this study. Following the previous literature (Duchin and Sosyura 2012, 2014; Li 2013; Calabrese, Degl'Innocenti, and Osmetti 2017), we use the following proxy variables for CAMELS: the ratio of tier 1 (core) capital to risk-weighted assets as a proxy of capital adequacy (*ca*); the ratio of all nonperforming loans to total assets as a proxy of asset quality (*aq*); the age of a bank as the proxy for management quality (*mq*); the ratio of net income to total equity as a proxy of earnings (*roe*); the sum of cash and balances due from other financial institutions, federal funds sold and securities purchased under resale agreements, and available-for-sale securities, scaled by total assets as a proxy for liquidity (*liq*); and the total loans-to-deposits ratio to capture a bank's sensitivity to the funding market risk (*ltd*).[10]

Besides the proxy variables for CAMELS defined above, we also control for bank holding company (*bhc*) status because the same BHC may serve as internal capital market to provide capital/liquidity to its different subsidiaries (Houston and James 1998). Credit risk (*crerisk*) is used because it is an important determinant for managing bank liquidity (Berger and Bouwman 2009; Cornett et al. 2011); it is measured as the bank's Basel I risk-weighted assets divided by total assets. Loan loss provisions (*llp*), measured as the ratio of loan loss provision expense to total loans and leases, is a forward-looking measure of expected loan losses (Bayazitova and Shivdasani 2012). We include bank size (*banksize*), the log of total assets in each subsample of banks. Finally, we use *dwtaf*, a dummy if a bank received discount window and/or Term Auction Facility funding during the crisis, because these funds increased the lending of banks significantly (Berger et al. 2017).

The second set of control variables captures macroeconomic and local economic conditions. This study employs "yield spread" (*spread*), measured as the difference between long-term interest rates (10-year Treasury yield) and short-term interest rates (three-month Treasury yield), as a predictor of future real economic activity, for which the data are obtained from the Federal Reserve Bank of New York. This study also employs the natural logarithm of gross domestic product (*lngdp*) as a macro control, which is sourced from the "FRED" public database of the Federal Reserve Bank of St. Louis. In addition, local economic data (e.g., natural logarithm of total population (*lnpop*), natural logarithm of population density (*lnpopden*), and income growth rate (*ingr*) in a county) are sourced from the Bureau of Economic Analysis (BEA). The Herfindahl-Hirschman Index (*hhi*) is used to measure the level of competition for deposits among banks in local markets. We collect the bank deposit data from the FDIC Summary of Deposits to calculate the bank-level *hhi*, which is the sum of the squares of the market shares (deposits)

[10]Each acronym of CAMELS stands for capital adequacy, asset quality, management capability, earnings, liquidity, and sensitivity to market risk.

of each individual bank. We also control for *merger*, a dummy variable equal to one from the time that the bank acquired another institution, and zero otherwise. Finally, we control for the recent financial crisis period, *crisisdummy*. This variable has a value of one from the third quarter of 2007 to the fourth quarter of 2009, and zero otherwise.

Table 2 presents the DID estimation results for equation (3). For small banks, regression estimates show that the coefficients of the DID interaction term, *Post TARP*×*TARP Recipient,* are positive and statistically significant for both aggregate bank liquidity creation (*catfat_gta*) in column 1 and on-balance-sheet liquidity creation only (*catnonfat_gta*) in column 4. In terms of economic magnitudes, the coefficients of *Post TARP*×*TARP Recipient* of 0.008 and 0.014 in columns 1 and 4 suggest that TARP capital support increases liquidity creation by 2.68 percent and 5.69 percent, when applied to the average total liquidity creation of 0.299 and on-balance-sheet liquidity creation of 0.246 for small banks, respectively. However, the results presented in columns 2, 3, 5, and 6 indicate insignificant coefficients of the DID interaction term with respect to the medium and large bank groups. These results lend support to the views that TARP capital injections encourage small banks to create more liquidity but have no significant effects on medium and large banks' liquidity creation.

These findings are important but not surprising for two reasons. First, it is widely recognized that the "precautionary motive" is relatively strong for small banks but weak for large banks. Allen, Peristiani, and Saunders (1989) find that, in the interbank market, small banks tend to act as lenders while large banks tend to act as borrowers. They argue that small banks face greater information asymmetry, making it costly for them to access the interbank market and, thereby, they have an incentive to keep some cash at hand. Consistent with this line of argument, small banks are expected to have strong incentives to hoard liquidity in order to avoid financing constraints and costly default. In contrast, large banks can access funding from national or international capital markets more easily, so they are less likely to hoard cash; or they may use their diversification advantage to operate with lower levels of cash. Therefore, if TARP capital support can alleviate banks' precautionary motive for liquidity holdings and promote bank liquidity creation,

Table 2. Effects of TARP on Bank Liquidity Creation: Main Results

	Dependent Variables: Bank Liquidity Creation					
	catfat_gta			*catnonfat_gta*		
Variables	**Small Banks (1)**	**Medium Banks (2)**	**Large Banks (3)**	**Small Banks (4)**	**Medium Banks (5)**	**Large Banks (6)**
Post TARP*×*TARP Recipient	**0.008****	**−0.009**	**−0.002**	**0.014*****	**−0.007**	**−0.023**
	(0.00)	(0.01)	(0.02)	(0.00)	(0.01)	(0.02)
TARP Recipient	−0.009***	−0.004	0.018	−0.013***	−0.004	0.046***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.02)
ca	−1.051***	−1.062***	−0.456***	−1.065***	−1.114***	−1.143***
	(0.03)	(0.25)	(0.18)	(0.03)	(0.26)	(0.20)
aq	−0.529***	−0.397	0.433	−0.126***	0.091	1.581***
	(0.04)	(0.25)	(0.38)	(0.04)	(0.23)	(0.38)
mq	−0.000***	−0.000***	−0.000	−0.000***	−0.000***	−0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
roe	0.005	0.152*	0.422***	0.012	0.122	−0.270***
	(0.02)	(0.08)	(0.07)	(0.02)	(0.08)	(0.09)
liq	0.278***	0.255***	−0.011	0.228***	0.148	−0.468***
	(0.02)	(0.09)	(0.13)	(0.02)	(0.09)	(0.14)
ltd	0.339***	0.196***	0.000	0.236***	0.057**	−0.000
	(0.01)	(0.02)	(0.00)	(0.01)	(0.02)	(0.00)
bhc	0.009***	0.067**	−0.051	0.008***	0.054**	−0.013
	(0.00)	(0.03)	(0.03)	(0.00)	(0.03)	(0.08)
banksize	0.007***	0.027**	0.013	0.002	0.020*	−0.059***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
llp	−0.001	−0.421	2.722***	−0.516*	−1.155	−7.769***
	(0.16)	(0.95)	(0.86)	(0.29)	(0.92)	(1.30)

(*continued*)

Table 2. (Continued)

	Dependent Variables: Bank Liquidity Creation					
	catfat_gta			*catnonfat_gta*		
Variables	**Small Banks (1)**	**Medium Banks (2)**	**Large Banks (3)**	**Small Banks (4)**	**Medium Banks (5)**	**Large Banks (6)**
crerisk	0.511***	0.704***	1.021***	0.531***	0.702***	0.556***
	(0.02)	(0.05)	(0.04)	(0.02)	(0.05)	(0.06)
spread	0.008	0.129***	0.405***	−0.018	0.068	−0.052
	(0.01)	(0.06)	(0.10)	(0.02)	(0.06)	(0.10)
lngdp	0.154***	0.261***	0.318***	0.155***	0.263***	0.354***
	(0.01)	(0.03)	(0.05)	(0.01)	(0.03)	(0.05)
hhi	0.000***	0.000	−0.000	0.000***	0.000	−0.000*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
dwtaf	0.002	0.010	−0.010	0.002	0.010	−0.011
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
lnpop	0.026***	0.010*	0.017**	0.023***	0.006	0.031***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
lnpopden	−0.022***	−0.008	−0.021***	−0.019***	−0.006	−0.031***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
ingr	0.001***	0.001***	−0.001	0.001***	0.001**	−0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
merger	0.013***	0.020***	−0.004	0.010***	0.016**	−0.002
	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
crisisdummy	−0.038***	−0.111**	−0.346***	−0.013	−0.057	0.098
	(0.01)	(0.05)	(0.07)	(0.01)	(0.05)	(0.08)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,613	7,972	4,378	181,613	7,972	4,378
Adjusted R^2	0.757	0.671	0.692	0.726	0.589	0.567

Note: This table reports estimates from difference-in-difference (DID) regression for analyzing the impact of TARP on bank liquidity creation across different sizes of banks. *TARP Recipient* takes the value of one if a bank is a TARP recipient, and zero otherwise. *Post TARP* is a dummy equal to one in the 2009–14 period after TARP initiation, and zero otherwise. *catfat_gta* is the sum of on-balance-sheet and off-balance-sheet liquidity creation; *catnonfat_gta* measures liquidity created on the balance sheet only. All models include time fixed effects. The estimation results are for 2003–14. The variable descriptions are in the table in the appendix. Robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

the effect should be more pronounced for small banks than for large ones.

Second, it is expected that the "moral hazard effect" is more pronounced in large banks than in small banks. On the one hand, large banks are perceived to be "too big to fail," so they would pay less attention to the risks they take, making them more vulnerable to liquidity shocks and market failures during a crisis period. In this regard, previous studies find that bank size is correlated positively with risk-taking measures and failure probabilities (e.g., Boyd and Runkle 1993; Bhagat, Bolton, and Lu 2015). Laeven, Ratnovski, and Tong (2016) also document that large banks tend to be financed with more short-term debt and have lower capital ratios. Hence, banks with high insolvency risk may be less able to create liquidity for the public. Along the same line, Black and Hazelwood (2013) find that the risk of loan originations increased at large TARP banks but decreased at small TARP banks. Duchin and Sosyura (2014) find that large, publicly traded TARP banks appeared to have approved riskier loans without changing the overall quantities of loans and guarantees. On the other hand, the restrictions imposed by TARP bailout, such as capital "stress test" and limits on executive compensation, are more applicable to large banks (Bayazitova and Shivdasani 2012), which would decrease incentives for aggressive behavior and risk taking. Therefore, we predict that after receiving TARP capital support, large banks are more likely to build up a capital buffer for compensating severe capital shortage/losses, because of their pre-crisis excessive risk-taking behavior, resulting in an insignificant impact of TARP on these banks' liquidity creation.

Turning to the bank control variables, the coefficient estimates on these variables in Table 2 are generally intuitive and consistent with those found in previous studies. In line with the "financial fragility–crowding-out" hypothesis (Berger and Bouwman 2009), we find that bank capital (*ca*) is associated significantly and negatively with bank liquidity creation. Similar to, for example, Li (2013), who investigated the effects of TARP and bank loan supply, asset quality (*aq*) and management quality (*mq*) variables enter negative and significant coefficients, whereas total loans-to-deposits ratio (*ltd*) enters positively and is significant at conventional levels in most regressions. Consistent with Kim and Sohn (2017), the coefficient estimate on liquidity ratio (*liq*) is significant and positive, indicating that banks in a better liquidity position may supply more liquidity following the implementation of TARP. Concerning the coefficients of the bank holding company (*bhc*) and bank size (*banksize*), the estimated coefficients in most cases are positive and statistically significant as expected. We also find a positive and statistically significant relation between credit risk (*crerisk*) and bank liquidity creation, suggesting that a variety of risks including credit risk, are associated with liquidity creation (Bouwman 2014). Among the proxies for macroeconomic and local economic variables, we find several results that are consistent with expectations. For example, banks in better economic conditions, measured by GDP (*lngdp*) and income growth (*ingr*), are able to create more liquidity. Also, as expected, the crisis-period dummy variable indicates that banks are less able to create liquidity for the public during the GFC.

4.2 Concerns of Endogeneity

A concern exists that the *TARP Recipient* variable could bias our findings by way of potential reverse causality. For example, as discussed above, TARP capital may have been provided to more viable and healthier banks (Berger and Roman 2017). These stronger banks may be likely to create more liquidity than weaker banks do, yielding a spurious relationship. In addition, the TARP capital injections were not randomly assigned to banks. Under TARP, banks could decide whether to apply for TARP funds. The U.S. Treasury could choose whether to approve or disapprove the application and, once approved, banks could decide whether to accept or reject TARP funds. The non-randomness of the TARP allocation may give rise to a sample-selection bias problem. In other words, the impact of TARP capital injections on liquidity creation can be observed only for those banks that received the funds. To mitigate these concerns, we perform several tests, including an instrumental-variable approach, a two-part model, a placebo experiment, and a propensity score matching analysis.

4.2.1 Instrumental-Variable (IV) Approach

Prior research on TARP finds that the political connections of banks can affect their probability of receiving TARP funds (e.g., Li 2013;

Berger and Roman 2017; Berger, Makaew, and Roman 2019; Berger, Roman, and Sedunov 2020). Following this line of literature, we use the Subcommittee on Financial Institutions and Consumer Credit, which supervises all federal banking regulators, as an instrument for the *TARP Recipient* variable.[11] It takes the form of a dummy variable, *Subcomm on FI*, with the value of one if a local representative of the bank that applies for TARP serves on the subcommittee, and zero otherwise, based on the possibility that the elected representative may influence federal banking regulator decisions if he/she serves on this subcommittee. This dummy variable is, therefore, expected to be related positively to TARP approval decisions about banks in the representative's local area, but it is unlikely to be under the control of individual banks. Thus, this instrumental variable is likely to satisfy both the relevance condition and the exclusion condition. Because the *TARP Recipient* variable is binary, we follow Wooldridge's (2002) procedure to estimate a dummy endogenous variable model (also see Berger and Roman 2015, 2017). For the first stage, we use a probit model in which *TARP Recipient* dummy is regressed on the political instrument, *Subcomm on FI*, along with all other control variables from the main regression model, for predicting the probability of receiving TARP. We then use the predicted probability obtained from the first stage as an instrument for the second stage and estimate the model via a two-stage least-square (2SLS) method.

The results of the IV regressions are reported in Table 3. We report the first-stage regression results in panel A. The second-stage results for the IV specification are contained in panel B. The first-stage results in panel A indicate that, for small banks, the instrumental variable, *Subcomm on FI*, has a positive and significant effect on the probability of receiving TARP injections, and the first-stage F-test suggests that the instrument is valid. However, we find that the instrumental variable has no significant effects on TARP injections for medium banks, and it is negatively related to TARP injections for large banks. The second-stage results in panel B show that, after controlling for endogeneity, the coefficients of the DID terms are statistically positive and significant for the BB measures for small

[11] We are grateful for Lei Li for offering this data.

Table 3. Effects of TARP on Bank Liquidity Creation: Instrumental-Variable (IV) Approach

A. First Stage: Probit Model			
	Dependent Variables: *TARP Recipient*		
Variables	**Small Banks (1)**	**Medium Banks (2)**	**Large Banks (3)**
Subcomm on FI	**0.154*****	**0.056**	**−0.417*****
	(0.02)	(0.05)	(0.06)
Bank Controls	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Observations	181,433	7,972	4,369
Pseudo R^2	0.168	0.077	0.161

(*continued*)

Table 3. (Continued)

B. Second Stage: Two-Stage Least-Square (2SLS) IV Approach						
	Dependent Variables: Bank Liquidity Creation					
	catfat_gta			*catnonfat_gta*		
Variables	**Small Banks (1)**	**Medium Banks (2)**	**Large Banks (3)**	**Small Banks (4)**	**Medium Banks (5)**	**Large Banks (6)**
Post TARP*× *TARP Recipient	**0.110*****	**0.022**	**−0.021**	**0.161*****	**0.039**	**−0.000**
	(0.01)	(0.04)	(0.04)	(0.01)	(0.04)	(0.04)
TARP Recipient	−0.058***	−0.022	0.029	−0.084***	−0.031	0.035
	(0.01)	(0.03)	(0.02)	(0.01)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,433	7,972	4,369	181,433	7,972	4,369
Adjusted R^2	0.750	0.668	0.692	0.709	0.581	0.565
First-Stage Kleibergen-Paap rk Wald F-test	446.43***	56.19***	79.54***	446.43***	56.19***	79.54***

Note: This table shows difference-in-difference (DID) regression estimates for analyzing the impact of TARP on bank liquidity creation using a two-stage least-square (2SLS) IV approach. We use *Subcommittee on Financial Institutions and Consumer Credit* (*Subcomm on FI*) as an instrument for the potential endogenous explanatory variable *TARP Recipient*. This instrument is a dummy variable that takes the value of one if a local representative of the bank that applies for TARP serves on the Subcommittee on FI, which supervises all federal banking regulators, and zero otherwise. *TARP Recipient* takes the value of one if a bank is a TARP recipient, and zero otherwise. *Post TARP* is a dummy equal to one in the 2009–14 period after TARP initiation, and zero otherwise. *catfat_gta* is the sum of on-balance-sheet and off-balance-sheet liquidity creation; *catnonfat_gta* measures liquidity created on the balance sheet only. All models include time fixed effects. The estimation results are for 2003–14. The variable descriptions are in the table in the appendix. Robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

banks, and insignificant for medium and large banks. Therefore, we find consistent evidence that small TARP banks, after receiving TARP funding, increase their liquidity creation significantly, relative to non-TARP banks. The economic magnitude of the coefficients of the DID terms is larger in absolute value terms than the ordinary least-squares (OLS) estimates, consistent with other findings in the literature (e.g., Berger and Bouwman 2009; Berger and Sedunov 2017).

4.2.2 Two-Part Model

The two-part model is employed to address the fact that the decision for banks to apply for TARP is a choice variable. We use a logit model in the first part and an OLS regression model for the second part. Specifically, the first part models the probability of receiving TARP funds using a logit regression model with a binary outcome. The first-part equation is

$$TARP_i = \begin{cases} 1, & if\ \beta_0 + \beta'_{BC}X_{BC} + \beta'_{MLE}X_{MLE} \\ & \quad + \beta'_{PR}X_{PR} + u_{1i} > 0 \\ 0, & otherwise, \end{cases} \tag{4}$$

where equation (4) is the logit model of the TARP dummy. TARP equals one if bank i is a TARP recipient and zero otherwise; X_{BC} consists of bank characteristics; X_{MLE} controls for macroeconomic and local economic conditions; and X_{PR} includes the political connection variable.

The equation used in the second part models the distribution of the TARP amount received by banks (applied for and approved) by using an OLS regression framework with a continuous outcome. The variables that are used for the specification of the first part are also used for the specification of the second part, including bank characteristics, macroeconomic and local economic conditions, and the political connection variable. The second-part equation is

$$TARP\ amount_i = \beta_0 + \beta'_{BC}X_{BC} + \beta'_{MLE}X_{MLE} + \beta'_{PR}X_{PR} + u_{2i}. \tag{5}$$

The predicted residual, $\widehat{Residual}$, estimated after the two-part model, is added as an additional regressor in the DID estimation.

Because the predicted residual is a generated regressor (i.e., with estimation errors) that influences the computation of the standard error of the regression coefficient, bootstrapping is applied to deal with this issue (1,000 bootstrap replications are performed).

The estimation results, shown in panel A of Table 4, are qualitatively similar to the findings in the main analysis and indicate a strong positive effect of TARP on liquidity creation of small TARP banks (see columns 1 and 4). Furthermore, the evidence shows no significant effects of TARP on medium and large TARP banks' liquidity creation, as indicated by the economically small and/or statistically insignificant coefficients of the interaction term *Post TARP*× *TARP Recipient* (see columns 2, 3, 5, and 6). These results reinforce our main findings. Meanwhile, the coefficients of the DID terms maintain an economic magnitude similar to that found in the previous baseline regressions.

4.2.3 Placebo Experiment

As discussed above, we find that TARP capital injection has a positive effect on liquidity creation of small banks. It is also possible that alternative confounding forces that affect TARP and non-TARP banks differently may drive our results. To alleviate this potential problem, we conduct a placebo experiment following Berger and Roman (2015, 2017) and Puddu and Waelchli (2015) for small bank subsamples. We use a six-year period immediately preceding TARP from 2003 to 2008 and assume that the fictional *Post TARP* period begins three years before the actual program, but we still distinguish between TARP and non-TARP banks according to the "true" TARP. Therefore, we rerun the regressions using the placebo sample (2003–08) and define *Placebo Post TARP* as a dummy equal to one in 2006–08, the period after the fictional TARP initiation, and zero otherwise. If our main results reflect the true program, we should not find a significantly positive coefficient on the DID term for the BB measures. The placebo experiment results are reported in panel B of Table 4. As shown, the fictional TARP effect is negative and statistically significant (opposite direction of main findings), which may reflect these banks' inability to create liquidity for the public in the period just before TARP started. Thus, our main results do not appear to be driven by alternative confounding forces.

Table 4. Effects of TARP on Bank Liquidity Creation: Two-Part Model, Placebo Experiment, and Propensity Score Matching Analysis

A. Two-Part Model						
	Dependent Variables: Bank Liquidity Creation					
	catfat_gta			***catnonfat_gta***		
Variables	**Small Banks (1)**	**Medium Banks (2)**	**Large Banks (3)**	**Small Banks (4)**	**Medium Banks (5)**	**Large Banks (6)**
Post TARP × TARP Recipient	**0.008*****	**−0.001**	**−0.001**	**0.014*****	**−0.002**	**−0.012**
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
TARP Recipient	−0.014***	−0.017***	0.022***	−0.021***	−0.011***	0.059***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,613	7,972	4,378	181,613	7,972	4,378
Adjusted R^2	0.752	0.664	0.686	0.722	0.581	0.598

(*continued*)

Table 4. (Continued)

B. Placebo Experiment for Small Banks		
	Dependent Variables: Bank Liquidity Creation	
Variables	***catfat_gta*** **(1)**	***catnonfat_gta*** **(2)**
Placebo Post TARP×TARP Recipient	**−0.009*****	**−0.006****
	(0.00)	(0.00)
TARP Recipient	0.000	−0.004
	(0.00)	(0.00)
Bank Controls	Yes	Yes
Macro and Local Controls	Yes	Yes
Time Fixed Effects	Yes	Yes
Observations	93,852	93,852
Adjusted R^2	0.762	0.731

(*continued*)

Table 4. (Continued)

C.1 Propensity Score Matching (PSM): 1-to-1 Matching with Replacement Based on CAMELS						
	Dependent Variables: Bank Liquidity Creation					
	Small Banks		**Medium Banks**		**Large Banks**	
Variables	***catfat_gta*** **(1)**	***catnonfat_gta*** **(2)**	***catfat_gta*** **(3)**	***catnonfat_gta*** **(4)**	***catfat_gta*** **(5)**	***catnonfat_gta*** **(6)**
Post TARP×TARP Recipient	**0.014****	**0.015*****	**0.002**	**0.001**	**−0.006**	**−0.029**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
TARP Recipient	−0.016***	−0.017***	−0.003	−0.004	0.014	0.048***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,177	12,177	1,855	1,855	1,143	1,143
Adjusted R^2	0.673	0.623	0.682	0.602	0.710	0.578

(*continued*)

Table 4. (Continued)

C.2. Propensity Score Matching (PSM): 1-to-1 Matching without Replacement Based on CAMELS						
	Dependent Variables: Bank Liquidity Creation					
	Small Banks		**Medium Banks**		**Large Banks**	
Variables	***catfat_gta*** **(1)**	***catnonfat_gta*** **(2)**	***catfat_gta*** **(3)**	***catnonfat_gta*** **(4)**	***catfat_gta*** **(5)**	***catnonfat_gta*** **(6)**
Post TARP×TARP Recipient	**0.011***	**0.013****	**0.002**	**0.001**	**−0.008**	**−0.030**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
TARP Recipient	−0.013**	−0.014***	−0.007	−0.007	0.019	0.047***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,736	13,736	2,572	2,572	1,614	1,614
Adjusted R^2	0.666	0.614	0.681	0.608	0.699	0.553

(continued)

Table 4. (Continued)

C3. Propensity Score Matching (PSM): 1-to-1 Matching with Replacement Based on Other Bank Controls						
	Dependent Variables: Bank Liquidity Creation					
	Small Banks		**Medium Banks**		**Large Banks**	
Variables	***catfat_gta* (1)**	***catnonfat_gta* (2)**	***catfat_gta* (3)**	***catnonfat_gta* (4)**	***catfat_gta* (5)**	***catnonfat_gta* (6)**
Post TARP×TARP Recipient	**0.014****	**0.017*****	**−0.012**	**−0.011**	**0.009**	**−0.021**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
TARP Recipient	−0.020***	−0.020***	−0.001	0.000	0.012	0.043**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,259	12,259	2,069	2,069	1,287	1,287
Adjusted R^2	0.698	0.645	0.702	0.618	0.743	0.634

(*continued*)

Table 4. (Continued)

C4. Propensity Score Matching (PSM): 1-to-1 Matching without Replacement Based on Other Bank Controls

	Dependent Variables: Bank Liquidity Creation					
	Small Banks		Medium Banks		Large Banks	
Variables	***catfat_gta*** **(1)**	***catnonfat_gta*** **(2)**	***catfat_gta*** **(3)**	***catnonfat_gta*** **(4)**	***catfat_gta*** **(5)**	***catnonfat_gta*** **(6)**
Post TARP $\times$ ***TARP Recipient***	**0.015*****	**0.019*****	**−0.005**	**−0.006**	**0.009**	**−0.015**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
TARP Recipient	−0.019***	−0.021***	−0.003	−0.001	0.006	0.036**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,933	13,933	2,975	2,975	2,043	2,043
Adjusted R^2	0.694	0.641	0.694	0.606	0.728	0.609

Note: Panels A and B of this table report estimates from the two-part model and placebo experiment for small banks to address the potential selection bias caused by the non-random TARP funding. For the two-part model, the first part models the probability of receiving TARP funds using the logit model while the second part models the distribution of the TARP amount to be received if applied for it and if approved by using the OLS regression (not shown for brevity). The predicted residual value, *Residual*, estimated after the two-part model, is added as an additional regressor in the main DID estimation to examine the effects of TARP capital infusion on bank liquidity creation (bootstrapping with 1,000 replications is used to estimate standard error). Panel B reports regression estimates using a placebo experiment for small banks, in which we fictionally assume that the TARP participation took place three years earlier; we distinguish between banks that received TARP and those that did not according to their "true" TARP. Accordingly, we define *Placebo Post TARP* as a dummy equal to one in 2006–08, the period after the fictional TARP initiation. We rerun the regressions by using the placebo sample (2003–08). Panels C1–C4 report estimates using two samples obtained from propensity score matching: nearest-neighbor matching N=1 with replacement in panels C1 and C3, and nearest-neighbor matching N=1 without replacement in panels C2 and C4. We select one TARP bank that is closest to the non-TARP bank according to CAMELS in panels C1 and C2, and other bank characteristics in panels C3 and C4. *TARP Recipient* takes the value of one if a bank is a TARP recipient, and zero otherwise. *Post TARP* is a dummy equal to one in the 2009–14 period after TARP initiation, and zero otherwise. *catfat_gta* is the sum of on-balance-sheet and off-balance-sheet liquidity creation; *catnonfat_gta* measures liquidity created on the balance sheet only. The estimation results are for 2003–14. All models include time fixed effects. The variable descriptions are in the table in the appendix. Robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

4.2.4 Propensity Score Matching Analysis

To further address the potential sample-selection bias caused by the non-random TARP assignment, we use a propensity score matching analysis. This procedure can mitigate the concern that our results reflect differences in the characteristics of *TARP Recipient* and non-*TARP Recipient* spuriously, rather than the effects of TARP per se. The propensity score is the probability of a bank receiving TARP funds, based on the bank's characteristics before TARP allocation. We select one TARP bank that is closest to the non-TARP bank according to observable characteristics. The matching bank selected is the bank with the closest propensity score, estimated from a logit regression of *TARP Recipient* on the proxy variables for CAMELS. We also estimate the propensity scores of all banks using bank characteristics other than CAMELS, i.e., bank holding company status (*bhc*), bank size (*banksize*), credit risk (*crerisk*), and loan loss provision (*llp*). Following prior research (see, e.g., Berger, Roman, and Sedunov 2020), we use nearest-neighbor matching with N=1 without replacement, and with replacement, such that each treatment unit is matched to the nearest control unit, based on its closest propensity score.

Panels C1–C4 of Table 4 show that the coefficients of the DID interaction term (i.e., *Post TARP*$\times$*TARP Recipient*) are still positive and statistically significant for the BB measures in small bank subsamples in all specifications, with magnitudes comparable to those observed in the baseline test. This is consistent with the view that after TARP, small TARP banks tend to create more liquidity than non-TARP banks. However, the coefficients of the DID interaction term are insignificant for medium and large bank subsamples, indicating that TARP capital infusion has no significant impact on the bank liquidity creation of these banks.

5. Additional Analysis

5.1 TARP Repayment

The effects of a TARP capital injection on bank liquidity creation might vary between banks that repaid early and those that did not. For example, banks that exit the program early may not be able to take advantage of the U.S. Treasury's investment, to perform one of their central roles in the economy—liquidity creation. Thus, ignoring the time of repayment could lead to incomplete and sometimes erroneous conclusions about the impact of the TARP capital injection. In this section, we differentiate between TARP banks that repaid early in 2009 or 2010 and those that did not. Following Berger and Roman (2015), the DID regression model, which analyzes the different behavior of TARP banks that repaid early and those that did not, is estimated as follows:

$$\begin{aligned} &Bank\ Liquidity\ Creation_{i,t} \\ &\quad = \beta_0 + \beta_1 TARPRecipient\_Not\_Repaid_i \\ &\qquad + \beta_2 TARPRecipient\_Repaid_i + \beta_3 PostTARP_t \\ &\qquad \times TARPRecipient\_Not\_Repaid_i + \beta_4 PostTARP_t \\ &\qquad \times TARPRecipient\_Repaid_i + \beta_5 X_{i,t-1} + \beta_6 Time_t + \varepsilon_{i,t}. \end{aligned} \tag{6}$$

In Equation (6), *TARP Recipient_Not_Repaid*$_i$ is a dummy that takes a value of one if the bank did not repay in 2009:Q1–2010:Q4, and *TARP Recipient_Repaid*$_i$ is a dummy that takes a value of one if the bank repaid early in 2009:Q1–2010:Q4. *Post TARP*$_t \times$ *TARP Recipient_Not_Repaid*$_i$ and *Post TARP*$_t \times$ *TARP Recipient_Repaid*$_i$ are the DID terms, and capture the effects of the treatment (TARP capital injection) on the treated (TARP recipients that did not repay early and TARP recipients that repaid early) compared with the rest. All the other variables are the same as in equation (3).

Table 5 reports the DID estimation results for equation (6). As can be seen, for small banks, the DID terms, *Post TARP*$\times$ *TARP Recipient_Not_Repaid*, are positive and statistically significant, but the coefficient estimates for the DID terms, *Post TARP*$\times$ *TARP Recipient_Repaid,* are insignificant, suggesting that TARP banks' capital injections are associated with higher liquidity creation for small banks that did not repay early, predominantly, and that TARP has essentially no effect for small banks that repaid early. Our findings suggest that the timing of TARP repayment should be considered when evaluating the effectiveness of TARP. For medium and large banks, both DID terms, *Post TARP*$\times$ *TARP Recipient_Not_Repaid* and *Post TARP*$\times$ *TARP Recipient_Repaid,* are

Table 5. Effects of TARP Repayment on Bank Liquidity Creation

A. Estimates from Difference in Difference Regression

	Dependent Variables: Bank Liquidity Creation					
Variables	**Small Banks (1)**	**Medium Banks (2)**	**Large Banks (3)**	**Small Banks (4)**	**Medium Banks (5)**	**Large Banks (6)**
Post TARP×TARP Recipient_Not_Repaid	**0.014*****	**−0.013**	**−0.009**	**0.019*****	**−0.012**	**−0.009**
	(0.00)	(0.01)	(0.02)	(0.00)	(0.01)	(0.02)
Post TARP×TARP Recipient_Repaid	**−0.005**	**−0.002**	**0.008**	**0.000**	**0.003**	**−0.025**
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
TARP Recipient_Not_Repaid	−0.011***	−0.007	0.015	−0.015***	−0.005	0.062***
	(0.00)	(0.01)	(0.02)	(0.00)	(0.01)	(0.02)
TARP Recipient_Repaid	−0.008	0.004	0.019	−0.016**	−0.002	0.030
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,613	7,972	4,378	181,613	7,972	4,378
Adjusted R^2	0.757	0.672	0.694	0.727	0.590	0.575

B. Test of the Equality of the Effects of TARP for the Two Types of TARP Banks (t-statistics)

Effects Tested	***catfat_gta***	***catnonfat_gta***
Effect for small TARP banks that repaid early = Effect of small TARP banks that did not repay early	**3.320***	**4.180****
Effect for medium TARP banks that repaid early = Effect of medium TARP banks that did not repay early	0.480	0.720
Effect for large TARP banks that repaid early = Effect of large TARP banks that did not repay early	1.180	1.060

Note: Panel A of this table reports estimates from difference-in-difference (DID) regression for analyzing the impact of TARP on bank liquidity creation for banks that repaid early and those that did not repay early. *TARP Recipient_Repaid* is a dummy equal to one if the bank repaid in 2009–10, and zero otherwise. *TARP Recipient_Not_Repaid* is a dummy equal to one if the bank did not repay in 2009–10, and zero otherwise. Panel B shows the tests of equality for the effects of TARP for two types of TARP banks: TARP banks that repaid early and TARP banks that did not. *catfat_gta* is the sum of on-balance-sheet and off-balance-sheet liquidity creation; *catnonfat_gta* measures liquidity created on the balance sheet only. All models include time fixed effects. The estimation results are for 2003–14. The variable descriptions are in the table in the appendix. Robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

insignificant. This supports our main findings that TARP capital injection has no impact on liquidity creation of medium and large banks. Panel B showing *t*-tests for the difference in coefficients between the two groups indicates again that the effects are concentrated in small banks that did not repay early.

5.2 Dynamic Analysis of TARP Effects on Bank Liquidity Creation

Following Berger, Roman, and Sedunov (2020), we investigate the dynamic effects of TARP on liquidity creation by replacing the DID term, *Post TARP*×*TARP Recipient*, with a series of DID terms, interacting *TARP Recipient* with dummies for each year after TARP was implemented (2009, 2010, 2011, 2012, 2013, and 2014) to trace out the timing of the effects of TARP. As can be seen from panel A of Table 6, for small banks, we find that the coefficients of the DID terms are insignificant, or negatively significant, in the first year of the post-TARP period, 2009, as opposed to positive and statistically significant at the 1 percent level in the long term, and the magnitude is much larger in the long term than that in the short term, suggesting that TARP capital injection has no significant immediate impact or has negative impact on liquidity creation undertaken by small banks in the short run, and the positive effect is more pronounced in the long run. This is consistent with our preliminary results in Figure 1, showing small banks have to wait longer to receive TARP funds. Furthermore, regardless of short or long term, we still observe a statistically insignificant sign for all DID terms in medium and large bank subsamples, indicating that TARP essentially has no effect on the amount of liquidity created by these banks. In panel B, we separate the TARP recipients that repaid early (*TARP Recipient_Repaid*) from those that did not (*TARP Recipient_Not_Repaid*). We see that the coefficients are small and statistically insignificant for small banks that exited TARP early, but the coefficients are large and highly statistically significant for small banks that did not exit early, particularly in the long run. For medium and large banks, we see no significant effects for either TARP banks that repaid early or those that did not.

Table 6. Dynamics of the Effects of TARP on Bank Liquidity Creation

A. TARP Banks that Repaid Early and Those that Did Not Are Equally Considered						
	Dependent Variables: Bank Liquidity Creation					
	Small Banks		Medium Banks		Large Banks	
Variables	*catfat_gta* **(1)**	*catnonfat_gta* **(2)**	*catfat_gta* **(3)**	*catnonfat_gta* **(4)**	*catfat_gta* **(5)**	*catnonfat_gta* **(6)**
Post TARP_2009×TARP Recipient	**−0.008*****	**0.001**	**0.003**	**0.006**	**−0.005**	**−0.017**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2010×TARP Recipient	**0.008****	**0.014*****	**−0.004**	**0.001**	**−0.005**	**−0.029**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2011×TARP Recipient	**0.015*****	**0.019*****	**−0.007**	**−0.008**	**0.009**	**−0.027**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2012×TARP Recipient	**0.015*****	**0.019*****	**−0.011**	**−0.012**	**0.015**	**−0.010**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2013×TARP Recipient	**0.014*****	**0.017*****	**−0.017**	**−0.014**	**−0.010**	**−0.021**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2014×TARP Recipient	**0.013*****	**0.015*****	**−0.018**	**−0.017**	**−0.013**	**−0.033**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
TARP Recipient	−0.009***	−0.013***	−0.004	−0.004	0.018	0.047***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,613	181,613	7,972	7,972	4,378	4,378
Adjusted R^2	0.757	0.726	0.671	0.590	0.693	0.567

(*continued*)

Table 6. (Continued)

B. TARP Banks that Repaid Early and Those that Did Not Are Separated						
	Dependent Variables: Bank Liquidity Creation					
	Small Banks		Medium Banks		Large Banks	
	catfat_gta	*catnonfat_gta*	*catfat_gta*	*catnonfat_gta*	*catfat_gta*	*catnonfat_gta*
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Post TARP_2009×TARP Recipient_Repaid	**−0.008**	**−0.000**	**0.009**	**0.008**	**−0.002**	**−0.007**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2010×TARP Recipient_Repaid	**−0.005**	**0.001**	**−0.003**	**0.003**	**0.012**	**−0.028**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Post TARP_2011×TARP Recipient_Repaid	**0.007**	**0.009**	**−0.001**	**−0.000**	**0.026**	**−0.031**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Post TARP_2012×TARP Recipient_Repaid	**0.003**	**0.007**	**0.000**	**0.005**	**0.027**	**−0.022**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)
Post TARP_2013×TARP Recipient_Repaid	**−0.017**	**−0.010**	**−0.007**	**0.003**	**−0.003**	**−0.030**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Post TARP_2014×TARP Recipient_Repaid	**−0.014**	**−0.010**	**−0.010**	**−0.001**	**−0.008**	**−0.034**
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Post TARP_2009×TARP Recipient_Not_Repaid	**−0.006***	**0.002**	**−0.004**	**0.002**	**−0.032***	**−0.009**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2010×TARP Recipient_Not_Repaid	**0.013*****	**0.019*****	**−0.008**	**−0.001**	**−0.021**	**−0.009**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2011×TARP Recipient_Not_Repaid	**0.019*****	**0.024*****	**−0.014**	**−0.013**	**−0.006**	**−0.010**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2012×TARP Recipient_Not_Repaid	**0.021*****	**0.026*****	**−0.015**	**−0.017**	**0.012**	**0.007**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2013×TARP Recipient_Not_Repaid	**0.023*****	**0.026*****	**−0.021**	**−0.020**	**−0.004**	**−0.007**
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Post TARP_2014×TARP Recipient_Not_Repaid	**0.022*****	**0.024*****	**−0.021**	**−0.023***	**−0.003**	**−0.024**
	(0.01)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)

(*continued*)

Table 6. (Continued)

B. TARP Banks that Repaid Early and Those that Did Not Are Separated

	Dependent Variables: Bank Liquidity Creation					
	Small Banks		**Medium Banks**		**Large Banks**	
	catfat_gta	***catnonfat_gta***	***catfat_gta***	***catnonfat_gta***	***catfat_gta***	***catnonfat_gta***
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
TARP Recipient_Repaid	−0.008	−0.016**	0.004	−0.002	0.019	0.030
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
TARP Recipient_Not_Repaid	−0.011***	−0.015***	−0.007	−0.005	0.016	0.062***
	(0.00)	(0.00)	(0.01)	(0.01)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,613	181,613	7,972	7,972	4,378	4,378
Adjusted R^2	0.757	0.727	0.673	0.591	0.695	0.575

Note: This table reports difference-in-difference (DID) regression estimates for the timing of the (year-by-year) effects of TARP on bank liquidity creation. *TARP Recipient* takes the value of one if the bank is a TARP recipient, and zero otherwise. *Post TARP* is a dummy equal to one in the 2009–14 period after TARP initiation, and zero otherwise. *TARP Recipient_Repaid* is a dummy equal to one if the bank repaid in 2009–10, and zero otherwise. *TARP Recipient_Not_Repaid* is a dummy equal to one if the bank did not repay in 2009–10, and zero otherwise. DID coefficients are the interactions of the *TARP Recipient* variable with year dummies for each year after TARP was implemented (2009, 2010, 2011, 2012, 2013, and 2014). In panel A, we consider equally both TARP banks that repaid early and those that did not repay early. In panel B, we separate the TARP recipients that repaid early (*TARP Recipient_Repaid*) from those that did not (*TARP Recipient_Not_Repaid*). *catfat_gta* is the sum of on-balance-sheet and off-balance-sheet liquidity creation; *catnonfat_gta* measures liquidity created on the balance sheet only. All models include time fixed effects. The estimation results are for 2003–14. The variable descriptions are in the table in the appendix. Robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

In addition, we analyze quarter-by-quarter effects of TARP on bank liquidity creation. Table A.1 in the online appendix (available at http://www.ijcb.org) reports the results. Consistent with our baseline findings, the effect of TARP is insignificant in large bank subsamples and weakly significant in medium bank subsamples. Most importantly, in panel A, we find that the impact of TARP on small banks' liquidity creation takes time to materialize and becomes significantly positive in 2010:Q2 for both measures of liquidity creation (*catfat_gta* and *catnonfat_gta*), remaining at a high level until the end of the sample period. This may suggest that the positive and highly significant effect of TARP on small banks' liquidity creation appeared only after the financial crisis was over. Again, panel B presents that the positive effect of TARP on small banks' liquidity creation may take longer to materialize, but only small TARP banks that did not repay early experienced an increase in liquidity creation, implying that small TARP banks that repaid early may have lost the advantage of increasing their liquidity creation from TARP. We plot the DID coefficients in Figure A.1 in the online appendix that considers equally both the TARP funds that were repaid early and those that were not. As illustrated, TARP does not affect bank liquidity creation immediately, and the positive effects are concentrated in small bank subsamples. We repeat the exercise by separating the TARP recipients that repaid early and those that did not. Figure A.2 illustrates that there is an increase in bank liquidity creation after TARP, but this positive effect is only for small banks that did not repay early.

5.3 The Role of Bank Size in the Disbursements and Repayments of TARP Funds

To investigate how bank size is related to the probability of receiving/repaying TARP funds, and the timing of the first repayment of TARP funds, we estimate probit and hazard models following Cornett, Li, and Tehranian (2013). In these regressions, we include a bank size variable (*banksize*), which is our key variable of interest, along with other bank controls and macroeconomic and local economic controls that are defined as in the baseline model. We first run probit regressions to examine the probability of receiving and repaying TARP funds. Panel A of Table 7 reports estimates of

Table 7. The Role of Bank Size in the Disbursements and Repayments of TARP Funds

A. Probit Regressions Examining Banks' Probabilities of Receiving and Repaying TARP Money

	Dependent Variables: *TARP Dummy*			
Variables	**(1)**	**(2)**	**(3)**	**(4)**
banksize	**0.351*****	**0.409*****	**0.351*****	**0.409*****
	(0.02)	(0.02)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	No	Yes	No
Time Fixed Effects	Yes	Yes	Yes	Yes
Observations	194,610	200,676	194,610	200,676
Adjusted R^2	0.222	0.211	0.222	0.211

B. Hazard Model Regressions Examining the Time to Repayment of TARP Funds

	Dependent Variables: *ln(time to repayment)*					
	Small Banks		**Large Banks**		**All Banks**	
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
banksize	**−0.033**	**−0.022**	**0.268****	**0.265*****	**0.128*****	**0.157*****
	(0.06)	(0.06)	(0.11)	(0.10)	(0.04)	(0.04)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	No	Yes	No	Yes	No
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,724	14,165	5,677	5,939	19,401	20,104

Note: Panel A of this table presents probit regressions that examine how bank characteristics only (see columns 2 and 4) or both bank characteristics and macroeconomic and local economic conditions (see columns 1 and 3) affect the probability of receiving and repaying TARP funds. The dependent variable in columns 1 and 2 is the *TARP dummy* that equals one for banks that receive TARP funds, and zero otherwise. The dependent variable in columns 3 and 4 is the *TARP dummy* that equals one for the banks that make their first TARP repayment, and zero otherwise. Panel B presents hazard model regressions that examine how bank characteristics only (see columns 2, 4, and 6) or both bank characteristics and macroeconomic and local economic conditions (see columns 1, 3, and 5) affect the time to repayment of TARP funds. The dependent variable is the log of the expected time to the first installment of TARP repayment. The estimation results are for 2003–14. The variable descriptions are in the table in the appendix. Robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

the probit model. A statistically positive coefficient of *banksize* suggests that larger banks are significantly more likely to receive and exit TARP. We also use a cox hazard model to examine the time to the first repayment of TARP funds. In panel B, the dependent variable is the log of the expected time to the first installment of TARP repayment. A positive coefficient means that an increase in the variable increases the hazard (risk) of a first repayment of TARP funds at a given date or, equivalently, decreases the expected time to first repayment. The coefficient of *banksize* is positive and statistically significant for large banks, whereas it is insignificant for small banks, indicating that larger banks repay TARP funds faster. The social stigma and restriction associated with TARP may explain why many banks gave up sizable subsidies to exit the program (Wilson and Wu 2012). Larger banks are particularly exposed to this stigma, because they have much larger international, national, and local media attention. As soon as they were allowed to, this group was likely to pay back their TARP funds. Smaller banks, on the other hand, did not receive the same sort of intense public scrutiny and, hence, were not under the same pressure to pay back their TARP funds. The evidence here further explains why small banks can create more liquidity after receiving TARP funds.

6. Robustness Tests

6.1 Decomposing Total Bank Liquidity Creation into Subcomponents

To better understand the driving forces behind the total liquidity creation, we examine off-balance-sheet liquidity creation (*lc_obs_gta*) and further decompose on-balance-sheet liquidity creation into asset-side liquidity creation (*lc_a_gta*) and liability-side liquidity creation (*lc_l_gta*). Our results are presented in panel A, Table 8. For small banks, as reported in column 1, we find that the estimated coefficient of the DID term, *Post TARP*$\times$*TARP Recipient,* is related to asset-side liquidity creation (*lc_a_gta*) significantly and positively. Furthermore, column 3 shows that the estimated coefficient of the DID term is negative and significant for off-balance-sheet liquidity creation (*lc_obs_gta*). However, the magnitude of the coefficient estimate is much smaller than that found using asset-side liquidity

Table 8. Effects of TARP on Subcomponents of Bank Liquidity Creation

	A. Asset-Side, Liability-Side, and Off-Balance-Sheet Bank Liquidity Creation								
	Dependent Variables: Bank Liquidity Creation								
	Small Banks			Medium Banks			Large Banks		
Variables	**Asset-Side Liquidity Creation** ***lc_a_gta*** **(1)**	**Liability-Side Liquidity Creation** ***lc_l_gta*** **(2)**	**Off-Balance-Sheet Liquidity Creation** ***lc_obs_gta*** **(3)**	**Asset-Side Liquidity Creation** ***lc_a_gta*** **(4)**	**Liability-Side Liquidity Creation** ***lc_l_gta*** **(5)**	**Off-Balance-Sheet Liquidity Creation** ***lc_obs_gta*** **(6)**	**Asset-Side Liquidity Creation** ***lc_a_gta*** **(7)**	**Liability-Side Liquidity Creation** ***lc_l_gta*** **(8)**	**Off-Balance-Sheet Liquidity Creation** ***lc_obs_gta*** **(9)**
Post TARP × TARP Recipient	**0.013*****	**0.000**	**−0.005*****	**−0.004**	**−0.002**	**0.002**	**−0.029****	**0.010**	**−0.000**
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
TARP Recipient	−0.009***	−0.005*	0.005***	0.007	−0.013*	−0.003	0.040**	0.001	−0.003
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,613	181,613	181,613	7,972	7,972	7,972	4,378	4,378	4,378
Adjusted R^2	0.825	0.326	0.488	0.697	0.350	0.531	0.633	0.339	0.565

(*continued*)

Table 8. (Continued)

B. Decomposition of Asset-Side Bank Liquidity Creation into Different Types of Bank Loans—Small Banks

	Dependent Variables: Bank Loan Supply					
Variables	**Net Loans and Leases** *nll_gta* **(1)**	**Commercial & Industrial (C&I) Loans** *ci_gta* **(2)**	**Commercial Real Estate Loans** *comrs_gta* **(3)**	**Residential Real Estate Loans** *resirs_gta* **(4)**	**All Real Estate Loans** *allrs_gta* **(5)**	**Consumer Loans** *consuml_gta* **(6)**
Post TARP× TARP Recipient	**0.019*****	**0.003**	**0.019*****	**0.002***	**0.011****	**0.006****
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TARP Recipient	−0.019***	0.008***	−0.005	0.000	−0.012***	−0.011***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	181,613	181,613	181,613	181,613	181,613	181,613
Adjusted R^2	0.813	0.197	0.501	0.180	0.533	0.148

(*continued*)

Table 8. (Continued)

C. Decomposition of Asset-Side Bank Liquidity Creation into Different Types of Bank Loans—Medium Banks						
	Dependent Variables: Bank Loan Supply					
Variables	**Net Loans and Leases** *nll_gta* **(1)**	**Commercial & Industrial (C&I) Loans** *ci_gta* **(2)**	**Commercial Real Estate Loans** *comrs_gta* **(3)**	**Residential Real Estate Loans** *resirs_gta* **(4)**	**All Real Estate Loans** *allrs_gta* **(5)**	**Consumer Loans** *consuml_gta* **(6)**
Post TARP*×*TARP Recipient	**−0.000**	**−0.010**	**0.003**	**0.003**	**0.014**	**0.003**
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
TARP Recipient	0.007	0.012	0.012	−0.004	0.004	−0.001
	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,972	7,972	7,972	7,972	7,972	7,972
Adjusted R^2	0.729	0.234	0.301	0.122	0.304	0.093

(continued)

Table 8. (Continued)

D. Decomposition of Asset-Side Bank Liquidity Creation into Different Types of Bank Loans—Large Banks						
	Dependent Variables: Bank Loan Supply					
Variables	**Net Loans and Leases** *nll_gta* **(1)**	**Commercial & Industrial (C&I) Loans** *ci_gta* **(2)**	**Commercial Real Estate Loans** *comrs_gta* **(3)**	**Residential Real Estate Loans** *resirs_gta* **(4)**	**All Real Estate Loans** *allrs_gta* **(5)**	**Consumer Loans** *consuml_gta* **(6)**
Post TARP× TARP Recipient	**−0.020**	**−0.011**	**0.007**	**0.008**	**−0.018**	**0.025**
	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
TARP Recipient	0.029**	0.015	0.012	−0.005	0.042*	−0.033*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro and Local Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,378	4,378	4,378	4,378	4,378	4,378
Adjusted R^2	0.626	0.351	0.483	0.177	0.458	0.403

Note: To better understand the driving forces behind the total liquidity creation and enhance our analysis, in panel A, we decompose on-balance-sheet liquidity creation into asset-side liquidity creation (*lc_a_gta*) and liability-side liquidity creation (*lc_l_gta*). We further report the results for off-balance-sheet liquidity creation (*lc_obs_gta*). We also break down asset-side liquidity creation (*lc_a_gta*) into net loans and leases (*nll_gta*), and five main lending categories: commercial and industrial (C&I) loans (*ci_gta*), commercial real estate loans (*comrs_gta*), residential real estate loans (*resirs_gta*), all real estate loans (*allrs_gta*), and consumer loans (*consuml_gta*) in panels B–D for small, medium, and large banks, respectively. *Post TARP* is a dummy equal to 1 in the 2009–14 period after TARP initiation and 0 otherwise. *catfat_gta* is the sum of on-balance-sheet and off-balance-sheet liquidity creation; *catnonfat_gta* measures liquidity created on the balance sheet only. The variable descriptions are in the table in the appendix. Robust standard errors clustered by bank are in parentheses. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent level, respectively.

creation (*lc_a_gta*). In other words, TARP capital support increases asset-side liquidity creation significantly but reduces off-balance-sheet liquidity creation marginally, which explains why we find an overall positive effect of TARP capital support on the total liquidity creation of small banks. Additionally, column 2 shows that the effect of TARP is insignificant for liability-side liquidity creation (*lc_l_gta*). For medium banks across columns 4–6, the coefficients of the DID term, *Post TARP*$\times$*TARP Recipient,* are insignificant in all cases. For large banks, we find that the coefficient of the DID term is modestly negative at the 5 percent significance level for asset-side liquidity creation (*lc_a_gta*) only, as shown in column 7. However, the magnitude and significance of the coefficients on liability-side liquidity creation (*lc_l_gta*) and off-balance-sheet liquidity creation (*lc_obs_gta*) in columns 8 and 9, respectively, are small and statistically insignificant, which explains why TARP bailouts did not affect the total liquidity creation of large banks. A possible reason for the negative effect of TARP on large banks' asset-side liquidity creation may arise from the decreased moral hazard associated with bank bailout. As is well documented in the literature, the notion of bank liquidity creation is related to a mismatch between the maturities of banks' assets and liabilities. The structural mismatches in bank balance sheets reflect the portion of long-term, illiquid assets that are financed with short-term funding and non-core deposits (Vazquez and Federico 2015). Thus, a bank with larger structural liquidity mismatches/higher risk-taking would create more liquidity. If government bailouts can decrease incentives for aggressive behavior and risk taking, then bailed-out banks are expected to take less risk and hence create less liquidity.

Following prior literature (e.g., Li 2013; Berger et al. 2016; Berger and Roman 2017), we also investigate the impact of TARP capital infusion on bank lending across different sizes of banks directly, since lending is a key component of asset-side liquidity creation. Specifically, we examine net loans and leases (*nll_gta*), and further break down loans into five main lending categories: commercial and industrial (C&I) loans (*ci_gta*), commercial real estate loans (*comrs_gta*), residential real estate loans (*resirs_gta*), all real estate loans (*allrs_gta*), and consumer loans (*consuml_gta*). Panel B indicates that, for small banks, the coefficients of DID term, *Post TARP*$\times$*TARP Recipient,* are positive and statistically significant in most specifications, which is consistent with our finding that TARP capital support increases asset-side liquidity creation. This result is also consistent with recent findings of, for example, Li (2013), that there is a positive effect of TARP capital infusion on bank lending. In contrast, as shown in panels C and D, the coefficients of DID terms are not statistically significant for either medium or large banks.

6.2 Other Robustness Checks

To test whether our findings are sensitive to the way banks are classified as large or small, we do additional tests by classifying our sample of banks in three different ways in terms of size.[12] We perform separate analyses of differences between small and large banks for each of the size classification methods applied. First, we use alternative cut-offs ($5 billion and $10 billion, respectively) separating medium and large banks, while the small bank definition remains at the $1 billion cut-off. Second, we split our sample of banks using a cut-off of $1 billion dollars in assets, because banks with sizes below $1 billion are generally considered to be community banks. In fact, $1 billion is used as the traditional dividing line to distinguish between small and large banks in major empirical banking literature (Berger and Sedunov 2017). Third, we run regressions categorizing all banks as either small or large using a cut-off of $10 billion dollars in assets. Finally, very large banks may be considered too big to fail (TBTF), and in the event of distress, they tend to receive government support. To make sure that our large bank results are not overly influenced by TBTF banks, we rerun our $10 billion cut-off analysis while excluding these banks. Following the 2010 Dodd-Frank Act, we define TBTF banks as those with total assets exceeding $50 billion. The results in Table A.2 in the online appendix show that our results remain unchanged and provide qualitatively similar conclusions.

In panel A, Table A.3 of the online appendix, we test the robustness of our main results to the use of an alternative measure of TARP, *ln(1+Bailout Amount)*. In panel B, we follow a conservative

[12]In addition to using bank size subsamples, in unreported results, we perform triple DID tests that interact *Post TARP*$\times$*TARP Recipient* with indicators of size bins. This test helps ensure that the control groups are consistent in the tests. We continue to find support for our main findings.

approach and reestimate the results from a sample that eliminates involuntary participants in TARP in order to mitigate the concern that the Treasury Department might have had different motivations when approving TARP funds for these banks.[13] Following prior literature, in panel C, we exclude the largest 19 banks from our sample that were subject to the "stress test" (called the Supervisory Capital Assessment Program, or SCAP), because its institutional design was different from that of TARP (Duchin and Sosyura 2014). For example, in contrast to TARP, the capital raised under SCAP was in the form of common stock, rather than preferred stock. Overall, our main results continue to hold in these robustness checks.

7. Conclusion

The literature provides two opposing views on the effect of government bailouts like TARP on bank liquidity creation. On the one hand, the "precautionary motive" view argues that government capital support may provide banks with the assurance of safety and, thereby, reduce precautionary liquidity holding incentives (i.e., banks would not have to hold as much cash for survival) and encourage bank liquidity creation. On the other hand, the "moral hazard" view predicts that TARP may have an insignificant effect on bank liquidity creation. Moral hazard attributable to the expectation of government safety nets for financial firms may trigger excessive risk-taking, resulting in huge capital losses and exacerbating bank failure risk, which would, in turn, harm the banks' ability to create liquidity for the public. Furthermore, it is possible that bank bailouts could decrease moral hazard incentives, which suggests that, after receiving TARP capital support, banks may use TARP funds to repair their weak balance sheets and boost their capital ratios, rather than increase liquidity creation for the nonbank public. Our analysis corroborates and complements these two strands of literature. Specifically, we find that the effect on bank liquidity creation of TARP, the

[13] On the very day that TARP was announced, Citigroup, JP Morgan, Bank of America (including Merrill Lynch), Goldman Sachs, Morgan Stanley, State Street, Bank of New York Mellon, and Wells Fargo (including Wachovia) were reportedly called into Treasury and told that they would receive a capital injection whether they wanted it or not.

largest government intervention in the U.S. financial sector, depends crucially on bank size. Consistent with the "precautionary motive" view in the literature, we find strong evidence that TARP capital infusions have a significantly positive stimulus effect on small banks' liquidity creation. In line with the "moral hazard" view, we do not find a significant impact of TARP on the liquidity creation of large banks. Further analysis shows that the positive and highly significant effect of TARP on small banks' liquidity creation may take longer to materialize, and only small TARP banks that did not repay early experienced an increase in liquidity creation. In addition, our results suggest that the positive effect of TARP on small banks' liquidity creation is driven mainly by asset-side (on-balance-sheet) liquidity creation, and this effect holds in most lending categories.

We contribute to the literature along two dimensions. First, while there is an extensive empirical literature examining the effects of TARP on bank lending, little is known about how TARP capital injections affect banks' ability to create liquidity for the public: a major function of banks, supporting the macroeconomy. We extend this strand of the literature by broadening the focus to bank liquidity creation, which includes much more than lending, as lending is only one component of asset-side liquidity creation. Second, this is the first study that integrates bank size as a primary component in the analysis of the impact of TARP on bank liquidity creation. The results clearly show that one size does not fit all when it comes to government capital support. Our findings are heavily concentrated among the usual notion of "community banks" with assets less than $1 billion, indicating that small banks create more liquidity after they receive government support. This suggests that, from the bank liquidity creation perspective, government capital injections should target a large fraction of small banks. Therefore, this study has important policy implications for policymakers and bank regulators, as it sheds new light on how the design features of future government bailout programs can promote bank liquidity creation.

Appendix

Variable Definitions

Variable	Definition
A. Bank Liquidity Creation and TARP Variables	
catfat_gta	Dollar amount of "*catfat*" liquidity creation normalized by gross total assets. "*catfat*" measures the liquidity created on and off balance sheet, following Berger and Bouwman (2009).
catnonfat_gta	Dollar amount of "*catnonfat*" liquidity creation normalized by gross total asset. "*catnonfat*" measures the liquidity created on the balance sheet only, following Berger and Bouwman (2009).
TARP amount	The natural logarithm of one plus the bailout amount.
TARP dummy	Takes the value of one if a bank was a TARP recipient, and zero otherwise.
B. Bank-Specific Variables	
ca	The ratio of tier 1 capital to total risk-weighted assets.
aq	The ratio of all nonperforming loans (past due plus non-accrual loans) to total assets.
mq	The number of years that a bank had been in existence as of 2014.
roe	The ratio of net income to total equity.
liq	The sum of cash and balances due from other financial institutions, federal funds sold and securities purchased under resale agreements, and available-for-sale securities, scaled by total assets.
ltd	The ratio of loans to deposits.
bhc	A dummy variable that takes the value of one if bank holding company (BHC) status applies, and zero otherwise
crerisk	The bank's Basel I risk-weighted assets divided by total assets.
llp	The ratio of loan loss provision expenses to total loans and leases.
banksize	The natural logarithm of total assets.
dwtaf	A dummy variable equal to one if a bank received discount window loans and/or Term Auction Facility funding during the crisis, and zero otherwise.
C. Instrumental Variable	
SubcommonFI	Takes the value of one if a representative sat on the Subcommittee on Financial Institutions and Consumer Credit, which supervises all federal banking regulators, and zero otherwise
D. Macroeconomic and Local Economic Variables	
spread	The spread between three-month U.S. T-bills and 10-year U.S. Treasuries.
lngdp	Natural logarithm of gross domestic product.
lnpop	Natural logarithm of population in a county.
lnpopden	Natural logarithm of population per square mile (i.e., population density) in a county.
ingr	Income growth rate in a county.
hhi	Bank-level HHI of deposit concentration for the local markets in which the bank is operating. HHI is calculated as the sum of the squares of the market shares (deposits) of each individual bank. The larger is HHI, the greater is a bank's market concentration.
merger	A dummy variable that takes a value of one from the time that a bank acquired another institution, and zero otherwise.
crisisdummy	A dummy variable that equals one from the third quarter of 2007 to the fourth quarter of 2009, and zero otherwise.

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