Too Big to Care, Too Small to Matter: Macrofinancial Policy and Bank Liquidity Creation

Michael Bowe, Olga Kolokolova, Marcin Michalski†

This version: 27th April 2020

Abstract

We estimate the volume of liquidity creation by U.S. bank holding companies between 1997 and 2015, and examine the impact of changes in macrofinancial policies on the dynamics of this process. We focus on three major policy developments occurring in the aftermath of the 2007 - 2009 financial crisis: bank capital regulation reform, monetary stimulus through quantitative easing, and the Troubled Asset Relief Program (TARP). The dynamics of bank liquidity creation differ considerably between small and large institutions. The level of bank capital requirements and the stance of monetary policy affect the liquidity creation of small and medium-sized banks, but not the largest institutions which control over 80% of the banking system's assets. In contrast, TARP has only short-term effects on small and medium banks, and leads to a long-term decline in liquidity provision per dollar of assets of the largest banks.

JEL classification: G01, G18, G21, G28.

Keywords: Banks, Liquidity Creation, Bank Regulation, Capital Requirements, Capital Purchase Program (CPP), Troubled Asset Relief Program (TARP).

We would like to thank the participants at the Bank of England Conference on Financial Services Indices, Liquidity and Economic Activity; the 7th International Conference of Financial Engineering and Banking Society (FEBS); the 15th INFINITI Conference; the International Conference on Banking and Finance at the University of Warsaw; the IFABS 2017 Oxford Conference; the 49th Annual Conference of the Money Macro and Finance Group; the 2018 Meeting of the Eastern Finance Association; the 2018 European Conference of the Financial Management Association, and presentations at the University of Manchester for their helpful comments on an earlier version of the paper. The authors gratefully acknowledge the financial support of the University of Manchester, the Centre for the Analysis of Investment Risk (CAIR), and the Economic and Social Research Council (ESRC).

† Michael Bowe and Olga Kolokolova are affiliated with Alliance Manchester Business School, the University of Manchester. Marcin Michalski is affiliated with the University of Liverpool Management School. Please direct all enquiries and comments about this paper to Marcin Michalski (m.michalski@liverpool.ac.uk).

1 Introduction

The mechanisms by which a banking institution creates liquidity by engaging in qualitative asset transformation on its balance sheet are the focal point of virtually all modern theories of financial intermediation (see Diamond and Dybvig (1983), Diamond (1984), Kashyap, et al. (2002), and Diamond and Rajan (2001), among many others). However, to date only a few empirical studies attempt to measure how much liquidity banks actually create, and how the liquidity creation process responds to changes in macrofinancial conditions.

This study implements the methodological approach proposed by Berger and Bouwman (2009), who construct four alternative liquidity creation measures, according to whether loan classifications are undertaken by category or maturity, and whether off-balance sheet items are accounted for. Using the annual data reports of U.S. commercial banks between 1993 - 2003, they examine the cross-sectional properties of their measures. Our contribution is to extend Berger and Bouwman's (2009) study in two important areas. First, we provide estimates of liquidity created by the banking sector between 1997 and 2015, and study the dynamics of this process during the period of prolonged economic uncertainty subsequent to the 2007 collapse of the U.S. real estate bubble and the ensuing financial crisis. Second, we investigate whether liquidity creation by banks is impacted by large-scale government capital support programmes (TARP), and changes in the monetary policy regime and reform of bank capital regulations which occur in the crisis' aftermath.

Berger and Bouwman's (2009) results demonstrate that the total amount of liquidity created doubles during the sample period, with more than 80% of the total attributable to the largest banks, accounting for only 2% of sample observations. Our major findings suggest that bank size is indeed a significant factor impacting the dynamics of liquidity creation.

We provide the first comprehensive empirical analysis of how TARP influences bank liquidity creation. TARP became law on the 3rd October 2008, and gave the U.S. Federal Government the power to purchase or insure up to $700 billion of assets held by privately-owned financial institutions (Financial Crisis Inquiry Commission, 2011). Under the Capital Purchase Program, the Treasury set aside $250 billion to purchase senior preferred stock in the four largest bank holding companies, three investment banks, and two clearing and settlement banks, subsequently opening the program to all healthy and viable banks. TARP's objective is not only to restore the confidence in the financial system, but also to provide banking institutions with sufficient capital to continue their lending and dividend activities (Financial Crisis Inquiry Commission, 2011).

Li (2013) claims that as a result of TARP, under-capitalised banks increase their loan supply by more than 6%, corresponding to $404 billion in new loans. However, the average TARP-recipient institution uses only a third of the enhanced funding to create loans, keeping the remainder to restore the strength of its balance sheet. Further, the new loans which originate at large, TARP-recipient institutions are riskier relative to those generated by non-participant banks. In contrast, loans created by small, TARP-funded banks are safer than those issued by corresponding non-TARP banks (Black and Hazelwood, 2013). Duchin and Sosyura (2014) provide evidence that this risk shifting occurs within the same asset classes, and consequently does not alter the regulatory capital ratios of institutions supported by TARP. This makes such institutions appear better capitalised despite the increased riskiness of their investments. Moreover, Berger and Roman (2015) claim that receiving TARP funds gives certain banks a competitive advantage allowing them to increase their market share and market power. This arises as a consequence of the government's explicit TARP objective to support healthy and viable institutions, making the institutions participating in the programme appear safer. Our paper further contributes to this literature by examining the relative changes in the amount of liquidity created by TARP and non-TARP banks, and by identifying significant asymmetries in the short- and long-term effects of government aid on the extent of liquidity creation across small and large banking institutions.

While we find no differences in the patterns of liquidity creation of large banks that participate in TARP from those that do not, our evidence suggests that small institutions which receive TARP injections create a lower amount of liquidity per unit of their assets than prior to the crisis. The impact is short-term and the difference in liquidity provision disappears after repayment of TARP funds. In contrast, despite the policy having no immediate effects, large institutions demonstrate a pronounced decrease in efficiency of liquidity provision in the period following the end of their participation in TARP.

The literature on the bank lending channel of conventional monetary policy maintains that contractionary monetary shocks may increase the external financing premium, and reduce bank credit supply (Bernanke and Gertler, 1995). The empirical evidence in Kashyap and Stein (1995) and Kishan and Opiela (2000) shows that the effects of monetary tightening appear particularly pertinent for small banks, which may not be able to access non-deposit financing as easily as larger financial institutions. Berger and Bouwman (2012) find similar effects of the changes in the stance of monetary policy between 1984 and 2008 on the amount of liquidity creation by small banks, but no significant effects for medium and large banks. Chatterjee (2015) suggests that the amount of liquidity large banks create is inversely related to asset market liquidity.

The diminishing effectiveness of conventional monetary policy once the nominal interest rate approaches its zero lower bound, such as occurs in late 2008, led the Federal Reserve to adopt a programme of large-scale asset purchases to further ease monetary conditions. Joyce, et al. (2012) discuss the potential effects of this quantitative easing on bank credit supply through the bank lending policy transmission channel. When the central bank engages in large-scale purchases of assets, *ceteris paribus*, banks' deposits and reserve balances increase, allowing them to issue new loans or, at the very least, to sustain their lending activities. However, this channel only operates if banks do not use the additional funds to increase their holdings of highly liquid assets. The reduction in long-term yields that quantitative easing achieves may also result in an expansion of bank lending, due to an increase in asset prices, and a strengthening of the balance sheets of firms and consumers (Fawley and Neely, 2013). D'Amico, et al. (2012) estimate that the first two rounds of quantitative easing carried out by the Federal Reserve between 2009 and mid-2011 reduce long-term Treasury yields by 35 basis points and 45 basis points, respectively. This is equivalent to a 140 basis points and a 180 basis points decrease in the federal funds rate. The empirical analysis we undertake fails to uncover any evidence that the additional loosening of monetary policy between 2008 and 2015 stimulates any increase in bank liquidity creation, a finding consistent with banks' diverting the additional funds to bolster their capital ratios. .

Further, examining the relation between bank equity capital and liquidity creation, Berger and Bowuman (2009) find it is positive for large banks and negative for small banks. This important result potentially reconciles two contradictory predictions of existing financial intermediation theories, one suggesting that equity capital reduces banks' incentives to monitor risky borrowers and thus their ability to create liquidity (e.g., Diamond and Rajan, 2001), with another maintaining that it increases their risk-absorption capacity and allows for greater liquidity creation (e.g., Bhattacharya and Thakor, 1993). The 2010 reform of the bank capital requirements system, embodied in the Third Basel Capital Accord (Basel III), is another policy development which has a profound effect on the banking sector during the period we examine. The failure of a number of prominent financial institutions during the 2007 - 2009 financial crisis led regulators to recognise the importance of potential economy-wide distress stemming from systemic risk. To strengthen the resilience of the banking sector, the Basel Committee on Banking Supervision responded by raising the minimum bank capital requirements, with special provisions envisaged for institutions deemed systemically important. They also introduce additional short- and long-term liquidity requirements, namely the Liquidity Coverage Ratio and the Net Stable Funding Ratio (Basel Committee on Banking Supervision, 2011, 2013, 2014).

Requiring banks to hold a greater amount of capital on their balance sheets serves to reduce the costs incurred in financial sector efforts to resolve any future banking crises (Miles, et al., 2013). Berger and Bouwman (2013) demonstrate that bank capital is positively related to the probability of survival of small banks at all times, and survival of large banks during banking crises. Other studies reveal that financial institutions with lower funding liquidity risk are also less likely to fail during periods of severe economic stress (Khan, et al., 2013, Velazquez and Federico, 2015, Bai, et al., 2016).

This reduction in crisis resolution costs should be considered in the context of potential output loss and overall banking sector performance. Several studies evaluate the macroeconomic impact of higher bank capital requirements, and examine how financial institutions adjust their business models in response. Bowe, et al. (2016) undertake simulations which indicate that excessive levels of bank capital requirements reduce the expected output of a macrofinancial system. Slovik and Cournède (2011) estimate that the implementation of Basel III results in a -0.05 to -0.15 percentage point reduction in annual gross domestic product growth rates, while analysis by Oxford Economics (2013) suggests a decline of as much as 0.8 to 2 percentage points per year. This loss of output is attributable to the actions taken by financial institutions to conform with the increased regulatory requirements, e.g. reducing commercial real estate and secured household lending growth rates (Bridges, et al., 2014), or accumulating retained earnings and lowering dividend payouts (Cohen and Scatigna, 2016). Our study advances this debate and provides further empirical evidence on the impact of macroprudential regulation on banking sector performance, as we show that the level of Tier 1 capital has no discernible impact on large bank's liquidity creation but adversely affects the amount created by small banks. This effect is amplified in the second half of our sample, capturing the increase in minimum bank capital requirements in 2010.

2 Data and methodology

Our approach relates closely to Berger and Bouwman (2009) and the procedure for measuring liquidity creation they develop. They invoke a three-step process. Initially they classify all assets, liabilities, equity and off-balance sheet items of a bank as liquid, semi-liquid or illiquid according to the ease with which they can be transformed into cash to meet the liquidity demands of depositors. Subsequently these liquidity classifications are assigned a liquidity weight of $+1/2$ (illiquid assets and liquid liabilities), 0 (semi-liquid assets and liabilities), or $-1/2$ (liquid assets, illiquid liabilities and equity), respectively. Finally, they calculate the total amount of liquidity created as the sum of all the claims categorised in step one, multiplied by their respective liquidity weights assigned in step two.

To construct the Berger and Bouwman (2009) bank liquidity creation measure we obtain the financial data reports in the FR Y-9C Consolidated Financial Statements for Holding Companies forms from the Federal Bank of Chicago's database.[1] U.S. bank holding companies, savings and loan holding companies, and securities holding companies complete the report on a quarterly basis, providing granular balance sheet, income statement, and off balance-sheet items information. We refer to the Federal Reserve Board's Micro Data Reference Manual[2] to account for the historical changes in the reporting form's structure in order to construct consistent time series of financial data. Prior to the first quarter of 1997, financial institutions completing the FR Y9-C are not required to report their holdings of certain off balance-sheet items necessary to compute the liquidity creation measure (e.g., their net positions in credit derivatives). Accordingly, our raw data sample begins with the first quarter of 1997 and spans 76 quarters, until the end of 2015, comprising 278,341 firm-quarter observations.

The liquidity creation measure we compute for each bank-quarter in the sample corresponds to Berger and Bouwman's (2009) "cat fat"measure, which classifies loans by category, rather than maturity, and includes off balance-sheet activities.[3] We also calculate the return on assets, three alternative capital ratios (Tier 1 capital ratio, Tier 1 capital to gross total assets, and total equity capital to gross total assets), and a ratio of risk-weighted assets to gross total assets for each institution.

To ensure cross-sectional consistency of the sample we apply a number of filters. First, we eliminate all observations with missing information on the variables of interest. Second, as the asset-size threshold for completing the FR Y9-C increases from \$150 million to \$500 million in March 2006, and then to \$1 billion in March 2015,[4] we remove all institutions with total assets of less than \$1 billion at the end of each quarter from the sample. Third, we exclude all firms reporting no time, transaction, or savings deposits. Finally, we eliminate all observations with normalised liquidity creation, return on assets, and Tier 1 capital ratio below the 1st or above the 99th percentile in each quarter. This generates our primary data sample of 27,744 firm-quarter observations. Table 1 reports the number of observations remaining in the sample, together with aggregate gross total assets and liquidity creation following each of the filtering steps. Although the final sample comprises only 30% of all observations with non-missing values, it incorporates banks holding nearly 80% of aggregate gross total assets and creating more than 86% of the total dollar amount

[1] https://www.chicagofed.org/banking/financial-institution-reports/bhc-data

[2] https://www.federalreserve.gov/apps/mdrm/

[3] Although Berger and Bouwman (2009) find that the patterns of changes in bank liquidity creation are virtually the same for all four measures, they document that nearly 50% of total liquidity is created through off-balance sheet activities. Further, as the FR Y9-C forms only provide a very general view of a bank's loan portfolio maturity structure, classifying loans by category allows for a more effective use of the available data.

[4] Between 2010 and 2014, standby letters of credit and foreign office guarantees were only to be reported by holding companies with total assets of at least \$1 billion as of June 2010.

of banking sector liquidity.

Table 1: Sample construction details TBU

Criterion	Number of observations	Aggregate gross total assets	Aggregate liquidity creation
No missing values	91,557	\$11,131,068,367,000	\$3,985,223,976,000
	(100%)	(100%)	(100%)
Total assets $\geq$ \$1bn	29,605	\$10,443,265,424,000	\$3,724,974,268,500
	(32.34%)	(93.82%)	(93.47%)
No zero deposits	29,198	\$10,107,430,761,000	\$3,780,937,296,000
	(31.89%)	(90.80%)	(94.87%)
No outliers	27,744	\$8,759,728,658,000	\$3,446,212,127,000
	(30.30%)	(78.70%)	(86.47%)

The number of observations remaining in the sample, aggregate gross total assets and dollar amount of liquidity creation following each step of the sample construction process. Aggregate gross total assets and liquidity creation reported as of 2005:Q4, which is the last quarter before the total asset threshold above which the FR Y9-C report has to be submitted is raised. Figures in parentheses are the percentages of observations remaining in the sample relative to the number of observations with no missing values, and the corresponding amounts of aggregate gross total assets and aggregate liquidity creation.

We obtain a list of all financial institutions receiving TARP government support from the websites of the Treasury Department and ProPublica,[5] together with their Federal Reserve RSSD identifiers. This allows us to differentiate between non-TARP and TARP recipient institutions in the sample. We also hand collect the information on the amount of government support each institution receives, the time they require to repay the funds, and the amount the Treasury earns in the form of interest, dividends, and proceeds from warrants. Our data sample includes 9,941 firm-quarter observations for 247 TARP-recipient institutions, corresponding to approximately one-third of all banks receiving capital support from the U.S. government.

We supplement the bank-specific data by a range of macroeconomic and financial variables capturing overall market and economic conditions. From the Federal Reserve Economic Database, we collect nominal gross domestic product, M1 money supply, consumer price index, and Case-Shiller home price index data. Bloomberg provides market-specific data, namely, the credit spread between BAA- and AAA-rated corporate bonds, the 3-month TED spread, the VIX index, and S&P 500 price and trading volume information. We construct the Amihud (2002) illiquidity measure for S&P 500 as a proxy for asset market illiquidity. Further, we generate the term spread time series by subtracting Wu and Xia's (2016) shadow policy rate from the yield on 30-year government bonds. The shadow policy rate is equal to (i) the federal funds rate when conventional monetary policy is implemented, and to (ii) the short rate from Black's (1995) shadow rate term structure model when the official policy rate is constrained by the zero lower bound. This allows

[5] https://www.treasury.gov/initiatives/financial-stability/TARP-Programs/Pages/default.aspx https://projects.propublica.org/bailout/

the shadow rate to become negative when the monetary authorities are unable to lower the official policy rate any further and instead engage in credit easing. As a consequence, our term spread measure widens upon the instigation of expansionary monetary policy, initiated either through reducing interest rates or pursuing quantitative easing. Finally, to ensure we record all variables in our analysis at the same frequency, we aggregate all high-frequency variables by calculating their quarterly averages. Table 2 provides the descriptive statistics for all variables used in our analysis.

Table 2: Descriptive statistics TBU

Variable	Mean	Median	25^{th} percentile	75^{th} percentile	Standard deviation
Liquidity Creation/GTA	0.39	0.39	0.29	0.49	0.16
Tier 1 Ratio	0.12	0.12	0.11	0.13	0.04
Total Equity/GTA	0.09	0.09	0.08	0.11	0.03
Tier 1 Capital/GTA	0.09	0.08	0.07	0.10	0.02
Asset Growth	0.02	0.01	−0.01	0.03	0.07
Risk-weighted Assets/GTA	0.72	0.72	0.65	0.79	0.12
Return on Assets	0.01	0.01	0.01	0.01	0.01
Amihud Illiquidity Measure (10^{-6})	9.41	8.59	6.11	11.92	4.68
Term Spread	0.03	0.03	0.01	0.04	0.02
Credit Spread	0.01	0.01	0.01	0.01	0.01
TED Spread	0.01	0.00	0.00	0.01	0.04
VIX Index	21.21	20.09	15.29	25.15	7.78
GDP Growth	0.01	0.01	0.01	0.01	0.01
M1 Money Supply/GDP	0.12	0.11	0.11	0.13	0.02
Inflation	0.01	0.01	0.00	0.01	0.01
Case-Shiller Index	140.04	144.22	115.62	165.23	30.18

The table reports mean, median, 25^{th} and 75^{th} percentile values, and the standard deviations for all variables used in the analysis. Where indicated, the variables are normalised by the institution's gross total assets (GTA), defined as the sum of total assets, allowance for loans and lease losses and the allocated transfer risk reserve.

We examine the macrofinancial determinants of bank liquidity creation within a panel regression framework. To alleviate potential biases introduced by persistence in certain macrofinancial time series we estimate the models with all variables in first differences. The key variables of interest are changes in Tier 1 capital ratio, the ratio of risk-weighted assets to gross total assets, and the change in the term spread. The former measure the impact of bank capital requirements on liquidity provision, whereas the latter captures the effects of conventional monetary policy and quantitative easing. To establish whether bank liquidity creation differs systematically between financial institutions which do and do not receive capital support under the TARP, we create an additional dummy variable $TARP_{i,t}$, taking the value of 1 in each quarter t during which bank i is in receipt of TARP funding, and 0 otherwise. We introduce the TARP dummy in the model, and estimate the following regression:

$$\Delta \textit{Normalised Liquidity Creation}_{i,t} = \beta \Delta \textit{Tier 1 Ratio}_{i,t} + \\ + \beta \Delta \textit{RW Assets Ratio}_{i,t} + \beta \Delta \textit{Term Spread}_t + \Delta \boldsymbol{x'\beta}_{i,t} + TARP_{i,t} + \alpha_i + \epsilon_{i,t} \quad (1)$$

where $\Delta \textit{Normalised Liquidity Creation}_{i,t}$ is the change in liquidity created by bank i divided by its gross total assets, $\Delta \textit{Tier 1 Ratio}_{i,t}$ and $\Delta \textit{RW Assets Ratio}_{i,t}$ are changes in its Tier 1 capital ratio and the ratio of risk-weighted assets to gross total assets, and $\Delta \textit{Term Spread}_t$ is the change in the term spread between quarters t-1 and t. $\Delta \boldsymbol{x}_{i,t}$ is a vector of control variables consisting of bank i's asset growth rate and change in return on assets, as well as changes in all macrofinancial variables between t-1 and t, and α_i is the firm-fixed effect dummy. $\epsilon_{i,t}$ is a serially uncorellated, zero-mean idiosyncratic error term with possibly heteroscedastic variance. As discussed in Stock and Watson (2008), fixed-effects estimators of panel data may produce biased results if the number of entities in the panel (n), or its time dimension are large ($T > 2$). As this concern applies to the data sample used in this study, to correct for the potential bias we estimate the fixed effects regression of specification (1) using the robust variance matrix estimator outlined by Arellano (1987). This ensures we obtain standard errors which are robust to heteroscedasticity of any arbitrary form and to serial correlation. We include lagged terms on Tier 1 capital ratio, asset growth and the ratio of risk-weighted assets to gross total assets in specification (1) in order to alleviate any potential endogeneity concerns. However, we do not claim that our results establish a causal relation between the variables in the model. Rather, we interpret them as useful indicators of the dynamics of the relation between changing macrofinancial conditions and the process of bank liquidity creation.

Equity capital bears a weight of $-1/2$ in the Berger and Bouwman (2009) liquidity creation formula. It follows TARP injections will result in no change in the total amount of liquidity created only if the recipient bank allocates the entire TARP funding to new illiquid loans, with a formula weight of $+1/2$. As a consequence, receiving TARP support should have a strictly negative impact on an institution's normalised liquidity creation, as the value of its gross total assets (denominator) will increase, even when the amount of liquidity it creates (numerator) does not change. *Ceteris paribus*, a capital injection amounting to 1% of a bank's gross total assets should, by construction, result in a reduction of normalised liquidity creation by at least 0.9%.[6]

TARP capital injections should impact the rate of change in the recipient institution's

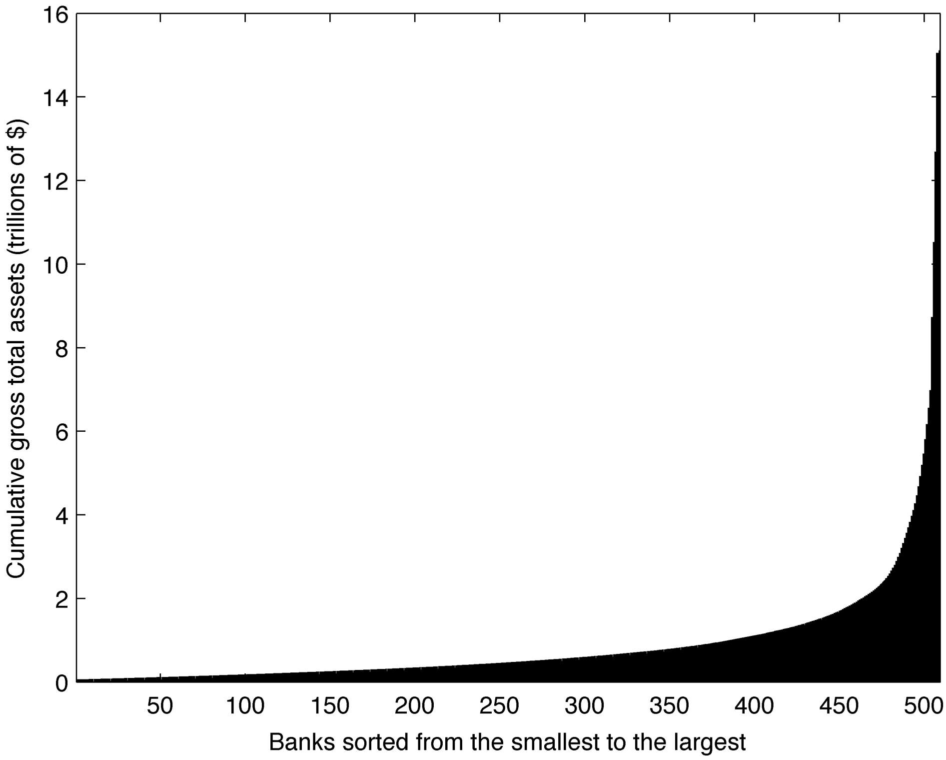
[6] Assuming an initial level of normalised liquidity creation of $LC_{t=0}/GTA_{t=0}$, a capital injection amounting to 1% of $GTA_{t=0}$ invested only in illiquid assets will change the level of normalised liquidity creation to $LC_{t=0}/1.01 \times GTA_{t=0}$. Should a certain proportion of the additional capital be diverted to semi-liquid or liquid assets, then $LC_{t=1} < LC_{t=0}$, resulting in an even greater reduction in normalised liquidity creation.

normalised liquidity creation in the quarter in which they occur. However, nearly all institutions in our sample receive the additional funds in a single payment. Thus, the pattern of changes in normalised liquidity creation of TARP banks may not be significantly different relative to non-participant banks, in the subsequent quarters during which they are in receipt of capital support. Consequently, we are unlikely to be able to quantify the impact of TARP using our specification (1) based on first differences.

Estimating model (1) with all variables in levels allows us to examine the effects of TARP during the entire period an institution is assisted by the policymaker. It could, however, produce biased and inconsistent results. Therefore, we undertake a non-regression based test in order to establish if the levels of normalised liquidity creation differ systematically between TARP and non-TARP institutions. First, we implement a nearest neighbour matching algorithm to identify pairs of TARP-funded and otherwise similar non-TARP institutions. The banks are matched without replacement on the basis of their Tier 1 capital ratio, the ratio of risk-weighted assets to gross total assets, the natural logarithm of gross total assets, and their return on assets as of 2007:Q4 (one year prior to the implementation of TARP). This produces 165 unique pairs of TARP and non-TARP banks. Second, we perform a difference-in-difference analysis. We calculate the changes in normalised liquidity creation relative to the 2007:Q4 level in every quarter during which an institution is in receipt of TARP capital for each pair of matched banks. We then perform a t-test to establish whether the changes in levels of normalised liquidity creation during the period when a bank holds TARP capital differ significantly from those of an otherwise similar institution not participating in the programme.

Finally, we recognise that the size distribution in our sample is highly skewed. Figure 1 plots the cumulative gross total assets of the banks in our dataset at the end of 2015. A small number of institutions with gross total assets significantly greater than those of the remaining banks dominate the sample. In particular, the largest 5% of institutions control 82% of the total assets and create 76% of total liquidity. As such, the inherent behaviour and characteristics of large banks likely differ from their smaller peers (e.g. the former may be able to access capital more easily, or be subject to more regulatory scrutiny), we examine whether changes in the macrofinancial environment affect small and large banks differently. Specifically, we estimate the panel models on the subsamples of small and large banks separately by splitting the sample around the 95^{th} percentile of gross total assets in each quarter, and categorise banks with assets above (below) that value as large (small) institutions.

Figure 1: Cumulative gross total assets as of 2015:Q4 TBU



The figure plots cumulative gross total assets of the banks in the sample as of 2015:Q4. The graph demonstrates the substantial difference in size of the majority of firms in the sample, indicating a small number of large institutions.

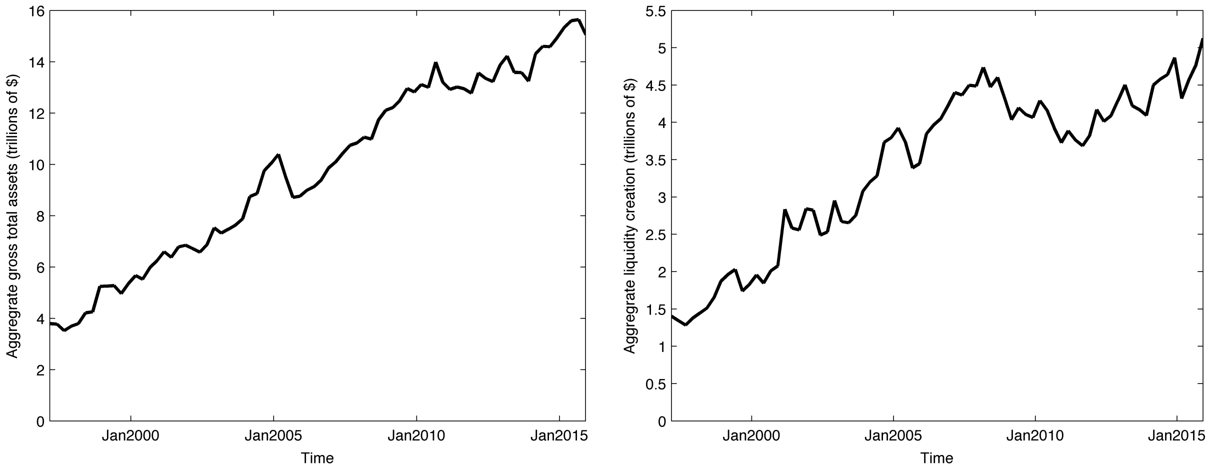
3 Empirical results

3.1 Descriptive analysis of liquidity creation

Both the size of the banking sector and the dollar amount of liquidity it produces grow considerably over the sample period. As Figure 2 indicates, the aggregate gross total assets of the institutions in the sample nearly quadruple, from approximately \$3.8 trillion in 1997:Q1 to more than \$15 trillion in 2015:Q4. Simultaneously, total liquidity creation increases by a factor of 3.65, from \$1.4 trillion in 1997:Q1 to \$5.1 trillion in 2015:Q4. The deterioration of economic conditions following the 2007 - 2009 crisis impacts significantly on the total amount of liquidity creation, which peaks at \$4.7 trillion in 2008:Q1 and subsequently declines by more than \$1 trillion by 2011:Q3. It is not until 2014:Q4 that the amount of liquidity creation surpasses the levels attained before the crisis. In contrast, aggregate gross total assets of the banking sector continue growing until 2010:Q3, reaching nearly \$14 trillion, subsequent to which they decrease by approximately \$1 trillion by 2011:Q4, before reversing the decline to exceed their previous peak level as early as

2013:Q1.

Figure 2: Aggregate liquidity creation and the size of the banking sector 1997:Q1 - 2015:Q4 TBU



(a) Aggregate gross total assets

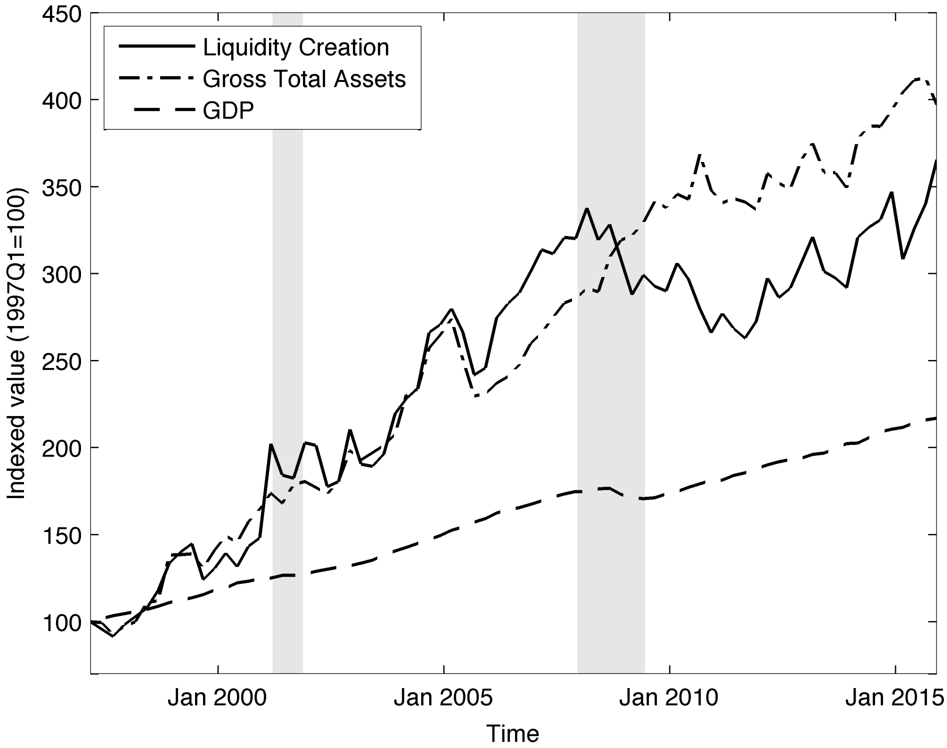
(b) Aggregate liquidity creation

Sub-figure (a) plots the aggregate gross total assets, and sub-figure(b) plots the dollar amount of liquidity creation by bank holding companies in the sample between 1997:Q1 and 2015:Q4.

As Figure 3 indicates, the aggregate gross total assets of the bank holding companies in the sample and the dollar amount of liquidity they create grow at a faster pace than the gross domestic product of the United States during the sample period. Further, while the growth rates of the two measures were roughly commensurate with one another until early 2008, they rapidly diverge with the onset of the 2007 - 2009 financial crisis. The correlation coefficient between their quarterly growth rates declines from 0.65 for 1997:Q1-2007:Q4 to 0.06 for 2008:Q1-2011:Q4. Once economic conditions stabilise, however, the relation between gross total asset growth and the amount of liquidity creation again reflects its pre-Crisis dynamic, and the correlation coefficient for the period of 2012:Q1 to 2015:Q4 increases to 0.47.

The substantial and long-lasting reduction in liquidity creation which occurs between 2008 and 2011 is in sharp contrast to the impact of the bursting of a previous asset bubble, the dot-com bubble, and the early 2000s recession that followed. Figure 3 indicates that the peak-to-trough decline in the amount of liquidity creation is considerably smaller during 2001, namely, a decline from $2.8 trillion in 2001:Q1 to $2.55 trillion in 2001:Q3, recovering to exceed its previous highest level after just one quarter, in 2001:Q4.

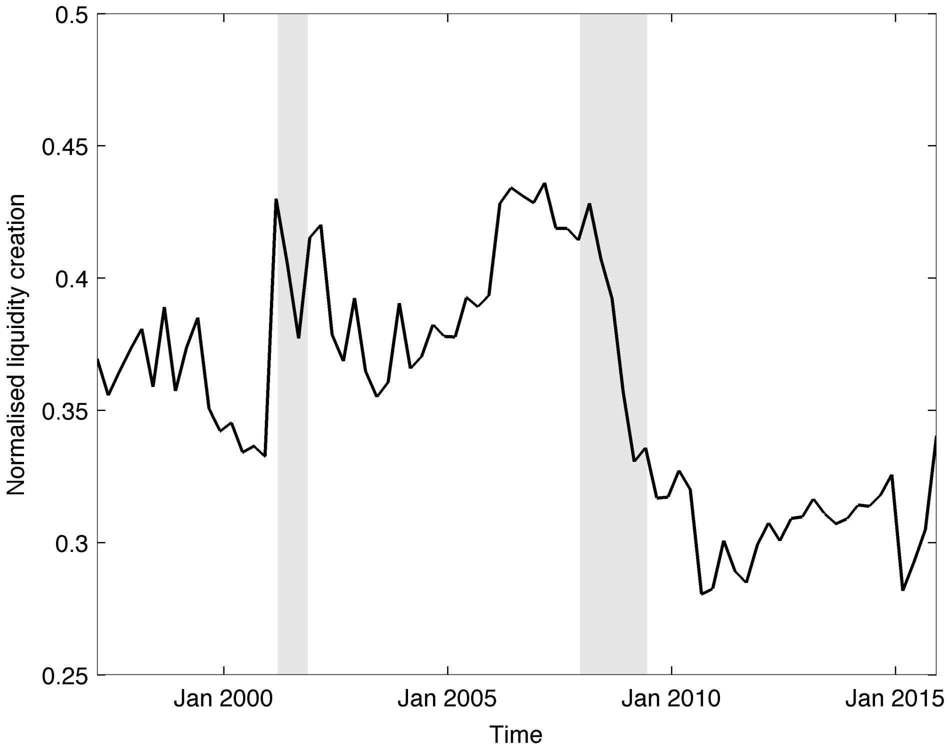
Figure 3: Evolution of aggregate liquidity creation, the size of the banking sector, and US GDP 1997:Q1 – 2015:Q4 TBU



The figure plots aggregate gross total assets and the dollar amount of liquidity creation by bank holding companies, relative to the gross domestic product of the United States. All values indexed relative to the 1997:Q1 levels, scaled to 100. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

The variation in the amount of liquidity created per $1 of gross total assets in Figure 4 closely reflects the close relation between the changes in macrofinancial conditions and bank liquidity. The measure declines considerably in the course of the two economic recessions occurring during the sample period, and also exhibits increased volatility in the late 1990's, reflecting the market and economic uncertainty following the Asian financial crisis, the Russian debt crisis, and the failure of Long-Term Capital Management. Figure 4 also indicates that the financial crisis of 2007 - 2009 may initiate a switch to a new regime characterised by lower efficiency of liquidity creation, as average liquidity creation per $1 of gross total assets declines from approximately $0.38 for 1997:Q1 - 2008:Q3 to $0.3 for 2008:Q4 - 2015:Q4.

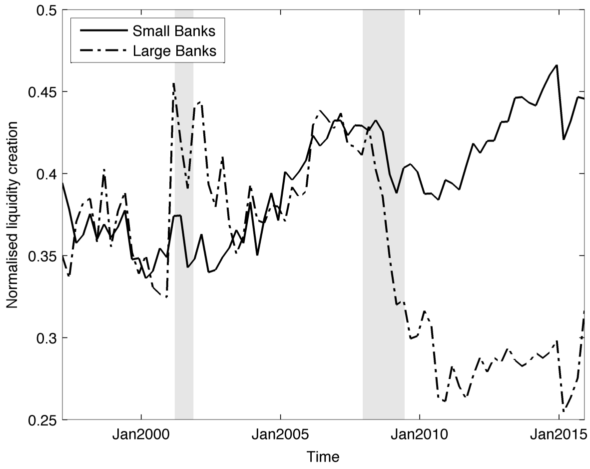
Figure 4: Normalised liquidity creation 1997:Q1 – 2015:Q4 TBU



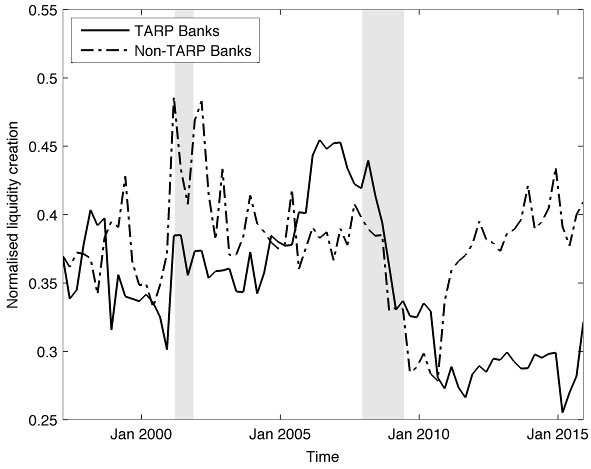
The figure plots the total amount of liquidity creation by financial institutions in the sample normalised by their gross total assets. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

Our data sample is unevenly distributed in terms of size of the institutions it comprises (Figure 1). Further, as discussed by Berger, et al. (2005) the competitive advantages of small and large banks differ, which may alter their market behaviour. Panel A of Figure 5 plots the normalised liquidity creation of small banks, classified as banks with gross total assets below the 95^{th} percentile in each quarter, relative to the large banks remaining in the sample. The impact of the 2007 - 2009 crisis on liquidity creation activity of small banks is considerably smaller than that on larger institutions. Even during the last quarter in our sample, the large banks still create less liquidity per $1 of gross total assets than at any other time in the sample period. Stratifying banks by TARP-recipient status, rather than size, reveals another stark difference in the performance of the two classes of institutions. Panel B of Figure 5 compares the changes in the amount of liquidity creation per $1 of gross total assets by TARP and non-TARP banks. While the institutions which do not receive capital support from the government restore their levels of liquidity creation to their pre-Crisis levels relatively quickly, TARP-funded banks continue to produce less liquidity than at any time in the past.

Figure 5: Normalised liquidity creation of banks classified by size and TARP-recipient status TBU



(a) Banks classified by size

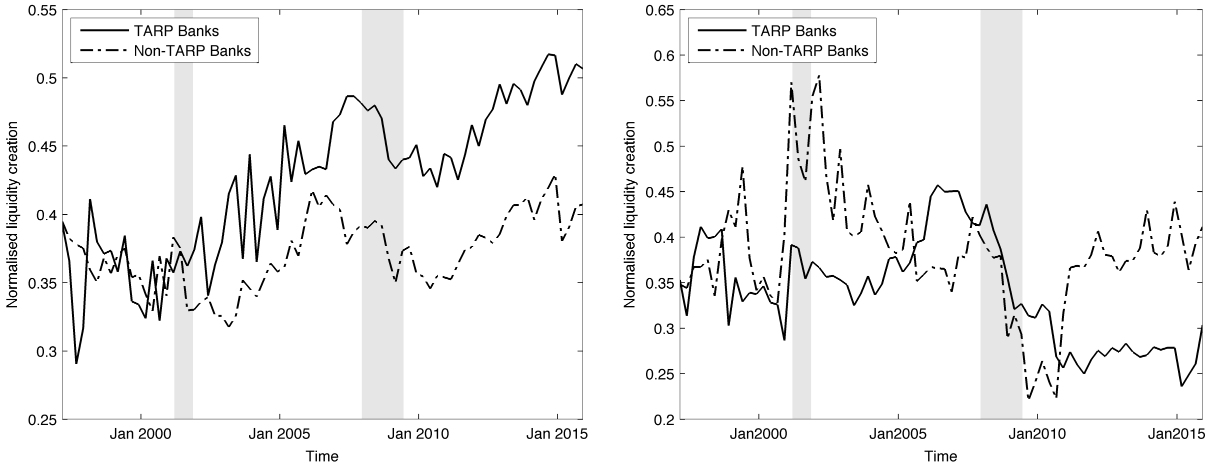


(b) Banks classified by TARP-recipient status

Sub-figures (a) and (b) plot the total amount of liquidity creation by institutions in the sample normalised by their gross total assets, classified by size and TARP-recipient status respectively. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

Figure 6a shows that the dynamics of normalised liquidity creation exhibit similar patterns when comparing small TARP banks and small non-TARP banks since the early 2000's, reflected in a correlation coefficient of 0.71 for the two series. Although small TARP banks create more liquidity per \$1 of gross total assets, the impact of the 2007 - 2009 financial crisis and the pace of post-Crisis recovery are comparable to those manifested by non-TARP banks. In contrast, the decline in the amount of liquidity creation per \$1 of gross total assets between 2008 and 2010 is greater for large non-TARP institutions than for large TARP banks (Figure 6b). At the trough, non-TARP banks create 10 cents less of liquidity per \$1 of assets relative to TARP banks. However, institutions not in receipt of government aid promptly restore their liquidity creation to pre-Crisis levels, whereas large TARP-recipient institutions continue to create less liquidity than at any other point during the sample period. As large institutions create almost 80% of the total amount of liquidity in our sample, we can conclude that the considerable decline in overall normalised liquidity creation is driven primarily by the performance of large institutions which receive capital support from TARP.

Figure 6: Normalised liquidity creation of TARP and non-TARP banks by size TBU



(a) Small banks

(b) Large banks

The figure plots the total amount of liquidity creation by small (panel A) and large (panel B) institutions in the sample normalised by their gross total assets and classified by TARP-recipient status. The shaded areas correspond to recession periods as reported by the National Bureau of Economic Research.

Potential reasons why TARP has such an asymmetric effect on large and small banks warrant further discussion. The average government capital injection amounts to approximately 2% of the receiver's gross total assets in the quarter in which it occurs. Therefore, it is unlikely that a small, temporary increase in bank capital results in any long-term impact for either type of institution in the sample. Yet, we observe a long-term negative impact of TARP on liquidity creation undertaken by large banks. A closer analysis of the list of large TARP institutions in the sample (see: Appendix A), reveals that they are nearly all classified as systemically important and are subject to additional stress tests under the Supervisory Capital Assessment Program in 2009.[7] Consequently, it may be the close government scrutiny of their performance which induces the largest institutions to reduce their liquidity creation activity by diverting a fraction of their resources towards safer, more liquid assets. Furthermore, following the financial crisis, some of these large TARP banks are involved in high-profile legal proceedings, which often result in substantial financial penalties.

3.2 Quantifying the impact of TARP

To more precisely quantify the impact of TARP on normalised liquidity creation we use the subsample of 330 matched TARP and non-TARP banks. We assess if the change in performance of the banks participating in the programme relative to the TARP non-

[7] An overview of the stress tests results can be accessed at https://www.treasury.gov/initiatives/financial-stability/briefing-room/reports/other/DocumentsOther/SCAPresults.pdf

participant institutions is significant.

In 2007:Q4, on average, TARP banks create \$0.4575 of liquidity per \$1 of gross total assets, as compared to a corresponding volume of \$0.4358 by matched non-TARP institutions. Relative to the levels at the end of 2007, normalised liquidity creation of an average TARP bank decreases by \$0.0626 during the quarters in which it holds the additional capital, while at the same time, the corresponding non-TARP institution reduces its normalised liquidity creation by \$0.0243. This difference in changes in liquidity provision is highly statistically significant, evidenced by a t-statistic of −12.41. We repeat this exercise for the banks in the matched sample classified as small and as large, respectively, with the results summarised in Table 3.

Table 3: TARP capital support and changes in bank liquidity creation TBU

	Small banks		Large banks	
	During TARP	After TARP	During TARP	After TARP
TARP banks	−\$0.0635	\$0.0031	−\$0.0552	−\$0.0508
Non-TARP banks	−\$0.0248	−\$0.0081	−\$0.046	\$0.075
Difference	−\$0.0387***	\$0.0112**	−\$0.0092	−\$0.1258***
t-statistic	−12.29	2.49	−0.37	−9.27

This table reports the average changes in normalised liquidity creation relative to the 2007:Q4 levels for matched TARP- and non-TARP banks stratified by size during the period an institution is in receipt of TARP support, and following the completion of the programme. It also reports the average difference of differences for the two groups, and a t-statistic for a test of mean and variance equality. *, ** and *** denote 10%, 5% and 1% level of significance.

The results for small banks are virtually the same as those for the entire sample. Relative to the 2007:Q4 level, an average small TARP bank reduces its normalised liquidity creation by \$0.0635 during the period it is in receipt of government funding, compared to a decrease of \$0.0248 for an institution not participating in the programme. The difference in performance of the two classes of banks is statistically significant (a t-test statistic of −12.29). Large banks, however, exhibit different behaviour. We find that when receiving TARP capital, an average large institution reduces its normalised liquidity creation by \$0.0552, while the normalised liquidity creation of an otherwise similar large non-TARP bank decreases by \$0.046 during the same period. Given a test statistic of −0.37, we conclude that, in contrast to small banks, TARP capital injections have no immediate significant effects on the liquidity provision of large banks.

Our results for small banks corroborate previous empirical evidence demonstrating that an average TARP-recipient bank uses two-thirds of these funds to strengthen its balance sheet (Li, 2013). The average amount of government aid amounts to approximately 2% of the recipient bank's gross total assets in the quarter in which it occurs. Investing the entire amount in illiquid loans would result in a 1.9% fall in normalised liquidity creation while a bank is holding the additional capital. On average, normalised liquidity creation of small TARP-recipient institutions decreases by \$0.0387 more than that of a non-TARP bank, which corresponds to nearly 10% of the level of liquidity creation in the last quarter before receiving capital support.

In order to identify any potential long-term effects of direct regulatory scrutiny, we calculate the difference in normalised liquidity creation in the quarters following the completion of the programme relative to the 2007:Q4 levels for both TARP and matched non-TARP banks. We then employ the same framework to establish whether these differences are statistically significant. The results for the subsample of small matched banks indicate that TARP-supported banks increase the level of their normalised liquidity creation by \$0.0031 relative to the 2007:Q4 level in the period following the completion of the programme, whereas non-TARP banks reduce it by \$0.0081. This difference of approximately \$0.01 of liquidity created per \$1 of gross total assets is significant (test statistic of 2.49). In stark contrast, we find that normalised liquidity creation of large TARP banks in fact decreases by -\$0.0508 relative to its 2007:Q4 level, while, during the same period, large non-participant institutions increase their normalised liquidity creation by \$0.075. This difference in the performance of large TARP and non-TARP institutions is also highly statistically significant (t-statistic is 9.27).

Finally, we regress the amount of liquidity creation divided by gross total assets in 2015:Q4 by institutions which received TARP funding on the following: (i) the amount of TARP funding they receive relative to the programme's budget; (ii) the time they require to entirely repay the funds; (iii) the amount of fees paid to the government; and (iv) the bank-specific control variables used in our analysis. Table 4 reports the coefficient estimates. The findings demonstrate that, consistent with the results presented above, the amount of TARP funding a bank receives is positively related to the long-term level of normalised liquidity creation by small banks, but does not affect liquidity provision by large banks.

Table 4: Long-term effects of TARP capital support TBU

	All banks	Small banks	Large banks
TARP Funds Received	-1.588***	27.099*	-0.874
	(-2.92)	(1.80)	(-0.79)
Time to Repayment	-0.001	-0.002**	-0.000
	(-1.54)	(-2.42)	(-0.00)
Fees Paid	-0.084	-0.053	-0.148
	(-1.05)	(-0.77)	(-0.10)
Tier 1 Ratio	-0.567*	-0.865***	0.873
	(-1.73)	(-3.01)	(0.24)
RW Assets Ratio	1.137***	0.924***	1.637***
	(14.70)	(12.17)	(4.66)
ROA	-2.196	-2.896	19.442
	(-0.93)	(-1.40)	(1.16)
Constant	-0.245***	-0.041	-1.045
	(-2.92)	(-0.52)	(-1.57)
Observations	140	124	16
Adjusted R^2 (%)	74	72.5	85.2

Results of bank-level regression of normalised liquidity creation in 2015:Q4 by banks supported by TARP on the amount of government aid received relative to the budget of the programme, the length of the period during which an institution was in receipt of TARP funding, the fees it pays to the government, and the bank-specific variables used in previous regressions. Robust t-statistics in parentheses. *, ** and *** denote 10%, 5% and 1% level of significance.

Overall, our conclusion is that while holding TARP capital results in a statistically significant reduction in normalised liquidity creation by small banks relative to small non-TARP banks, it allows them to marginally increase their long-term levels following the completion of the programme. Conversely, while TARP capital injections have no significant immediate impact on the performance of large banks, the institutions which receive capital aid from the government subsequently reduce their normalised liquidity creation even after repaying the additional TARP funds. This suggests that large bank liquidity provision may be adversely affected by their status as systemically important financial institutions, thereby attracting increased scrutiny from the regulators.

3.3 Panel regressions results

We now analyse the effects of changes in monetary policy regime and bank capital regulation reform on the dynamics of bank liquidity creation. Table 5 reports the results of bank-level regressions of changes in normalised liquidity creation on the bank-specific and macrofinancial variables discussed in section 3 over the entire sample period.

The results for all institutions in the sample demonstrate that changes in liquidity creation are inversely related to changes in an institution's Tier 1 capital ratio, but positively affected by both changes in a bank's ratio of risk-weighted assets to gross total assets and changes in the term spread. The highly statistically significant coefficient of 0.568 on the risk-weighted assets ratio shows that raising the proportion of risky assets a bank holds by 1 percentage point increases its normalised liquidity creation by nearly 0.6 cents per $1 of gross total assets. Similarly, the positive and significant coefficient on changes in the term spread suggests that an easing of monetary policy induces financial institutions to create an additional 0.3 cents of liquidity per $1 of assets for every percentage point the term spread widens. As issuing new loans or increasing the proportion of risky assets held by a bank results in a reduction of its Tier 1 capital ratio, these results are consistent with the negative and statistically significant coefficient on changes in Tier 1 capital ratio reported in Table 5. Alternatively, in order to increase its Tier 1 capital ratio, a financial institution may reallocate resources from activities which create liquidity to core equity capital, resulting in a decrease of nearly 0.4 cents of liquidity creation per $1 of assets for every percentage point increase in the Tier 1 ratio.

Further, Table 5 again highlights a striking difference between the dynamics of liquidity creation undertaken by small and large banks. While the coefficients on risk-weighted assets ratio are significant and of broadly similar order of magnitude for either institutional size category, the coefficient on changes in the Tier 1 capital ratio is significant only for small banks. This result supports the view that equity capital may be much more expensive for small banks, and that any increase in their Tier 1 capital ratio is mainly achieved by reducing the growth rates of risky, illiquid assets.

Additionally, the effects of monetary easing and improving economic conditions, captured by a positive and significant coefficient on GDP growth, appear to be only pertinent to small banks. This result corroborates the findings of Berger and Bouwman (2012). In contrast, a negative and statistically significant coefficient on changes in credit spread indicates that liquidity creation undertaken by large banks appears to be inversely related to overall credit risk.

Table 5: Baseline regression results TBU

	All banks	Small banks	Large banks
Δ *Tier 1 Ratio*	-0.377***	-0.377***	-0.113
	(-8.11)	(-8.06)	(-0.58)
Δ *RWAssets Ratio*	0.568***	0.570***	0.576***
	(23.06)	(21.91)	(7.07)
Δ *Term Spread*	0.278***	0.289***	-0.012
	(7.20)	(7.25)	(-0.06)
Δ *ln(Assets)*	-0.055***	-0.052***	-0.062*
	(-4.86)	(-4.46)	(-1.77)
Δ *Tier 1 Ratio* (-1)	0.033*	0.041**	-0.155
	(1.77)	(2.11)	(-1.35)
Δ *ln(Assets)* (-1)	0.016***	0.015***	0.005
	(4.10)	(3.84)	(0.46)
Δ *RWAssets Ratio* (-1)	0.032***	0.034***	0.026
	(2.88)	(2.90)	(0.75)
Δ *ROA*	0.085***	0.094***	-0.085
	(2.81)	(3.09)	(-0.52)
Δ *Amihud Measure*	104.091	114.476	684.646
	(1.03)	(1.12)	(1.11)
Δ *Credit Spread*	-0.115	-0.103	-1.472***
	(-0.89)	(-0.77)	(-2.69)
Δ *TED Spread*	-0.037	0.009	-0.403
	(-0.40)	(0.09)	(-0.70)
Δ *VIX Index*	-0.000**	-0.000***	-0.000
	(-2.55)	(-2.93)	(-0.44)
Δ *ln(GDP)*	0.226***	0.251***	0.185
	(3.87)	(4.19)	(1.16)
Δ *M1/GDP Ratio*	0.253**	0.309***	0.251
	(2.55)	(2.97)	(0.57)
Δ *ln(CPI)*	-0.021	-0.043	0.129
	(-0.51)	(-0.99)	(0.68)
Δ *Case-Shiller Index*	0.000	0.000	-0.001
	(1.53)	(1.33)	(-1.65)
TARP	-0.001	-0.001	-0.005
	(-0.97)	(-0.89)	(-1.49)
Constant	0.000	-0.000	0.001
	(0.20)	(-0.17)	(0.89)
Firm-fixed effects	Yes	Yes	Yes
Observations	25,776	24,405	1,310
Adjusted R^2 (%)	37.1	37.9	30.3

This table reports the results of bank-level regressions of changes in normalised liquidity creation (liquidity creation divided by gross total assets) on changes in bank-specific and macrofinancial factors. Robust t-statistics in parentheses. *, ** and *** denote 10%, 5% and 1% levels of significance.

In order to determine whether the dynamics of liquidity creation undertaken by small and large banks changes following the adoption of unconventional monetary policy and bank capital regulation reform, we estimate the model again on two sub-samples, spanning 1997:Q1 - 2008:Q3 and 2008:Q4 - 2015:Q4, respectively. The results in Table 6 demonstrate that the relation between changes in small banks' liquidity creation and the macrofinancial factors changes with the onset of the 2007 - 2009 financial crisis. In particular, the coefficient on the term spread is considerably smaller and only marginally significant for the 2008 - 2015 period, indicating that quantitative easing may not be as effective in influencing the lending behaviour of financial institutions as conventional monetary policy. Further, the coefficient on the Tier 1 capital ratio increases in absolute terms from -0.386 to -0.416, and the coefficient on the risk-weighted asset ratio decreases from 0.642 to 0.505. These estimates indicate that the introduction of a stricter bank capital regulation system in 2010 may have adverse effects on banks' ability to create liquidity, despite the concurrent substantial easing of monetary policy, echoing the predictions of Thakor's (1996) model. In contrast, although the coefficients on the risk-weighted assets ratio of large banks display similar patterns of changes for the two sub-samples, no other bank-specific or macrofinancial variables appear to consistently relate to changes in institutions' normalised liquidity creation.

Note that after 2008:Q4, the amount of liquidity creation by small banks becomes positively related to asset market illiquidity (Δ $Amihud\ Measure$), as indicated by a change from a negative and significant coefficient for 1997 - 2008 to a positive and significant coefficient for 2008 - 2015. This result suggests that small financial institutions play an important role in providing liquidity to the economy during the period in which stress in asset markets might prevent them from performing their usual functions. Additionally, although the coefficient on the inflation rate (Δ $ln(CPI)$) is negative and statistically significant for 1997 - 2008 for small banks, it becomes positive, albeit only marginally significant during 2008 - 2015. As inflation targeting is the key tool of conventional monetary policy, higher inflation can result in an increase in central bank policy rate. In turn, this results in a narrowing of the term spread and a reduction in bank liquidity creation. Following the recent financial crisis, however, the U.S. economy first experiences a period of sharp deflation, and then enters into secular stagnation with near-zero inflation and low economic growth. In such conditions, increases in the inflation rate may be indicative of a recovery in economic conditions, prompting banks to re-engage in liquidity creation activities.

Table 6: Panel regression results for small and large banks for 1997-2008 and 2008-2015 TBU

	Small banks		Large banks	
	1997-2008	2008-2015	1997-2008	2008-2015
Δ *Tier 1 Ratio*	-0.386***	-0.416***	0.292	-0.320*
	(-3.54)	(-11.18)	(0.78)	(-1.86)
Δ *RWAssets Ratio*	0.642***	0.505***	0.651***	0.501***
	(18.29)	(17.45)	(6.43)	(4.37)
Δ *Term Spread*	0.517***	0.121*	-0.047	0.157
	(7.99)	(1.89)	(-0.14)	(0.54)
Δ *ln(Assets)*	-0.050***	-0.064***	-0.041	-0.112**
	(-3.49)	(-5.95)	(-0.89)	(-2.19)
Δ *Tier 1 Ratio* (-1)	0.048	0.019	-0.095	-0.100
	(1.25)	(0.89)	(-0.33)	(-0.68)
Δ *ln(Assets)* (-1)	0.014**	0.017***	0.005	0.005
	(2.56)	(3.11)	(0.31)	(0.23)
Δ *RWAssets Ratio* (-1)	0.040***	0.026*	-0.065	0.098**
	(2.76)	(1.74)	(-1.44)	(2.38)
Δ *ROA*	-0.128*	0.086***	-0.592*	0.127
	(-1.86)	(2.59)	(-1.99)	(0.52)
Δ *Amihud Measure*	-524.508***	363.750***	-1141.720	1340.163
	(-2.76)	(2.88)	(-1.22)	(1.48)
Δ *Credit Spread*	-0.012	0.133	0.036	-1.036
	(-0.06)	(0.76)	(0.03)	(-1.41)
Δ *TED Spread*	0.540***	-0.106	0.483	-0.341
	(3.55)	(-0.61)	(0.69)	(-0.35)
Δ *VIX Index*	0.000	-0.000**	0.000	-0.000
	(0.59)	(-2.21)	(0.85)	(-0.75)
Δ *ln(GDP)*	-0.066	0.238***	-0.138	0.283
	(-0.44)	(4.69)	(-0.58)	(1.27)
Δ *M1/GDP Ratio*	-0.268	0.098	-0.226	-0.017
	(-0.65)	(0.60)	(-0.17)	(-0.05)
Δ *ln(CPI)*	-0.302***	0.198*	-0.056	0.215
	(-3.11)	(1.91)	(-0.29)	(0.50)
Δ *Case-Shiller Index*	0.001***	0.000	0.001	-0.001*
	(6.00)	(0.30)	(1.18)	(-1.85)
TARP		-0.001		-0.003
		(-0.87)		(-0.76)
Constant	0.004*	0.000	0.004	0.001
	(1.84)	(0.07)	(1.35)	(0.51)
Firm-fixed effects	Yes	Yes	Yes	Yes
Observations	12,613	11,792	676	634
Adjusted R^2 (%)	34.5	43.9	27.4	38.6

This table reports the results of bank-level regressions of changes in normalised liquidity creation (liquidity creation divided by gross total assets) on changes in bank-specific and macrofinancial factors between 1997:Q1 - 2008:Q3, and 2008:Q4 -2015:Q4, stratified by institution size. Robust t-statistics in parentheses. *, ** and *** denote 10%, 5% and 1% levels of significance.

To establish whether the aforementioned changes in the dynamics of the liquidity creation process occurring after 2008 are statistically significant, we create an additional dummy variable, *Post*-2008, taking the value of 1 for all observations after 2008:Q3. We re-estimate the panel regressions for small and large banks on the full sample incorporating additional interaction terms between the explanatory variables and the *Post*-2008 dummy. We report the coefficient estimates in Table 7.

For small banks, the statistically significant and negative coefficients on the interaction terms with both changes in the risk-weighted assets ratio and changes in the term spread, reaffirm the validity of the results presented in Table 6. Although the coefficient on the interaction term with changes in the Tier 1 capital ratio is negative, it is statistically insignificant. In contrast, none of the interaction terms with other key variables of interest are significant in the regression estimates for the largest banks in the sample.

Additionally, for small banks, the coefficients on changes in the Amihud measure, ROA, and inflation rate are negative and statistically significant, whereas the coefficients on their interaction terms with the *Post*-2008 dummy are positive and statistically significant. Collectively, these results indicate that the dynamics of bank liquidity creation change considerably in the post-Crisis period, and the changes are especially pronounced for small banks.

Table 7: Significance of changes in liquidity creation dynamics after 2008:Q4 TBU

	Small banks	Large banks
Δ *Tier 1 Ratio*	-0.382***	0.294
	(-3.55)	(0.78)
Δ *RWAssets Ratio*	0.646***	0.645***
	(18.70)	(6.31)
Δ *Term Spread*	0.520***	-0.045
	(8.05)	(-0.14)
Δ *ln(Assets)*	-0.050***	-0.040
	(-3.56)	(-0.87)
Δ *Tier 1 Ratio* (-1)	0.052	-0.090
	(1.33)	(-0.32)
Δ *ln(Assets)* (-1)	0.014***	0.006
	(2.63)	(0.38)
Δ *RWAssets Ratio* (-1)	0.045***	-0.072
	(3.05)	(-1.60)
Δ *ROA*	-0.127*	-0.590*
	(-1.84)	(-2.00)
Δ *Amihud Measure*	-516.906***	-1132.045
	(-2.75)	(-1.20)
Δ *Credit Spread*	0.015	0.030
	(0.07)	(0.02)
Δ *TED Spread*	0.538***	0.420
	(3.55)	(0.61)
Δ *VIX Index*	0.000	0.000
	(0.61)	(0.80)
Δ *ln(GDP)*	-0.063	-0.155
	(-0.42)	(-0.67)
Δ *M1/GDP Ratio*	-0.275	-0.308
	(-0.67)	(-0.23)
Δ *ln(CPI)*	-0.289***	-0.070
	(-2.99)	(-0.36)
Δ *Case-Shiller Index*	0.001***	0.001
	(5.82)	(1.34)
TARP	-0.001	-0.002
	(-0.99)	(-0.70)
Constant	0.004*	0.004*
	(1.92)	(1.68)

Table continued overleaf.

Table 7 continued: Significance of changes in liquidity creation dynamics after 2008:Q4

	Small banks	Large banks
Post-2008 × Δ *Tier 1 Ratio*	-0.006	-0.633
	(-0.05)	(-1.53)
Post-2008 × Δ *RWAssets Ratio*	-0.137***	-0.145
	(-2.93)	(-1.02)
Post-2008 × Δ *Term Spread*	-0.430***	0.193
	(-4.50)	(0.48)
Post-2008 × Δ *ln(Assets)*	-0.010	-0.070
	(-0.58)	(-1.18)
Post-2008 × Δ *Tier 1 Ratio* (-1)	-0.010	-0.022
	(-0.22)	(-0.07)
Post-2008 × Δ *ln(Assets)* (-1)	0.007	0.000
	(1.00)	(0.01)
Post-2008 × Δ *RWAssets Ratio* (-1)	-0.009	0.169**
	(-0.46)	(2.65)
Post-2008 × Δ *ROA*	0.231***	0.716*
	(2.92)	(1.87)
Post-2008 × Δ *Amihud Measure*	880.540***	2457.269*
	(3.88)	(1.75)
Post-2008 × Δ *Credit Spread*	0.091	-1.076
	(0.35)	(-0.79)
Post-2008 × Δ *TED Spread*	-0.555**	-0.757
	(-2.56)	(-0.73)
Post-2008 × Δ *VIX Index*	-0.000**	-0.001
	(-2.16)	(-1.11)
Post-2008 × Δ *ln(GDP)*	0.302*	0.431
	(1.89)	(1.45)
Post-2008 × Δ *M1/GDP Ratio*	0.374	0.294
	(0.83)	(0.20)
Post-2008 × Δ *ln(CPI)*	0.501***	0.278
	(3.49)	(0.61)
Post-2008 × Δ *Case-Shiller Index*	-0.001***	-0.001**
	(-4.78)	(-2.20)
Post-2008	-0.004**	-0.004
	(-2.03)	(-1.19)
Firm-fixed effects	Yes	Yes
Observations	24,405	1,310
Adjusted R^2 (%)	38.8	31.9

The table reports the results of bank-level regressions of changes in normalised liquidity creation (liquidity creation divided by gross total assets) on changes in bank-specific and macrofinancial factors together with the interaction terms with the *Post*-2008 dummy, stratified by institution size. Robust t-statistics in parentheses. *, ** and *** denote 10%, 5% and 1% levels of significance.

3.4 Robustness checks and further tests

We undertake several additional tests in order to establish the robustness of our findings. First, we re-estimate all models on the sample of matched TARP and non-TARP banks. Next, we repeat the analysis using an alternative measure of bank liquidity creation, in which residential real estate loans are treated as illiquid assets, rather than semi-liquid assets as proposed in the original Berger and Bouwman (2009) measure. Finally, we estimate the regressions using two alternative bank capital ratios, namely (i) the ratio of Tier 1 equity to gross total assets ($Tier\ 1\ Equity/GTA$), and (ii) total equity to gross total assets ($Total\ Equity/GTA$). The results of these additional regressions, reported in Tables B1, B2, B3 and B4 in Appendix B, are broadly in line with these reported in Table 6 and do not alter the conclusions of the paper.

4 Conclusion

Modern theories of financial intermediation centre on the role of banks in creating liquidity by transforming the illiquid assets held on their balance sheets into liquid liabilities. Owing to the previous absence of consistent and comprehensive methodology for measuring the amount of liquidity creation by financial institutions, the body of literature examining the empirical properties of this process is only now beginning to emerge.

This paper uses the methodology proposed by Berger and Bouwman (2009) to estimate the amount of liquidity creation by U.S. bank holding companies between 1997 and 2015, and to study the relation between bank liquidity creation and changes in macrofinacial conditions. The focus of our analysis is upon examining the effects of three policy developments which occur in the aftermath of the 2007 - 2009 financial crisis, specifically: the reform of the bank capital requirements system, the use of unconventional monetary policy by the Federal Reserve, and government-mandated provision of capital support for the banking sector under the Trouble Asset Relief Program (TARP).

Although the amount of liquidity creation by the institutions in our sample increases substantially, from $1.4 trillion to $5.1 trillion, during the period we study, it declines considerably in the years following the collapse of the real estate bubble in the United States, and does not surpass its pre-Crisis levels until the end of 2014. We find that to the end of 2015 the amount of liquidity creation per $1 of gross total assets of the U.S. banks in our sample does not return to its pre-2008 average level.

We find that being in receipt of government aid leads to a statistically significant deterioration in the liquidity provision efficiency of small banks in the short run, relative to otherwise similar institutions not participating in TARP. This effect disappears after the completion of the programme. In contrast, we document no significant short-term impact on the large institutions supported by TARP capital injections, but a very pronounced decrease in their liquidity creation efficiency subsequent to the end of their participation in the programme. As nearly all the large TARP-recipient banks in our sample are classified as systemically important financial institutions, we conjecture this reduction in liquidity creation may be a consequence of increased regulatory scrutiny.

Our results establish that the dynamics of liquidity creation undertaken by small and large banks differs greatly, and that the former are more likely to be affected by changes in bank capital requirements regulations and in the stance of monetary policy. We find that the increase in the minimum bank capital requirements introduced by the Third Basel Capital Accord in 2010 has adverse effects on small banks' ability to create liquidity, and that this may offset any positive effects initiated by the monetary stimulus following the quantitative easing policies pursued at the same time. At the same time the liquidity provision efficiency of the largest, systemically important banks does not seem to be affected by changes in either the stance of monetary policy or the level of bank capital requirements. Our results have important implications for the design of effective macroprudential policies. The policies adopted to date appear to impact only small institutions, but fail to influence the key players in the sector. It suggests that targeting specific regulations towards systematically important banks may be more effective than adopting universal rules uniformly applicable to all financial institutions.

Bibliography

1. Amihud, Y. (2002), "Illiquidity and Stock Returns: Cross-Section and Time-Series Effects", *Journal of Financial Markets*, Vol. 5, No. 1, pp. 31 - 56;

2. Arellano, M. (1987), "Computing Robust Standard Errors for Within-groups Estimators", *Oxford Bulletin of Economics and Statistics*, Vol. 49, No. 4., pp. 431 - 434;

3. Bai, J., Krishnamurthy, A., Weymuller, C.-H. (2016), "Measuring Liquidity Mismatch in the Banking Sector", *NBER Working Papers*, No. 22729;

4. Basel Committee on Banking Supervision (2011), *Basel III: A global regulatory framework for more resilient banks and banking systems*, available online at http://www.bis.org/publ/bcbs189.pdf;

5. Basel Committee on Banking Supervision (2013), *Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools*, available online at http://www.bis.org/publ/bcbs238.pdf;

6. Basel Committee on Banking Supervision (2014), *Basel III: The Net Stable Funding Ratio*, available online at http://www.bis.org/bcbs/publ/d295.pdf;

7. Berger, A. N., Bouwman, C. H. S. (2009), "Bank Liquidity Creation", *The Review of Financial Studies*, Vol. 22, No. 9, pp. 3779 - 3837;

8. Berger, A. N., Bouwman, C. H. S. (2012), "Bank Liquidity Creation, Monetary Policy, and Financial Crises", Working paper, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1952728;

9. Berger, A. N., Bouwman, C. H. S. (2013), "How does capital affect bank performance during financial crises?", *Journal of Financial Economics*, Vol. 109, No. 1, pp. 146 - 176;

10. Berger, A. N., Miller, N. H., Petersen, M. A., Rajan, R. G., Stein, J. C. (2005), "Does function follow organizational form? Evidence from the lending practices of large and small banks", *Journal of Financial Economics*, Vol. 76, No. 2, pp. 237 - 269;

11. Berger, A. N., Roman, R. A. (2015), "Did TARP Banks Get Competitive Advantages?", *Journal of Financial and Quantitative Analysis*, Vol. 50, No. 6, pp. 1199 - 1236;

12. Bernanke, B. S., Gertler, M. (1995), "Inside the Black Box: The Credit Channel of Monetary Policy Transmission", *Journal of Economic Perspectives*, Vol. 9, No. 4,

pp. 27 - 48;

13. Bhattacharya, S., Thakor, A. V. (1993), "Contemporary Banking Theory", *Journal of Financial Intermediation*, Vol. 3, No. 2, pp. 2 - 50;

14. Black, F. (1995), "Interest Rates as Options", *The Journal of Finance*, Vol. 50, No. 5, pp. 1371 - 1376;

15. Black, L. K., Hazelwood, L. N. (2013), "The effect of TARP on bank risk-taking", *Journal of Financial Stability*, Vol. 9, pp. 790 - 803;

16. Bowe, M., Kolokolova, O., Michalski, M. (2016), *Systemic Risk, Interbank Market Contagion, and the Lender of Last Resort Function*, Working Paper, available online at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2760879;

17. Bridges, J., Gregory, D., Nielsen, M., Pezzini, S., Radia, A., Spaltro, M. (2014), "The impact of capital requirements on bank lending", *Bank of England Working Papers*, No. 486;

18. Chatterjee, U. K. (2015), "Bank liquidity creation and asset market liquidity", *Journal of Financial Stability*, Vol. 18, pp. 139 - 153;

19. Cohen, B. H., Scatigna, M. (2016), "Banks and capital requirements: Channels of adjustment", *Journal of Banking & Finance*, Vol. 69, Supplement 1, pp. S56 - S69;

20. D'Amico, S., English, W., López-Salido, D., Nelson, E. (2012), "The Federal Reserve's Large-Scale Asset Purchase Programmes: Rationale and Effects", *The Economic Journal*, Vol. 122, No. 564, pp. 415 - 446;

21. Diamond, D. W. (1984), "Financial Intermediation and Delegated Monitoring", *The Review of Economic Studies*, Vol. 51, No. 3, pp. 393 - 414;

22. Diamond, D. W., Dybvig, P. H. (1983), "Bank Runs, Deposit Insurance, and Liquidity", *The Journal of Political Economy*, Vol. 91, No. 3, pp. 401 - 419;

23. Diamond, D. W., Rajan, R. G. (2001), "Liquidity Risk, Liquidity Creation, and Financial Fragility: A Theory of Banking", *The Journal of Political Economy*, Vol. 109, No. 2, pp. 287 - 327;

24. Duchin, R., Sosyura, D. (2014), "Safer ratios, riskier portfolios: Banks' response to government aid", *Journal of Financial Economics*, Vol. 113, No. 1, pp. 1 - 28;

25. Fawley, B. W., Neely, C. J. (2013), "Four Stories of Quantitative Easing", *Federal Reserve Bank of St. Louis Review*, Vol. 95, No. 1, pp. 51 - 88;

26. Financial Crisis Inquiry Commission (2011), *The Financial Crisis Inquiry Report.*

Final Report of the National Commission on the Causes of the Financial and Economic Crisis in the United States, Authorised Edition, New York, NY: Public Affairs;

27. Joyce, M, Miles, D., Scott, A., Vayanos, D. (2012), "Quantitative Easing and Unconventional Monetary Policy - An Introduction", *The Economic Journal*, Vol. 122, No. 564, pp. 271 - 288;
28. Kashyap, A. K., Rajan, R., Stein, J. C. (2002), "Banks as Liquidity Providers: An Explanation for the Coexistence of Lending and Deposit-taking", *The Journal of Finance*, Vol. 57, No. 1, pp. 33 - 73;
29. Kashyap, A. K., Stein, J. C. (1995), "The impact of monetary policy on bank balance sheets", *Carnegie-Rochester Conference Series on Public Policy*, Vol. 42, pp. 151 - 195;
30. Khan, M. S., Scheule, H., Wu, E. (2016), "Funding liquidity and bank risk taking", *Journal of Banking & Finance*, In Press, available at http://www.sciencedirect.com/science/article/pii/S0378426616301558;
31. Kishan, R. P., Opiela, T. P. (2000), "Bank Size, Bank Capital, and the Bank Lending Channel", *Journal of Money, Credit and Banking*, Vol. 32, No. 1, pp. 121 - 141;
32. Li, L. (2013), "TARP funds distribution and bank loan supply", *Journal of Banking & Finance*, Vol. 37, pp. 4777 - 4792;
33. Miles, D., Yang, J., Marcheggiano, G. (2013), "Optimal Bank Capital", *The Economic Journal*, Vol. 123, No. 567, pp. 1 - 37;
34. Oxford Economics (2013), *Analyzing the impact of bank capital and liquidity regulations on US economic growth*, The Clearing House Association;
35. Slovik, P., Cournède, B. (2011), "Macroeconomic Impact of Basel III", *OECD Economics Department Working Papers*, No. 844;
36. Stock, J. H., Watson, M. W. (2008), "Heteroskedasticity-Robust Standard Errors For Fixed Effects Panel Data Regression", *Econometrica*, Vol. 76, No. 1, pp. 155 - 174;
37. Thakor, A. V. (1996), "Capital Requirements, Monetary Policy, and Aggregate Bank Lending: Theory and Empirical Evidence", *The Journal of Finance*, Vol. 51, No. 1, pp. 279 - 324;
38. Vazquez, F., Federico, P. (2015), "Bank funding structures and risk: Evidence from the global financial crisis", *Journal of Banking & Finance*, Vol. 61, pp. 1 - 14;
39. Wu, J. C., Xia, F. D. (2016), "Measuring the Macroeconomic Impact of Monetary

Policy at the Zero Lower Bound", *Journal of Money, Credit and Banking*, Vol. 48, No. 2, pp. 253 - 291.

Appendix A: TARP recipients in the large banks subsample

The subsample of large banks includes the following institutions which received TARP capital support:

1. **Bank of America Corporation**;
2. **The Bank of New York Mellon Corporation**;
3. **BB&T Corporation**;
4. **Capital One Financial Corporation**;
5. **Citigroup, Inc.**;
6. Comerica, Inc.;
7. **Fifth Third Bancorp**;
8. **JPMorgan Chase & Co.**;
9. **KeyCorp**;
10. M&T Bank Corporation;
11. Marshall & Ilsley Corporation;
12. **Morgan Stanley**;
13. Northern Trust Corporation;
14. **PNC Financial Services Group, Inc.**;
15. **State Street Corporation**;
16. **SunTrust Banks, Inc.**;
17. **U.S. Bancorp**;
18. **Wells Fargo & Company**;
19. Zions Bancorporation.

The institutions marked in bold were among the 19 bank holding companies selected for a stress test under the Supervisory Capital Assessment Program in 2009.

Appendix B: Additional panel regressions results

Table B1: Panel regression results for matched TARP and non-TARP banks

	Small banks		Large banks	
	1997-2008	2008-2015	1997-2008	2008-2015
Δ *Tier 1 Ratio*	-0.223***	-0.405***	0.704	-0.219
	(-2.98)	(-8.01)	(1.08)	(-0.98)
Δ *RWAssets Ratio*	0.642***	0.495***	0.753***	0.390***
	(13.72)	(10.76)	(6.74)	(3.88)
Δ *Term Spread*	0.476***	0.084	-0.164	-0.366
	(6.72)	(1.11)	(-0.56)	(-1.25)
Δ *ln(Assets)*	-0.024	-0.069***	0.025	-0.068
	(-1.15)	(-4.91)	(0.47)	(-1.50)
Δ *Tier 1 Ratio* (-1)	0.030	0.037	0.089	-0.041
	(0.74)	(1.27)	(0.33)	(-0.38)
Δ *ln(Assets)* (-1)	0.008	0.020**	0.024	0.016
	(1.20)	(2.38)	(1.42)	(1.06)
Δ *RWAssets Ratio* (-1)	0.046***	0.039	-0.050	0.069*
	(3.01)	(1.56)	(-0.92)	(1.90)
Δ *ROA*	0.009	0.118***	-0.675	-0.107
	(0.14)	(3.02)	(-1.61)	(-0.29)
Δ *Amihud Measure*	-502.685*	326.980**	-1045.044	248.768
	(-1.95)	(2.12)	(-0.92)	(0.36)
Δ *Credit Spread*	-0.022	0.144	0.478	-0.623
	(-0.09)	(0.69)	(0.43)	(-0.91)
Δ *TED Spread*	0.456***	-0.057	0.848	0.124
	(3.05)	(-0.31)	(1.02)	(0.10)
Δ *VIX Index*	0.000	-0.000	0.000	-0.000
	(0.43)	(-1.49)	(0.07)	(-0.29)
Δ *ln(GDP)*	0.013	0.153***	-0.461*	-0.014
	(0.08)	(2.87)	(-1.91)	(-0.09)
Δ *M1/GDP Ratio*	0.017	-0.361**	0.198	-0.050
	(0.04)	(-2.28)	(0.15)	(-0.14)
Δ *ln(CPI)*	-0.285***	0.291***	-0.080	0.634**
	(-2.85)	(3.47)	(-0.35)	(2.78)
Δ *Case-Shiller Index*	0.001***	-0.000	0.001*	-0.000*
	(4.85)	(-0.93)	(1.99)	(-1.77)
TARP		-0.001		0.000
		(-0.54)		(0.02)
Constant	0.003	0.001**	0.004***	0.001
	(1.36)	(2.16)	(2.90)	(0.54)
Firm-fixed effects	Yes	Yes	Yes	Yes
Observations	8,330	6,613	474	485
Adjusted R^2	34%	44%	28.6%	33.1%

Results of bank-level regressions of changes in normalised liquidity creation (liquidity creation divided by gross total assets) on changes in bank-specific and macrofinancial factors, stratified by institution size. Robust t-statistics in parentheses. *, ** and *** denote 10%, 5% and 1% levels of significance.

Table B2: Panel regression results based on an alternative specification of the bank liquidity measure

	Small banks		Large banks	
	1997-2008	2008-2015	1997-2008	2008-2015
Δ *Tier 1 Ratio*	-0.430***	-0.435***	0.304	-0.233
	(-3.33)	(-11.30)	(0.72)	(-1.21)
Δ *RWAssets Ratio*	0.679***	0.564***	0.656***	0.545***
	(18.72)	(17.45)	(6.34)	(4.62)
Δ *Term Spread*	0.459***	0.224***	-0.022	0.152
	(6.02)	(3.41)	(-0.06)	(0.48)
Δ *ln(Assets)*	-0.053***	-0.062***	-0.055	-0.106*
	(-3.57)	(-5.33)	(-1.21)	(-1.83)
Δ *Tier 1 Ratio* (-1)	0.046	0.035	-0.159	-0.115
	(1.13)	(1.56)	(-0.57)	(-0.76)
Δ *ln(Assets)* (-1)	0.015**	0.019***	0.001	0.002
	(2.43)	(3.19)	(0.05)	(0.07)
Δ *RWAssets Ratio* (-1)	0.044***	0.024	-0.072	0.097**
	(2.76)	(1.51)	(-1.68)	(2.12)
Δ *ROA*	-0.108	0.083**	-0.692**	0.110
	(-1.49)	(2.40)	(-2.31)	(0.40)
Δ *Amihud Measure*	-585.492***	490.140***	-1348.409	1552.505*
	(-2.60)	(3.59)	(-1.35)	(1.76)
Δ *Credit Spread*	0.039	0.372**	0.044	-1.001
	(0.17)	(2.05)	(0.04)	(-1.21)
Δ *TED Spread*	0.610***	-0.358**	1.012	-0.496
	(3.62)	(-2.01)	(1.45)	(-0.44)
Δ *VIX Index*	0.000	-0.000**	0.000	-0.001
	(0.63)	(-2.20)	(0.81)	(-1.15)
Δ *ln(GDP)*	-0.072	0.329***	-0.366	0.323
	(-0.44)	(6.29)	(-1.53)	(1.33)
Δ *M1/GDP Ratio*	-0.206	0.123	-0.265	0.139
	(-0.42)	(0.70)	(-0.17)	(0.45)
Δ *ln(CPI)*	-0.232**	0.201*	-0.022	0.041
	(-2.27)	(1.89)	(-0.11)	(0.08)
Δ *Case-Shiller Index*	0.001***	0.000	0.001**	-0.001*
	(5.85)	(0.80)	(2.31)	(-1.95)
TARP		-0.001		-0.003
		(-0.48)		(-0.68)
Constant	0.003	-0.001	0.006**	0.000
	(1.25)	(-1.18)	(2.29)	(0.01)
Firm-fixed effects	Yes	Yes	Yes	Yes
Observations	12,613	11,792	676	634
Adjusted R^2	33.2%	45.8%	28%	38.7%

Results of bank-level regressions of changes in normalised liquidity creation (liquidity creation divided by gross total assets) on changes in bank-specific and macrofinancial factors, stratified by institution size. Robust t-statistics in parentheses. *, ** and *** denote 10%, 5% and 1% levels of significance.

Table B3: Panel regression results based on Tier 1 Equity/GTA bank capital ratio

	Small banks		Large banks	
	1997-2008	2008-2015	1997-2008	2008-2015
Δ *Tier 1 Equity/GTA*	-0.614***	-0.659***	0.273	-0.563**
	(-3.52)	(-12.43)	(0.54)	(-2.47)
Δ *RWAssets Ratio*	0.711***	0.592***	0.627***	0.565***
	(20.38)	(21.56)	(6.77)	(4.72)
Δ *Term Spread*	0.516***	0.131**	-0.057	0.188
	(7.95)	(2.07)	(-0.17)	(0.63)
Δ *ln(Assets)*	-0.052***	-0.064***	-0.043	-0.114**
	(-3.64)	(-6.05)	(-0.94)	(-2.28)
Δ *Tier 1 Equity/GTA* (-1)	0.077	0.023	-0.254	-0.060
	(1.29)	(0.66)	(-0.78)	(-0.33)
Δ *ln(Assets)* (-1)	0.014***	0.016***	0.004	0.010
	(2.61)	(3.03)	(0.25)	(0.42)
Δ *RWAssets Ratio* (-1)	0.030**	0.022	-0.050	0.117**
	(2.06)	(1.45)	(-1.09)	(2.35)
Δ *ROA*	-0.118*	0.101***	-0.590*	0.118
	(-1.69)	(3.06)	(-2.01)	(0.49)
Δ *Amihud Measure*	-524.079***	356.539***	-1099.568	1265.496
	(-2.75)	(2.84)	(-1.18)	(1.41)
Δ *Credit Spread*	-0.005	0.133	0.022	-1.079
	(-0.02)	(0.77)	(0.02)	(-1.39)
Δ *TED Spread*	0.506***	-0.135	0.481	-0.267
	(3.31)	(-0.78)	(0.69)	(-0.27)
Δ *VIX Index*	0.000	-0.000**	0.000	-0.000
	(0.60)	(-2.11)	(0.78)	(-0.63)
Δ *ln(GDP)*	-0.051	0.247***	-0.131	0.292
	(-0.35)	(4.81)	(-0.56)	(1.31)
Δ *M1/GDP Ratio*	-0.246	0.135	-0.215	-0.017
	(-0.61)	(0.82)	(-0.16)	(-0.05)
Δ *ln(CPI)*	-0.294***	0.184*	-0.055	0.191
	(-3.02)	(1.80)	(-0.28)	(0.44)
Δ *Case-Shiller Index*	0.001***	0.000	0.001	-0.001*
	(5.99)	(0.32)	(1.15)	(-1.89)
TARP		-0.001		-0.003
		(-0.57)		(-0.76)
Constant	0.003*	-0.000	0.004	0.001
	(1.75)	(-0.08)	(1.36)	(0.56)
Firm-fixed effects	Yes	Yes	Yes	Yes
Observations	12,613	11,792	676	634
Adjusted R^2	34.7%	44.2%	27.4%	38.8%

Results of bank-level regressions of changes in normalised liquidity creation (liquidity creation divided by gross total assets) on changes in bank-specific and macrofinancial factors, stratified by institution size. Robust t-statistics in parentheses. *, ** and *** denote 10%, 5% and 1% levels of significance.

Table B4: Panel regression results based on Equity/GTA bank capital ratio

	Small banks		Large banks	
	1997-2008	2008-2015	1997-2008	2008-2015
Δ *Total Equity/GTA*	-0.206	-0.478***	1.153**	-0.308
	(-1.06)	(-8.66)	(2.27)	(-1.02)
Δ *RWAssets Ratio*	0.697***	0.593***	0.550***	0.552***
	(20.06)	(21.43)	(6.52)	(4.77)
Δ *Term Spread*	0.493***	0.098	-0.069	0.071
	(6.83)	(1.49)	(-0.21)	(0.24)
Δ *ln(Assets)*	-0.034**	-0.043***	-0.044	-0.106**
	(-2.36)	(-4.24)	(-1.19)	(-2.13)
Δ *Total Equity/GTA* (-1)	0.073	0.072**	-0.141	-0.024
	(1.27)	(2.05)	(-0.55)	(-0.17)
Δ *ln(Assets)* (-1)	0.012**	0.016***	0.007	0.012
	(2.30)	(3.00)	(0.50)	(0.55)
Δ *RWAssets Ratio* (-1)	0.035**	0.019	-0.060	0.115**
	(2.28)	(1.25)	(-1.48)	(2.26)
Δ *ROA*	-0.168**	0.122***	-0.733**	0.180
	(-2.36)	(3.44)	(-2.41)	(0.70)
Δ *Amihud Measure*	-501.025***	271.573**	-1109.065	1322.442
	(-2.60)	(2.11)	(-1.08)	(1.43)
Δ *Credit Spread*	0.062	-0.002	-0.028	-1.343
	(0.30)	(-0.01)	(-0.02)	(-1.67)
Δ *TED Spread*	0.607***	-0.091	0.830	-0.241
	(3.95)	(-0.51)	(1.18)	(-0.23)
Δ *VIX Index*	0.000	-0.000	0.000	-0.000
	(0.65)	(-1.50)	(0.82)	(-0.76)
Δ *ln(GDP)*	-0.081	0.236***	-0.183	0.284
	(-0.54)	(4.43)	(-0.79)	(1.28)
Δ *M1/GDP Ratio*	-0.305	0.088	-0.583	-0.066
	(-0.74)	(0.52)	(-0.46)	(-0.18)
Δ *ln(CPI)*	-0.273***	0.192*	-0.019	0.227
	(-2.86)	(1.83)	(-0.09)	(0.53)
Δ *Case-Shiller Index*	0.001***	0.000	0.001	-0.001*
	(6.01)	(0.44)	(1.12)	(-1.83)
TARP		-0.001		-0.003
		(-0.96)		(-0.88)
Constant	0.003	-0.000	0.004	0.001
	(1.62)	(-0.11)	(1.28)	(0.31)
Firm-fixed effects	Yes	Yes	Yes	Yes
Observations	12,613	11,792	676	634
Adjusted R^2	33.6%	43.1%	30.2%	38.3%

Results of bank-level regressions of changes in normalised liquidity creation (liquidity creation divided by gross total assets) on changes in bank-specific and macrofinancial factors, stratified by institution size. Robust t-statistics in parentheses. *, ** and *** denote 10%, 5% and 1% levels of significance.