ORIGINAL RESEARCH

Implications of a TAF program stigma for lenders: the case of publicly traded banks versus privately held banks

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Abstract Term auction facility (TAF) was created during the financial crisis as a substitute for the Federal Reserve's discount window, the lender of last resort. We hypothesize if TAF borrowing is viewed as a bailout then publicly traded banks would borrow relatively fewer TAF funds to avoid a bailout stigma. We find publicly traded banks did borrow less (as a percent of total assets) in the TAF program than privately held banks. Further, too-big-to-fail banks and investment banks borrowed relatively less than other publicly traded banks indicating greater levels of public scrutiny reduces borrowing under emergency government liquidity programs. We also find that publicly traded banks pledged lower quality and less liquid collateral than private banks when borrowing under the program. Our results suggest TAF provided more benefit to traditional privately held banks with strong balance sheets that were able to borrow relatively greater amounts in anticipation of either future liquidity needs as suggested by Ivashina and Scharfstein (J Financ Econ 97:319–338, 2010) or increased lending as found by Berger et al. (The Federal Reserve's discount window and TAF programs: "pushing on a string?" Working paper, University of South Carolina, 2014).

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1 Introduction

The 2008 U.S. financial crisis centered on the short-term debt markets. In response, the Federal Reserve (Fed) developed a number of programs for banks to address the crises in the different short-term debt markets. We examine one of those programs: the *term auction facility (TAF)* which was purported to act as a substitute for the discount window to provide liquidity to banks, to determine whether there are borrowing differences during the crisis between large banks, other publicly traded banks, and privately held banks.

The Federal Reserve operates the discount window as the lender of last resort for depository institutions with liquidity problems. This facility exists to address liquidity issues that can result from crises in short-term debt markets. Thus, even before the programs created during the 2008 financial crisis, an emergency management program existed for banks with immediate liquidity problems. Still, the Fed chose to create a new liquidity program for banks; the *term auction facility* as a substitute for the discount window because of concerns over a potential stigma associated with accessing the discount window (DW). Bernanke (2009), then Chairman of the Board of Governors of the Federal Reserve System, argued "(T)he perceived stigma of borrowing at the discount window threatened to prevent the Federal Reserve from getting much-needed liquidity into the system. To address this issue, in late 2007, the Federal Reserve established the term auction facility." We hypothesize that, if TAF is not an effective reputation-free substitute for the discount window, then privately held banks should borrow relatively more than publicly traded banks since the publicly traded banks are subject to more market scrutiny.[1]

Research on TAF is developing along two lines: (1) the market's reaction to TAF borrowing and (2) TAF borrowings as a substitute for other sources of funds. Cyree et al. (2013) find that the market viewed TAF borrowing negatively for all banks, but particularly negative for investment banks, reinforcing the argument that publicly traded banks face scrutiny over borrowing in times of crisis. Blau et al. (2016) examine TAF borrowing for publicly traded banks in an event study context and show that the market responded quickly and negatively to TAF borrowings. Further, they found the underperformance was greatest for institutions with the largest loans or amount of loans outstanding. Hence, there exists prima facie evidence that a stigma is associated with TAF borrowings for publicly traded firms.

Berger et al. (2014) examine which banks used the funds, how the use of other funding sources changed, and whether the use of these funds affected bank lending. They report three main findings: small banks receiving funds were weak banks whereas large banks generally were not; the funds substituted to a limited degree for other funding sources; and banks receiving funds increased their lending relative to other banks. Our results differ

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[1] We thank an anonymous referee for pointing out that while the reputation of publicly traded banks is easily measured in share prices; privately held banks can suffer from stigma as well. During a crisis, privately held banks have difficulty raising capital and stigma costs could significantly increase equity costs for such banks. That is, while it is easier for these banks to conceal borrowing, it may be more costly if revealed.

from those of Berger et al. as we separate TAF borrowings from discount window borrowings to focus on the former, which may result in different samples and, we examine on the possible stigma of TAF by comparing public and privately held bank borrowings.

We focus on the existence of a TAF stigma as perceived by both publicly traded and privately held bank borrowings because, during the crisis, very large banks that are subject to the most market scrutiny could be concerned that borrowing from the Fed would be perceived as a sign of weakness. Cyree et al. (2013) contend that although one might expect access to additional short-term credit through Fed programs during a crisis would increase bank stock returns, accessing Fed credit facilities could be viewed negatively by investors. For example, the discount window exists to provide liquidity, however repeated visits to the discount window, while necessary and successful during crises, has been viewed as having a stigma (Furfine (2003)), such that banks generally avoid discount window borrowing. Armantier et al. (2013) also use TAF data to empirically show the existence of the borrowing stigma. We address the following questions:

1. Was the TAF program a stigma-free substitute for discount window borrowing for all banks?
2. Was there a difference in TAF borrowing behavior between publicly traded banks and privately held banks?
3. Does the nature of the collateral influence TAF borrowing, and are there differences across publicly traded and privately held banks?

Our hypothesis is that publicly traded banks are more apt to experience a stronger stigma effect than privately held banks since publicly traded bank borrowings are more likely to be known and evaluated by market participants.

Collateral can constrain borrowing as shown by Shleifer and Vishny (2010) who find that banks borrow on a short-term basis against their inventory of securities to maximize short-term profits. As discussed by Gorton and Metrick (2012), the financial crisis was, in large part, a reaction to the reduced collateral values for repo transactions which greatly restricted banks' ability to borrow to meet short-term fluctuations in the volatile times of the crisis. Accordingly, we also contribute to the literature by examining the differences in collateral offered by both publicly traded and privately held banks in exchange for receiving TAF funds.

We find that while publicly traded banks are several orders of magnitude larger and borrowed more in dollar terms under the TAF program than privately held institutions, the latter borrowed considerably more on a relative basis (more than twice as much as a proportion of assets) even though they had a higher deposit base, a higher capitalization ratio, higher returns on assets, higher net interest margin, higher growth, greater collateral and fewer off balance-sheet liabilities. Only past-due loans are weaker for the privately held banks. That is, privately held banks exploited the opportunity to borrow at the fixed TAF rates to a much greater extent. Our findings are consistent with Boyson et al. (2014) who find weak banks borrow less during a crisis.

Further, we verify prior studies' initial results, finding that TAF borrowing is a substitute for discount window borrowing. However, we extend the analysis to show that both investment banks (I-banks) and too-big-to-fail (TBTF) banks borrow even less (relatively) than other publicly traded banks consistent with a TAF stigma due to increased scrutiny received by these very large and closely-followed banks. Since privately held banks borrow more, ceteris paribus, and since these institutions are subject to less market discipline, managers of these institutions likely have less concern about any perceived stigma effects.

Our results are also consistent with the conventional wisdom that publicly traded banks will avoid participating in government lending programs if they believe it can be perceived as a whole or partial bailout. The results are consistent with both Cyree et al. (2013) and Blau et al. (2016) since those publicly traded institutions that did borrow had negative wealth effects. From a policy standpoint, future crises programs should aim to reduce or eliminate the stigma of borrowing to banks to increase their effectiveness.

2 Background on Federal Reserve crisis facilities

The two principal Fed financial crisis facilities under which banks could access short-term credit are the discount window (DW) and the term auction facility (TAF). However, we control for the other major Fed crisis liquidity facilities available to banks during our sample period namely: the asset-backed commercial paper money market mutual fund liquidity facility (AMLF), the primary dealer credit facility (PD) and, the commercial paper funding facility (CPFF). Borrowing in these facilities could potentially offset the need for TAF or discount window access for some banks, thus we add them as control variables. A brief discussion of each of these facilities follows.[2]

The discount window (DW) facility has been in operation for decades as a means of implementing the Fed's lender-of-last-resort function. All discount window borrowing is immediately available but must be supported by collateral and, during the financial crisis, the Fed broadened the classes of acceptable collateral to include any asset of sound financial quality. In general, the Federal Reserve seeks to value all pledged collateral at an internal fair market value estimate. Our data are consistent with this guidance from the Fed.

Adrian et al. (Adrian et al. 2009, Chart. 4) show that discount window (primary credit) usage increased from approximately zero to roughly $10 billion in April 2008. They also report that discount window primary credit increased sharply to about $100 billion following the Lehman bankruptcy and remained above $40 billion through the end of 2009.

The term auction facility provided short-term (28-day or 84-day) funds for depository institutions. The facility requires depository institutions to bid in a single-price auction for collateralized term funds as an alternative to accessing the discount window. The use of the bidding process was thought to avoid the stigma of discount window borrowing (Cecchetti 2009; Armantier et al. 2013). These loans were required to be over-collateralized by at least a factor of two (i.e., a haircut of at least 50 %) although the Fed allowed a wide variety of illiquid collateral. Thus, while there are no differences in the rates paid by banks at the time of TAF access, there may be considerable differences in the nature and liquidity of the collateral provided. We examine these differences in Sect. 4.3.

The first TAF loan was made in December 2007 and the last loan was executed in March 2010. The program extended a total of $3.8 trillion of loans with $2.6 trillion at maturities of 28 days or less and, $1.2 trillion with maturities between 35 days and 85 days.[3] The maximum in TAF loans outstanding was about $266 billion in February and

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[2] More details on the Fed's financial crisis programs is available at: http://www.federalreserve.gov/monetarypolicy/bst_crisisresponse.htm.

[3] The FAQ from the Fed's webpage on TAF states TAF will have terms of 28 or 84 days with slight adjustment for holidays. The TAF data show other terms in days of: 13, 17, 35, 42, 70, 83, and 85 days. Clearly, 83 days and 85 days are holiday accommodations. The other maturities are outside the stated maturities. These maturities represent less than 6 % of the loans made under TAF.

March 2009. Since TAF was designed to infuse liquidity into banks, borrowing under this program could be seen by the market as admission of serious structural problems.[4],[5]

Gorton and Metrick (2012) use the term "securitized banking" to describe the process of packaging and selling loans and note that this process is funded using repurchase agreements (repos).[6] From the second quarter of 2007 to the first quarter of 2009, net repo financing provided to U.S. banks and broker-dealers fell by about $1.3 trillion—more than half of its pre-crisis total. The *primary dealer credit facility* (PD) was created to provide primary dealers collateral for participation in the repo market. Specifically, PD was an overnight loan facility for primary dealers secured by collateral with appropriate haircuts which was created to reduce the strain on the overnight repo market.[7] Acharya et al. (2012) state that this program played the role of a dealer "discount window." PD began in March 2008 with loans reaching $40 billion in the April following the Bear Stearns collapse. The facility peaked at approximately $200 billion in loans outstanding following the bankruptcy of Lehman Brothers. Loans under PD decline to zero in the second quarter of 2009 and the facility was closed in February 2010.

The securitization process allows for the creation of securities on mortgage pools which were funded by asset-backed commercial paper (ABCP). Griffiths et al. (2011) show that ABCP declined from $1.2 trillion at the beginning of the crisis to $600 billion by the end of the crisis. Two programs were created to address this decline: the *Asset-backed commercial paper money market mutual fund liquidity facility* (AMLF) and the *commercial paper funding facility* (CPFF).

AMLF provided loans to depository institutions and bank holding companies to purchase high-quality asset-backed commercial paper (ABCP) from money market mutual funds. AMLF began in September 2008 and was closed in February 2010. Akay et al. (2013) examine the AMLF program and document a total of $217 billion in loans to seven depository institutions resulting in 3249 purchases of ABCP from MMFs.

CPFF was the *commercial paper funding facility* and was somewhat unique in that the Fed created and funded a limited liability special purpose vehicle (SPV) with the Federal Reserve Bank of New York as the sole beneficiary of the new company. The vehicle purchased 3-month unsecured and asset-backed commercial paper from eligible issuers. The CPFF began in October of 2008 and was closed in February of 2010. Data from the Federal Reserve report a total of $738 billion in loans across the entire program. Griffiths et al. (2011) show that CPFF contributed to stabilizing rates in the ABCP market.

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[4] Stigum (1990) states there are two situations in which the Fed can provide emergency aid to banks. The first is an act of God—floods, hurricanes etc.—which adversely affects a group of banks, their borrowers or their depositors. The second, is when in the judgement of the Fed, long-term financing is needed to offset risk to the banking system as a whole while a long-term solution is worked out. TAF is this latter type of program.

[5] Blau et al. (2016) point out that despite the promise of anonymity by the Fed for those banks accessing the Fed, the Fed continued to release aggregate information on its lending programs by Federal Reserve District. Hence, knowledgeable market participants were able to identify the largest borrowers leading to statistically and economically significant negative returns for those banks.

[6] Gorton and Metrick (2012) note that securitized banking has historically been the business of investment banks.

[7] For a more complete discussion of PD see Adrian, Burke, and McAndrews (2009).

3 Data and sample size

Our sample includes both publicly traded and privately held banks that participated in the TAF program. When we examine the different crisis programs together, we use only publicly traded banks because privately held banks did not participate in some of the crisis programs. When we focus directly on TAF, we include privately held banks along with publicly traded banks in the analysis. As we discuss each set of our results, we will clearly identify whether or not privately held banks are in the analysis.

3.1 Data description

The data for Federal Reserve lending under the crisis management programs come from Bloomberg L.P. and comprise each bank's dollar amount by day for each program. In addition, we have Fed lending data from 8/1/2007 through 4/30/2010 and, as in Cyree et al. (2013), we restrict our sample to those banks which accessed one or more of the Fed programs during the crisis period. The end date in the Fed lending data is not a data collection restriction, but instead represents the end of Fed lending to banks under the various crisis programs.

We estimate the model separately over the following sub-periods to be consist with CGW (2013): (1) the BNP Paribus (8/9/07) announcement of the inability to value certain mortgage backed derivative structures through the Bear Stearns (3/14/08) failure, (2) the Bear Stearns failure (3/14/08) through the Lehman Brothers (9/12/08) bankruptcy, (3) the Lehman Brothers bankruptcy (9/12/08) through the end of 2008, and (4) from 1/3/09 through 12/31/10 which covers the period through the termination of all the Fed crisis facilities under analysis. These are well accepted breaks in the crisis timeline.[8]

For comparison purposes, we separate the sample into investment banks, banks named too-big-to-fail and traditional banks. Cyree et al. (2013) label Bank of America, Bank of New York-Mellon, Goldman Sachs, JP Morgan-Chase, and Morgan Stanley as investment banks based on the self-descriptions of their business model and we continue this labeling for consistency. Banks classified as too-big-to-fail banks are based on whether or not the Federal Reserve publicly announced their requirement to be "stress tested" in April 2009, and were not classified as investment banks. The too-big-to-fail banks are BB&T, Capital One, Citigroup, Fifth Third, Keycorp, PNC Financial, Regions Bank, State Street Bank, SunTrust, US Bancorp, and Wells Fargo.[9] Banks that are neither I-banks or TBTF banks are labeled as traditional banks. We hypothesize that the larger the publicly traded bank, the more widely followed and therefore the most likely to have a stronger stigma effect due to increased scrutiny.

Table 1 contains descriptive statistics for these three groups of banks on all Fed crisis programs available to all banks. Since privately held banks did not participate in PD or AMLF, the data reported for traditional banks in Table 1 includes only publicly traded banks. The financial data are reported quarterly, but the program amounts outstanding and

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[8] We do not analyze these events specifically. Instead, we use the events as reference points. While dozens of events may have influenced banks during the crisis, these three appeared to signal major turning points in the market in general. Afonso et al. (2009), Kapercyzk and Schnabl (2010) and Griffiths et al. (2011) all use similar events in their analyses of the money markets during the crisis.

[9] Of the 19 institutions that are stress tested, American Express, GMAC, and MetLife are removed from the sample since they are neither primarily banks nor investment banks. We recognize that regulators stress tested many more banks than these, but these are the ones initially reported to the public and such disclosure implies special status and thus, more scrutiny.

Table 1 Descriptive statistics for investment banks, too-big-to-fail banks, and traditional (publicly traded) bank daily borrowings under the four major Fed lending programs and related financial variables for the period 8/1/07 through 4/30/10

	Investment banks (N = 4844 daily obs.)		TBTF banks (N = 9900 daily obs.)		Traditional banks (N = 67,045 daily obs.)	
	Mean	Median	Mean	Median	Mean	Median
TAFA	0.1966[b,c]	0.0000[b,c]	0.9409[a,c]	0.0000[a,c]	1.0174[a,b]	0.0000[a,b]
DWA	0.0000[b,c]	0.0000[b,c]	0.0002[a,c]	0.0000[a]	0.0011[a,b]	0.0000[a]
PDA	0.2413[b,c]	0.0000[b,c]	0.0556[a,c]	0.0000[a,c]	0.0000[a,b]	0.0000[a,b]
AMLFA	0.1395[b,c]	0.0000[b,c]	0.2068[a,c]	0.0000[a,c]	0.0000[a,b]	0.0000[a,b]
TAFCHGA	0.0001	0.0000	0.0009	0.0000	−0.0001	0.0000
DWCHGA	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PDCHGA	−0.0005	0.0000[c]	0.0000[a]	0.0000[c]	0.0000	0.0000[a,b]
AMLFCHGA	−0.0002	0.0000[c]	−0.0018[a]	0.0000[c]	0.0000	0.0000[a,b]
FINPREM	0.1992	0.1960	0.1973	0.1960	0.1977	0.1960
VIX_CLOSE	0.2927	0.2916	0.2919	0.2916	0.2914	0.2916
ZSCORE	2.9934[b,c]	3.1042[b,c]	2.6541[a]	2.5080[a,c]	2.6472[a]	2.7717[a,b]
DEP2ASSET	0.2234[b,c]	0.2765[b,c]	0.5278[a,c]	0.6052[a,c]	0.7145[a,b]	0.7249[a,b]
CAPRATIO	0.0843[b,c]	0.0811[b,c]	0.0979[a,c]	0.0968[a,c]	0.0965[a,b]	0.0982[a,b]
ROA	0.0059[b,c]	0.0057[b,c]	0.0036[a,c]	0.0076[a,c]	−0.0004[a,b]	0.0050[a,b]
NIM	0.0601[b,c]	0.0381[b,c]	0.0358[a,c]	0.0342[a,c]	0.0366[a,b]	0.0352[a,b]
PD902TA	0.0075[b,c]	0.0044[b,c]	0.0203[a]	0.0195[a,c]	0.0201[a]	0.0139[a,b]
GAP12	0.1880[b,c]	0.1692[b,c]	0.1940[a,c]	0.2146[a,c]	0.1750[a,b]	0.1564[a,b]
OBSL	0.3533[b,c]	0.2067[b,c]	0.3651[a,c]	0.3753[a,c]	0.1869[a,b]	0.1845[a,b]
GROWTH	0.0250[b,c]	0.0071[b,c]	0.0304[a,c]	0.0045[a,c]	0.0168[a,b]	0.0080[a,b]

Investment banks are defined as Goldman Sachs, Bank of America, Bank of New York/Mellon, JP Morgan/Chase, and Morgan Stanley. Too-big-to-fail banks are defined as the 19 banks identified for stress testing by federal regulators. Traditional banks are those banks that are neither Investment banks nor too-big-to-fail banks. TAFA is the daily outstanding loan amount from the term auction facility, scaled by assets. DWA is the daily discount window borrowing outstanding, scaled by assets. PDA, and AMLFA are primary dealer and asset-backed money market loan facility outstanding, divided by assets. The percentage change in the daily borrowing scaled by bank assets for TAF, the discount window, primary dealer facility, and AMLF programs are DWCHGA, PDCHGA, and AMLFCHGA respectively. FINPREM is the difference between 30-day Financial and non-financial commercial paper rates in percentages. VIX_CLOSE is the closing value of the Chicago Board Options Exchange Market Volatility Index measuring the implied volatility of S&P 500 index options. ZSCORE is the log of (ROA + CAPITAL) divided by the standard deviation of ROA. DEP2ASSET is total deposits scaled by assets. CAPRATIO is the equity-to-assets ratio; ROA is return on assets, NIM is net interest margin for the quarter. PD902ta is past-due loans to assets, GAP12 is the interest rate risk measure of static repricing gap for the last 12 months, and OBSL are off-balance sheet liabilities, divided by assets. GROWTH is the quarterly growth rate of assets

All financial data are from the latest quarterly call report. The superscripts a, b, and c equal significantly different means or medians at the 5 % level or lower for I-banks (a), TBTF banks (b), and traditional banks (c), respectively

market data are daily figures. Because the banks are of substantially different sizes, we standardize the amount borrowed by the amount of total assets reported. Further, to provide additional insight into the institutions involved, we provide various bank-specific ratios including: *DEP2ASSET*—quarterly deposits scaled by assets, *ROA*—the return on assets,

NIM—net interest margin calculated as annualized quarterly net interest income, divided by earning assets, PD902TA—the level of past-due loans 90 days or more, scaled by total assets, GAP12—a measure of interest rate risk and calculated as the value of assets that will re-price in the next 12 months, scaled by assets, OBSL—off balance-sheet items including derivatives and loan commitments, scaled by total assets and GROWTH—the quarterly growth rate in total assets.

In addition, we provide several market value control variables including: FINPREM—the difference between 30-day financial and non-financial commercial paper rates in percentages, VIX_CLOSE—the closing value of the Chicago Board Options Exchange Market Volatility Index measuring the implied volatility of S&P 500 index options, and ZSCORE—the log of (ROA + CAPITAL) divided by the standard deviation of ROA. The FINPREM variable accounts for the direct premium for financial firm risk compared to non-financial firms. VIXCLOSE is a measure of overall market volatility and therefore overall market risk without taking into account industry effects. The Z-score provides a measure of insolvency with a higher value representing lower probability of default. Thus, if troubled banks borrow more there would be a negative relation with Z-score and borrowings.

Table 1 reports that traditional publicly traded banks borrow significantly more (as a percent of total assets) than either I-banks or TBTF banks under both DW and TAF. Since both I-banks and TBTF banks have access to virtually the same alternate funding sources, the fact that TBTF banks borrow approximately five times as much as I-banks but only eight percent less than other publicly traded banks is consistent with TAF representing a stigma to avoid, if possible. This is also consistent with DW performing its traditional role of providing liquidity and with TAF acting as its substitute. I-banks are the major players under PD, which is designed to provide securities to dealers for repos. I-banks and TBTF banks both use AMLF more than traditional banks. According to Akay et al. (2013), more than 90 % of all AMLF transactions were executed by JP Morgan and State Street. Generally, the changes in the amounts borrowed are small and not statistically significant, nor are the market variables that are measured each day.

The financial variables indicate the difference in business models with traditional banks having higher deposits-to-assets, but lower ROA, NIM, and interest rate risk as measured by GAP. Investment banks have the highest ROA and NIM, likely due to their non-interest income advantages. I-banks also have the highest ZSCORE. Too-big-to-fail banks have the highest capital ratios, past-due loans, off-balance-sheet liabilities, and quarterly growth in assets. In general, all of the financial variables have significantly different means and medians.

Table 2 provides descriptive statistics comparing privately held banks that borrowed in the TAF program to all publicly traded banks that borrowed in the TAF program. The privately held bank sample contains 184 banks with 1190 observations. The publicly traded bank sample contains 61 banks with 946 observations. There are only two I-banks (JP Morgan and Bank of America) and eight TBTF banks in the subsample of publicly traded TAF borrowers, with the remaining 51 banks being publicly traded traditional banks. If our hypothesis that publicly traded banks experience greater stigma effects, and the largest TBTF or I-banks even more so, then these banks should borrow relatively less than privately held banks.

While publicly traded banks are several orders of magnitude larger and borrowed more in dollar terms under the TAF program than privately held institutions, privately held banks borrowed considerably more on a relative basis (more than twice per level of assets—see: TAF loans/assets) even though they had a higher deposit base, a higher capitalization ratio,

Table 2 Descriptive statistics for publicly traded versus privately held banks on the TAF loan date for those banks that participated in the TAF program from 8/01/2007 through 4/30/2010

Variable	Privately held banks (N = 1190)	Publicly traded banks (N = 946)	T-stat. for difference
Loan amount ($ millions)	76.50	1086.58	−11.90**
TAF loan/assets (%)	5.3728	2.2198	8.02**
IBANK	NA	0.0412	NA
TBTF	NA	0.1596	NA
COLLATERAL	0.1383	0.0775	8.52**
FINPREM	0.1275	0.2679	−9.49**
VIX_CLOSE	0.3071	0.3451	−6.07**
ASSETS ($1000s)	3,371,521	196,371,609	−11.05**
ZSCORE	2.7761	2.5025	5.54**
DEP2ASSET	0.7212	0.6290	14.42**
CAPRATIO	0.1046	0.0992	3.21**
ROA	0.0026	−0.0031	7.60**
NIM	0.0417	0.0361	4.86**
PD902TA	0.0240	0.0209	2.94**
OBSL	0.1329	0.2411	−5.47**
GROWTH	0.0346	0.0147	4.33**

TAF is the loan amount from the term auction facility. I-BANK is an indicator for investment banks, consisting of Bank of America and JP Morgan/Chase. TBTF is an indicator variable for the 19 too-big-to-fail banks that were stress tested by federal regulators. COLLATERAL is the percentage of collateral pledged to assets. FINPREM is the difference between 30-day Financial and non-financial commercial paper rates in percentages. VIX_CLOSE is the closing value of the Chicago Board Options Exchange Market Volatility Index measuring the implied volatility of S&P 500 index options. ZSCORE is the log of (ROA + CAPITAL) divided by the standard deviation of ROA. DEP2ASSET is total deposits scaled by assets. CAPRATIO is the equity-to-assets ratio; ROA is return on assets, NIM is net interest margin for the quarter. PD902ta is past-due loans to assets, OBSL is the proportion of off-balance sheet liabilities including derivatives and commitments, and GROWTH is the quarterly growth rate of assets

* and ** equals significant at the 5 and 1 % level respectively

higher returns on assets, higher net interest margin, higher growth, greater collateral and fewer off balance-sheet liabilities. Only past-due loans are weaker for the privately held banks.[10] As shown by the mean of the indicator variables in Table 2, only about 4 % of the TAF borrowings for publicly traded banks were made to I-banks, and about 16 % of the TAF borrowings for publicly traded banks were to TBTF banks.

The mean of the financial premium is larger when publicly traded banks borrow in the TAF program, and volatility as measured by the closing VIX level is also higher, both indicating increased borrowing in times of greater uncertainty. We conclude that the nature of the average privately held bank borrowing in the TAF program is substantially different from the average publicly traded bank. While this may be somewhat attributable due to the availability of different funding sources, the differences between the three categories of

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[10] Smaller privately held banks do not have to report the same interest rate risk data that larger banks do, thus many of the privately held banks had missing data when calculating *GAP12*. Accordingly, we removed this variable from the analysis.

publicly traded banks reinforce the argument for a difference in the perception of and willingness to participate in the TAF program.

Figure 1 is a plot of the TAF borrowings by quarter, as a percent of non-deposit borrowings for the banks accessing the TAF facility. Each bar represents the mean proportion borrowed. As shown, the proportion of TAF borrowing is much higher for privately held banks as a percentage of non-deposit borrowed funds. In other words, the TAF program was relatively a much more important source of funds for privately held banks compared to publicly traded banks. Further, the steady increase in TAF as a percent of non-deposit borrowings for privately held banks indicates that TAF was recognized as an important and ongoing source of funds as the financial crisis and the subsequent recession progressed.

3.2 Empirical model

To study whether or not TAF is a substitute for the discount window, we model the change in the percentage of TAF borrowings scaled by assets as:

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\begin{aligned}
dTAFA_{i,t} = {} & \alpha + \omega_1 dDWA + \omega_2 dPDA\alpha_2 + \omega_3 dAMLFA + \alpha_1 TBTF + \alpha_2 IBANK \\
& + \lambda_1 FINPREM + \lambda_2 VIX\_CLOSE + \delta_1 DEP2ASSET + \delta_2 CAPRATIO + \delta_3 ROA \\
& + \delta_4 NIM + \delta_5 PD902TA + \delta_6 GAP12 + \delta_7 OBSL + \delta_8 GROWTH + \theta_1 QTREND \\
& + \vartheta_2 YEAREND + \varepsilon_{i,t}
\end{aligned}
$$

$$(1)$$

The variables are defined as follows[11]:

dDWA	is the daily change in the amount of discount window borrowings scaled by assets, in percentage terms
dPDA	is the daily change in the amount of primary dealer borrowings scaled by assets, in percentage terms
dAMLFA	is the daily change in the amount of AMLF borrowings scaled by assets, in percentage terms
TBTF	is an indicator variable for the too-big-to-fail banks that were stress tested by federal regulators
IBANK	is an indicator variable for investment banks, and equals one for Goldman Sachs, Bank of America, Bank of New York/Mellon, JP Morgan/Chase, and Morgan Stanley, and zero otherwise
FINPREM	is the difference between 30-day financial and non-financial commercial paper rates in percentages
VIX_CLOSE	is the closing value of the Chicago Board Options Exchange Market Volatility Index measuring the implied volatility of S&P 500 index options
DEP2ASSET	is quarterly deposits scaled by assets
ROA	is return on assets, measured as annualized quarterly net income divided by quarterly total assets
NIM	is net interest margin calculated as annualized quarterly net interest income, divided by earning assets

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[11] We develop our model from the model Cyree, Griffiths and Winters (2013, 2016) use to examine bank returns relative to participation in the crisis program examined in this paper. These variables, in general, are bank performance and risk measures drawn from the extant literature in general and Cornett et al. (2011) and Delis et al. (2014) in particular.
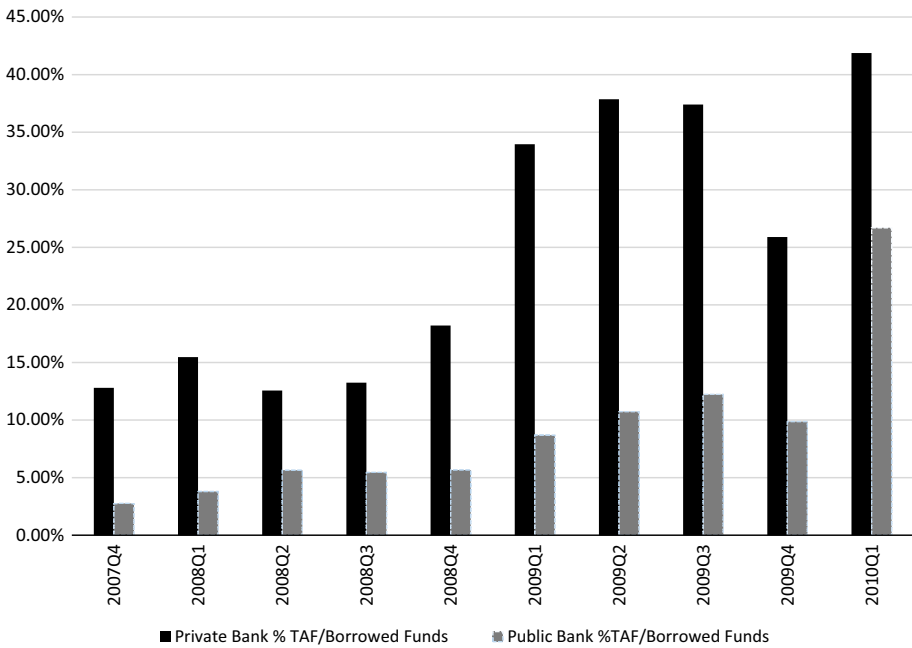
Fig. 1 Privately held bank versus publicly traded bank TAF borrowings

PD902TA	is the level of past-due loans 90 days or more past due, scaled by total assets
GAP12	is a measure of interest rate risk and is calculated as the value of assets that will re-price in the next 12 months, scaled by assets
OBSL	is off balance-sheet items including derivatives and loan commitments, scaled by total assets
GROWTH	is the quarterly growth rate in total assets
QTREND	is an indicator variable for the last 2 days of the quarter except for the fourth quarter
YEAREND	is an indicator for the last two trading days of the year end

Under normal conditions, when modeling a market-based process such as returns, the financial data would be lagged since it is not public until reported with some delay. Here, the decision to borrow or not from the Fed and under which program is internal, and thus, decision makers would be aware of their then current financial status. Accordingly, we do not lag our financial data, nor do we use changes in the financial data. The market data, such as *FINPREM* and *VIX_CLOSE* change daily, and thus are better proxies for con-current changes in the environment than the financial data. However, in the case of the change in borrowings (through TAF or the discount window), it is important to scale by the level of assets since such market value introduces excessive volatility during this period.[12] In addition, we cannot compare privately held banks to publicly traded banks if we use

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[12] The market value of some of these banks swings substantially in a matter of a few days. For example, Bank of America trades for $47.63 at the beginning of the sample period, rises to $52.71 on 10/5/2007, falls to $3.14 on 3/6/2009 before recovering to $17.83 by the end of the sample period. Our results are similar if we scale by deposits or other financial statement variables.

only market values. The use of a scaling variable is necessary as the banks in our sample vary widely in size.

For examining the second hypothesis of differences in TAF borrowing for publicly traded versus privately held banks, we estimate TAF borrowings scaled by assets in the following model:

$$
\begin{aligned}
TAFA_{i,t} = {} & \alpha + \rho PUBLIC + \alpha_1 TBTF + \alpha_2 IBANK + \lambda_1 COLLATER + \lambda_2 FINPREM \\
& + \lambda_3 ZSCORE + \lambda_4 VIX\_CLOSE + \delta_1 DEP2ASSET + \delta_2 CAPRATIO + \delta_3 ROA \\
& + \delta_4 NIM + \delta_5 PD902TA + \delta_6 OBSL + \delta_7 GROWTH + \varepsilon_{i,t}
\end{aligned} \tag{2}
$$

where $PUBLIC$ is an indicator variable equal to one if the bank is publicly traded and zero otherwise. A significant coefficient for PUBLIC is consistent with less TAF borrowing due to a stigma. The other variables are as defined in Eq. 1 with the addition of $COLLATER$ which is collateral pledged as a percent of the loan.

4 Results

We first analyze whether TAF functioned as a liquidity substitute and whether it provided necessary liquidity or simply bailed out poorly performing banks. This analysis will also verify whether our sample is consistent with other studies that find TAF is a stigmatized substitute for the discount window.

4.1 Is TAF a substitute?

Table 3 presents the results for the OLS model (1) that estimates the change in TAF (relative to total assets) and whether these changes represent substitutions from other crisis programs. The model is estimated only for publicly traded banks because privately held banks did not have access to or participate in all the crisis programs. The results are presented for the four previously defined sub-periods of the crisis: Period 1 is labeled BNP as this period starts when BNP halted redemptions on some money market funds, Period 2 is labeled Bear as this period starts with the failure of Bear Stearns, Period 3 is labeled Lehman as this period starts with the bankruptcy of Lehman Brothers, and Period 4 is labeled post-crisis and starts at January 2009. The variable *dDWA* estimates whether borrowing at the discount window substitutes for TAF borrowing. The coefficient for this variable is negative and highly significant across the crisis indicating that decreases in discount window borrowing relate to increases in TAF borrowings and is consistent with banks using the TAF program as a substitute for discount window borrowing. That is, it appears that banks used the TAF program instead of the discount window during the crisis. It is not knowable without surveying the decision-makers directly whether or not they were exactly substituting TAF for DW borrowings or, if they were borrowing TAF funds and would not have borrowed at the discount window in the absence of TAF.[13] The results for the variables PD and AMLF are insignificant. These two programs were focused on dealers and money market funds and thus, a priori, should not substitute for TAF borrowings, but serve as control variables to mitigate the effects of borrowing by some banks in these programs.

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[13] We thank an anonymous referee for pointing out that we cannot directly discern if it was a one-to-one substitute in TAF and the discount window.

Table 3 OLS regression for the daily percentage change of TAF borrowings scaled by assets for banks that borrowed TAF funds, by period

	Period 1 (BNP) (N = 17,760 daily obs.)		Period 2 (Bear) (N = 14,760 daily obs.)		Period 3 (Lehman) (N = 8672 daily obs.)		Post-crisis (N = 39,338 daily obs.)	
	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value
Intercept	0.0114	0.0789	0.0092	0.5855	−0.0293	0.4635	−0.0142	0.2593
DWCHGA	**−14.3730**	**<.0001**	**−3.8566**	**<.0001**	**−30.1959**	**<.0001**	**−58.6902**	**<.0001**
PDCHGA	–	–	−0.0049	0.9721	0.1632	0.4876	−0.0233	0.8946
AMLFCHGA	–	–	–	–	−0.0087	0.7293	0.0053	0.9522
TBTF	−0.0025	0.2637	0.0031	0.5428	−0.0034	0.8233	0.0016	0.7341
IBANK	−0.0024	0.5640	−0.0028	0.7579	−0.0109	0.6476	0.0034	0.6735
FINPREM	0.0040	0.4233	−0.0010	0.9274	−0.0124	0.1658	0.0226	0.1741
VIX_CLOSE	−0.0068	0.6379	−0.0558	0.1067	**0.1344**	**<.0001**	**0.0611**	**0.0013**
ZSCORE	−0.0001	0.9180	−0.0003	0.8283	−0.0017	0.7144	0.0002	0.8970
DEP2ASSET	**−0.0116**	**0.0410**	0.0016	0.9025	−0.0627	0.1068	−0.0002	0.9858
CAPRATIO	−0.0266	0.3985	0.0420	0.5444	0.0253	0.8922	−0.0623	0.2563
ROA	−0.0406	0.7439	0.0466	0.7594	−0.0737	0.8421	0.0443	0.5324
NIM	0.0227	0.7858	−0.0896	0.6512	0.9216	0.0958	−0.0277	0.6593
PD902TA	**0.2313**	**0.0105**	0.1172	0.3848	−0.0875	0.7781	−0.0611	0.4133
GAP12	0.0048	0.3053	0.0121	0.3101	0.0164	0.5912	−0.0005	0.9575
OBSL	−0.0046	0.3727	0.0065	0.5973	−0.0270	0.4417	−0.0092	0.4198
GROWTH	−0.0021	0.8225	0.0010	0.9527	0.0208	0.4262	0.0114	0.5769
QTREND	−0.0008	0.8894	0.0091	0.2886	−0.0039	0.8809	0.0022	0.8163
YEAREND	−0.0016	0.7792	0.0031	0.5428	−0.0102	0.6995	0.0128	0.4962
Adj. R^2	0.0039		0.0011		0.1130		0.1428	

The dependent variable is the daily change in the percentage borrowed from the term auction facility (TAF), scaled by bank assets. DWCHGA is the daily change in discount window borrowings, scaled by assets. PDCHGA is the daily change in primary dealer borrowings, scaled by assets. AMLFCHGA is the daily change in asset-backed money market liquidity fund borrowings, scaled by assets. TBTF is an indicator variable for the 19 too-big-to-fail banks that were stress tested by federal regulators. I-BANK is an indicator for investment banks, consisting of Bank of America and JP Morgan/Chase. COLLATERAL is the percentage of collateral pledged as a percent of assets. FINPREM is the difference between 30-day financial and non-financial commercial paper rates in percentages. ZSCORE is the log of (ROA + CAPITAL) divided by the standard deviation of ROA. VIX_CLOSE is the closing value of the Chicago Board Options Exchange Market Volatility Index measuring the implied volatility of S&P 500 index options. DEP2ASSET is total deposits scaled by assets. CAPRATIO is the equity-to-assets ratio; ROA is return on assets, NIM is net interest margin for the quarter. PD902ta is past-due loans to assets, OBSL is the proportion of off-balance sheet liabilities including derivatives and commitments, and GROWTH is the quarterly growth rate of assets. QTREND is an indicator equal to one for the last 2 days of a quarter, not including the fourth quarter, and zero otherwise. YEAREND is an indicator equal to one if the last 2 days of the year and zero otherwise. Period 1 (BNP) is the period between 8/1/2007 to 3/14/2008 when the crisis began after the BNP failure. Period 2 (BEAR) is the period from the bear stearns failure to the Lehman Brothers failure (3/7/2008 to 9/12/2008). Period 3 (LEHMAN) is the period from the Lehman Brothers failure on 9/15/2008 to the end of 2008. The post-crisis period is the beginning of 2009 to 4/30/2010. Estimates significant at the 5 % level or less are in bold

Importantly, both the too-big-to-fail and I-bank indicator variables are statistically insignificant and thus, are not different from other publicly traded banks throughout the sample period. We will explore whether publicly traded banks are different from privately held banks in a subsequent section, but this result indicates that those banks we believe to be under the most scrutiny—the largest publicly traded banks—do not significantly borrow more or less TAF funds generally during the crisis than other publicly traded banks. (We provide a more complete analysis of this point in the following section.) That is, the largest banks do not appear to have additional stigma associated with borrowing in the TAF program when compared only to other publicly traded banks.

Few of the control variables are significant and none are significant across all periods. This is not surprising as Discount Window borrowing and TAF crisis borrowing are for emergency liquidity and the control variables measure normal bank performance. The one control variable that is proxy for liquidity is *DEP2ASSETS* and it is significant and negative both during the first period (p value $= 0.041$) and negative with a p value of 0.1068 during the Lehman period. This suggests that banks with more deposits to total assets have less need of emergency liquidity. During the first period of the crisis, *PD902TA* is significant and positive. During this period, the crisis was considered to be a liquidity issue and TAF is a substitute for DW liquidity. Banks borrowed less when they had more deposits and borrowed more when they had larger past-due loans. *VIX_CLOSE* is significant and positive in the last two sub-periods which follows the Lehman bankruptcy. The *VIX* results indicate more TAF borrowings occurred when market uncertainty increased.

Finally, we note the low adjusted R-square for the BNP and Bear periods. BNP halted redemptions in August of 2007 and TAF started lending in December of 2007. Bear was rescued in March of 2008. Accordingly, TAF existed for only the second half of our first period hence, the model is unlikely to explain much about TAF borrowing. The second period follows the failure and assisted sale (i.e. bailout) of a large investment bank (Bear Stearns) which reduced the need for systematic emergency borrowing. Lehman signaled a full blown financial crisis and the need for emergency lending. More than half of all the TAF transaction occur after January 1, 2009 during our post-crisis period.

4.2 Regression results for TAF borrowings for privately held and publicly traded banks

To this point, our results suggest that TAF is a substitute for the discount window (Table 3) and that the largest TAF borrowers (on a relative basis) tend to be privately held banks which are not particularly distressed (Table 2). These results suggest TAF worked as designed, and that publicly traded banks borrow at the same rate as very large systemically important banks. We now turn to whether or not the stigma for TAF borrowing is different for publicly traded versus privately held banks.

Table 4 contains the regression results for all banks in the sample, both public and private, and the percentage of assets for their TAF borrowings. The key variables designed to answer our second research question are *PUBLIC*, and to a lesser extent, *TBTF* and *IBANK*. If any of these variables are significant and positive, it would suggest not only a lack of stigma, but perhaps a bailout of the largest banks vis-à-vis more traditional, non-publicly traded banks. If any of these variables have significantly negative coefficients, it suggests a stigma exists for publicly traded banks, and that the TAF program was more useful for smaller, traditional banks. Results show that publicly traded banks borrow significantly fewer TAF funds as a percent of assets than privately held banks. Further, TBTF and I-banks borrow even less than other publicly traded banks during Period 2

Table 4 OLS regression for the percentage of TAF borrowings scaled by assets on the loan date for banks that borrowed TAF funds, by period

	Period 1 (BNP) (N = 102)		Period 2 (Bear) (N = 285)		Period 3 (Lehman) (N = 238)		Post-Crisis (N = 1511)	
	Coeff.	*p* value	Coeff.	*p* value	Coeff.	*p* value	Coeff.	*p* value
Intercept	2.1737	0.2033	0.9388	0.4832	2.5826	0.1248	2.7725	0.0385
PUBLIC	**−1.7536**	**<0.0001**	**−1.5058**	**<0.0001**	−0.6376	0.1301	−0.0999	0.7551
TBTF	−0.4856	0.3512	**−0.8120**	**0.0126**	−0.3350	0.5925	−1.4151	0.0916
IBANK	–	–	**−2.4038**	**0.0027**	−0.2533	0.8153	−2.1977	0.1052
COLLATERAL	**15.4948**	**<0.0001**	**13.6103**	**<0.0001**	**26.7153**	**<0.0001**	**45.9285**	**<0.0001**
FINPREM	−1.0481	0.1625	−0.4306	0.6017	−0.0466	0.8663	−5.2233	0.2482
ZSCORE	0.2628	0.1744	**0.5659**	**<0.0001**	0.3291	0.1809	0.0609	0.7387
VIX_CLOSE	2.0412	0.7311	6.1598	0.1205	−1.6352	0.2667	2.6542	0.3749
DEP2ASSET	−1.7966	0.0891	**−5.3649**	**<0.0001**	**−8.8919**	**<0.0001**	**−9.1843**	**<0.0001**
CAPRATIO	**18.0026**	**0.0175**	**30.6286**	**<0.0001**	**39.4948**	**<0.0001**	1.9549	0.6646
ROA	**−26.0086**	**0.0230**	**−34.0408**	**0.0029**	−5.0758	0.7586	−4.8975	0.6201
NIM	−29.0190	0.0656	**−32.8170**	**0.0291**	14.3613	0.5430	**58.6667**	**<0.0001**
PD902TA	−27.2299	0.1175	17.8396	0.0656	11.3095	0.3574	−5.3871	0.4217
OBSL	−0.3610	0.7786	**0.6790**	**0.0292**	**−3.3129**	**0.0354**	−1.9697	0.0908
GROWTH	−3.7745	0.2791	1.4596	0.4230	**2.6240**	**0.0206**	**6.9997**	**<0.0001**
Adj. R2	0.7273		0.6174		0.4536		0.8024	

The dependent variable is the percentage borrowed from the term auction facility (TAF), scaled by bank assets. PUBLIC is an indicator variable equal to one if the bank is publicly traded and zero otherwise. I-bank is an indicator for investment banks, consisting of Bank of America and JP Morgan/Chase. TBTF is an indicator variable for the 19 too-big-to-fail banks that were stress tested by federal regulators. COL-LATERAL is the percentage of collateral pledged as a percent of assets. FINPREM is the difference between 30-day financial and non-financial commercial paper rates in percentages. ZSCORE is the log of (ROA + CAPITAL) divided by the standard deviation of ROA. VIX_CLOSE is the closing value of the Chicago Board Options Exchange Market Volatility Index measuring the implied volatility of S&P 500 index options. DEP2ASSET is total deposits scaled by assets. CAPRATIO is the equity-to-assets ratio; ROA is return on assets, NIM is net interest margin for the quarter. PD902ta is past-due loans to assets, OBSL is the proportion of off-balance sheet liabilities including derivatives and commitments, and GROWTH is the quarterly growth rate of assets. BNP is the period between 8/1/2007 to 3/14/2008 when the crisis began after the BNP failure. BEAR is the period from the Bear Stearns failure to the Lehman Brothers failure (3/7/2008 to 9/12/2008). LEHMAN is the period from the Lehman Brothers failure on 9/15/2008 to the end of 2008. Post-crisis is the beginning of 2009 to 4/30/2010

Estimates significant at the 5 % level or less are in bold

between the Bear Stearns and Lehman failures, a period when the crisis was rapidly worsening. That is, when liquidity was likely needed, the largest and most susceptible publicly traded banks borrowed less than other banks.[14]

Several control variables also provide interesting insights. First, as the crisis progresses banks with more deposits borrow less under TAF. Second, banks with more capital tend to borrow more under TAF. This is suggestive of prudent management toward available

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[14] A search of news releases during this period revealed 12 events related to capital infusions. The most significant of which were efforts by CitiGroup to raise an additional $3 billion, WaMu raising $7 billion and Wachovia planning to raise several billion dollars. Reports drawn from the Factiva Database.

opportunities in the middle of a crisis (Ivashina and Scharfstein 2010 and Berger et al. 2014). Consistent with prudent management following the Lehman Brothers bankruptcy, banks that are growing, as measured by increasing assets, borrow more from TAF.

4.3 Collateral

As shown in Table 2, privately held banks provide significantly more collateral for TAF borrowing than publicly traded banks. Lending against distressed collateral would be a method for bailing out banks that previously made poor business decisions. In this section, we examine the collateral available for TAF borrowing.

Each TAF transaction is accompanied by a list of collateral available to support that loan. The collateral is referred to as unencumbered collateral and defined as: "lendable value of TAF borrower's discount window collateral, after the application of appropriate margins (haircuts) and minus the value of any outstanding loans, in millions of dollars."[15] That is, our variable represents net collateral not total collateral, thus a TAF loan can be up to 100 % of the collateral listed with each transaction.

In Table 4, the collateral variable is significant and positive in each regression, even though it is used primarily in that regression as a control variable. As expected, the size of collateralized loans should be positively related to the amount of collateral available.

To directly examine collateral pledged, we regress our control variables on the amount of collateral expressed as a percentage of total assets and estimate the regression for each of the four sub-periods. Table 5 contains these results. None of the control variables is significant with the same sign across all four sub-periods. The control variables measure bank performance, so the lack of results on performance measures in Table 5 suggest that weaker banks are not pledging more collateral to access TAF. The most consistent results are: (1) publicly traded banks tend to pledge less collateral and, (2) better capitalized banks pledge less collateral.

The negative and significant coefficient for the *PUBLIC* variable in the collateral regression indicates publicly traded banks pledge less collateral, all else equal. This decision creates more flexibility for publicly traded banks in the future since they do not have to pledge as much collateral. In other words, publicly traded banks have more incentive to borrow in the TAF program since they do not have to pledge as much collateral and therefore their opportunity cost is lower compared to privately held banks. This result, coupled with the findings that publicly traded banks borrow fewer TAF funds than privately held banks (Table 4) reinforces the argument of a TAF stigma.

At this point, there is nothing in our results that suggests that weaker banks use more collateral to access more TAF loans and thus receive a bailout. We now extend our analysis to examine the types of collateral.

4.3.1 Collateral mix

If a bank has a liquidity problem, then it borrows from the discount window (or TAF during the crisis) and should pledge the least liquid collateral that the discount window will accept. In general, bank loans are less liquid than securities and, during the crisis, mortgage backed securities were considered low quality. The discount window would accept both of these types of collateral. Accordingly, the mix of collateral pledged for discount window (and thus TAF) borrowing provides insights into whether TAF borrowing is for liquidity

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[15] See: http://www.federalreserve.gov/newsevents/reform_taf.htm. Accessed 3/18/2014.

Table 5 OLS regression results for collateral pledged on the loan date for TAF borrowings as a percent of assets, by period

	Period 1 (BNP) (N = 102)		Period 2 (Bear) (N = 285)		Period 3 (Lehman) (N = 238)		Post crisis (N = 1511)	
	Coeff.	p value	Coeff.	p value	Coeff.	p value	Coeff.	p value
Intercept	**0.2634**	**0.0430**	0.0602	0.5264	**0.2463**	**<0.0001**	**0.1444**	**0.0031**
PUBLIC	−0.0328	0.2767	**−0.0573**	**0.0028**	**−0.0514**	**<0.0001**	**−0.0461**	**<0.0001**
TBTF	−0.0253	0.5292	**−0.0536**	**0.0191**	**−0.0333**	**0.0349**	−0.0057	0.8512
IBANK	–	–	**−0.1586**	**0.0047**	**−0.0641**	**0.0191**	−0.0466	0.3460
FINPREM	−0.0372	0.5194	0.0409	0.4853	0.0032	0.6491	0.2805	0.0889
ZSCORE	**0.0368**	**0.0118**	**0.0376**	**0.0001**	0.0015	0.8089	−0.0067	0.3151
VIX_CLOSE	0.2514	0.5841	−0.0675	0.8103	−0.0269	0.4701	−0.0855	0.4332
DEP2ASSET	0.0158	0.8456	0.1033	0.0971	−0.0140	0.6912	0.0126	0.7693
CAPRATIO	**−2.2461**	**<0.0001**	**−1.3636**	**0.0002**	**−1.0820**	**<0.0001**	−0.0027	0.9870
ROA	−0.8034	0.3562	**−1.9984**	**0.0127**	−0.6489	0.1205	0.0142	0.9687
NIM	−0.9918	0.4110	2.0403	0.0542	**1.3003**	**0.0290**	**1.2340**	**<0.0001**
PD902TA	−0.3365	0.8013	−1.1296	0.0988	**−1.0746**	**0.0005**	**−0.8974**	**0.0002**
OBSL	−0.1600	0.1049	**0.0613**	**0.0050**	−0.0769	0.0520	**−0.1182**	**0.0053**
GROWTH	−0.5064	0.0573	0.0135	0.9166	−0.0234	0.4128	0.0551	0.2578
Adj. R²	0.2065		0.1612		0.3182		0.1067	

The dependent variable is the percentage of pledged collateral for borrowings from the term auction facility (TAF), scaled by bank assets. PUBLIC is an indicator variable equal to one if the bank is publicly traded and zero otherwise. I-BANK is an indicator for investment banks, consisting of Bank of America and JP Morgan/Chase. TBTF is an indicator variable for the 19 too-big-to-fail banks that were stress tested by federal regulators. COLLATERAL is the percentage of collateral pledged as a percent of assets. FINPREM is the difference between 30-day Financial and non-financial commercial paper rates in percentages. ZSCORE is the log of (ROA + CAPITAL) divided by the standard deviation of ROA. VIX_CLOSE is the closing value of the Chicago Board Options Exchange Market Volatility Index measuring the implied volatility of S&P 500 index options. DEP2ASSET is total deposits scaled by assets. CAPRATIO is the equity-to-assets ratio; ROA is return on assets, NIM is net interest margin for the quarter. PD902ta is past-due loans to assets, OBSL is the proportion of off-balance sheet liabilities including derivatives and commitments, and GROWTH is the quarterly growth rate of assets. BNP is the period between 8/1/2007 and 3/14/2008 when the crisis began after the BNP failure. BEAR is the period from the Bear Stearns failure to the Lehman Brothers failure (3/7/2008–9/12/2008). LEHMAN is the period from the Lehman Brothers failure on 9/15/2008 to the end of 2008. Post-crisis is the beginning of 2009 to 4/30/2010. Estimates significant at the 5 % level or less are in bold

or, to provide a bail out of poorly performing banks. In addition to being distressed, another plausible explanation for pledging collateral is that a bank will pledge the least liquid collateral acceptable to maintain financial flexibility in case additional borrowing is required in the future.

Table 6 provides summary statistics on the collateral mix for each type of bank. Panel A reports the median percent of total collateral of each type and Panel B reports the number of TAF loans supported by each type of collateral.

I-banks pledge loans as collateral and use both commercial and consumer loans. This is consistent with pledging illiquid collateral and/or maintaining flexibility. TBTF banks also lean heavily toward loans as collateral, but do use some securities as collateral. For example, over half (88 of 161) of the TBTF transactions are supported by other MBS

Table 6 TAF collateral

Bank type	Com. loan	Res. mort.	Com. RE	Con. loans	Treasury	Muni	Corp. sec.	MBS/ agency	MBS/ other	Asset- backed	International	Other
Panel A: Median percent of collateral in each security type pledged												
I-banks	45 %	40 %	7 %	25 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
TBTF banks	36 %	38 %	38 %	19 %	4 %	1 %	2 %	8 %	8 %	4 %	0 %	0 %
Publicly traded banks	56 %	9 %	50 %	21 %	13 %	6 %	3 %	5 %	12 %	5 %	5 %	0 %
Privately held banks	34 %	12 %	70 %	14 %	21 %	21 %	9 %	45 %	3 %	3 %	4 %	25 %
International banks	29 %	73 %	10 %	26 %	10 %	1 %	17 %	16 %	5 %	28 %	11 %	0 %
Panel B: The number of TAF loans supported by each type of collateral												
I-banks (n = 35)	22	20	15	30	0	0	0	0	0	0	0	0
TBTF banks (n = 161)	139	40	107	91	28	56	55	52	88	96	20	0
Publicly traded banks (n = 719)	523	92	329	283	80	127	136	158	53	63	23	0
Privately held banks (n = 1126)	604	205	613	352	165	300	120	210	48	30	64	2
International banks (n = 1485)	675	5	262	61	460	489	1095	458	685	990	960	0

securities, but these securities represent only 8 % of the collateral available to support a loan. Publicly traded banks continue the pattern of submitting loans as collateral. Publicly traded banks do use securities, but securities of any type are used in less than 25 % of their TAF transactions. Privately held banks use less loans and more securities than I-banks, TBTF banks and traditional publicly traded banks. Only slightly more than half of the privately held bank TAF transactions are supported by loans and, when securities are used, they tend to be a higher percentage of the total collateral. Privately held banks pledge both a substantial dollar amount and numbers of high quality securities (Treasury, Agency, and MBS/agency guaranteed).

There are two important insights from the summary statistics on collateral. First, the collateral tends toward loans over securities consistent with the banks pledging illiquid collateral instead of distressed securities as well as maintaining flexibility. Second, privately held banks used securities as collateral more than publicly traded banks, but these securities are of high quality. These results support the argument that, in a crisis, one limiting factor for loans is the amount of highly liquid securities held, and especially for privately held banks.

Finally, there is a large group of TAF transactions that is not included in our sample. Our sample is limited to domestic banks to allow us access to bank financial data. Foreign banks account for 1485 TAF transactions. Hence, foreign banks are the largest group in this program.

We provide the collateral data for the foreign banks in the last row of each panel of Table 6 and, there are two important findings. First, foreign banks tend to prefer securities as collateral over loans implying that foreign banks were less concerned with flexibility or liquidity than US banks. Second, the securities provided are from the classes of securities that tended to show distress during the crisis (corporate, MBS/other and asset-backed).

4.4 Robustness of results

For robustness, we estimate the model across all periods and use indicator variables for the different periods omitting the post-crisis indicator. We do not present the specific results in the interest of brevity. The variable *PUBLIC* representing publicly traded firms is insignificant, largely because of the insignificance in the latter part of the crisis as shown in the period-specific tables. IBANK and TBTF continue to indicate that, during the whole sample period, both I-banks and too-big-to-fail banks borrowed less in the TAF program as a proportion of assets. Deposits are negatively related to TAF borrowings for the whole period supporting the argument of the importance of a stable depositor base. The negative sign on the capital ratio indicates that lower proportions of equity translate into higher TAF borrowings, ceteris paribus.[16] Banks with higher net interest margins and growth also borrow more in the TAF program.

We then perform panel regressions for one-way (cross-sectional) fixed effects. This model assumes a mean for each bank and subtracts this mean from the dependent variable. The results (available upon request) indicate that there are no significant fixed-effects. The *dDWA* variable remains significant in all cases with only minor changes in the control variables.[17]

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[16] We also use Tier 1 capital-to-assets, Tier 1 risk-adjusted capital-to-assets, and Total risk-based capital-to-assets for robustness with little difference. Our main results and conclusions are not changed.

[17] *DWCHGA* remained significant in all cases in subsequent two-way (cross-sectional and times-series) models.

We also perform a random effects model which assumes there is some underlying structure that is not necessarily the same for each bank and it is therefore "random" but correlated with the underlying structure. Excluding I-banks and TBTF banks results in the failure to reject the null hypothesis that a random-effects model appropriately measures the correlation between the effects variables and the dependent variables.[18] Collectively, the robustness tests indicate the OLS model is effective in capturing changes and levels of TAF borrowings.

4.4.1 3SLS system of equation results

For additional robustness and, because it is likely that financing decisions are jointly determined and therefore endogenous, we also estimate a three-stage least squares model to form a system of equations for the type of borrowing:

$$
\begin{aligned}
dY_{i,t} = \ &\alpha + \alpha_1 TBTF + \alpha_2 IBANK + \lambda_1 FINPREM + \lambda_2 VIX\_CLOSE + \delta_1 DEP2ASSET \\
&+ \delta_2 CAPRATIO + \delta_3 ROA + \delta_4 NIM + \delta_5 PD902TA + \delta_6 GAP12 + \delta_6 OBSL \\
&+ \delta_5 GROWTH + \lambda_3 QTREND + \lambda_4 YEAREND + \varepsilon_{i,t}
\end{aligned}
\tag{3}
$$

where the dependent variable (dY) in the 3SLS model is alternatively: *dTAFA, dDWA, dPDA, and dAMLFA* as defined earlier.

The three-stage least squares model in Eq. 3 accounts for the possible correlation across the available borrowing programs and possible endogeneity.[19] Again, we examine all the programs, so only publicly traded banks are included in the sample for this estimation since privately held banks did not have the opportunity to borrow in all programs. As specified, the model lends insight into how the different factors affect each individual program's borrowings, as well as providing an overall correlation matrix to examine any relation among the programs. These correlations measure more directly whether any of the programs are substitutes (negative correlation) or complements (positive correlation).

In the interest of brevity, the results from the 3SLS are not reported. Instead, we focus on the correlation matrix, which is presented in Table 7. The correlation matrix indicates that only TAF and the discount window are significantly related and supports the argument that they are substitutes consistent with the stated goal of the Federal Reserve (Bernanke, 2009):

> The introduction of this facility seems largely to have solved the stigma problem, partly because the sizable number of borrowers provides anonymity, and possibly also because the 3-day period between the auction and auction settlement suggests that the facility's users are not relying on it for acute funding needs on a particular day.

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[18] The Hausman *m*-statistic provides information about the appropriateness of the random-effects specification assumes under the null hypothesis, there no correlation between the effects variables and the regressors. Hence, a test can be based on the result that the covariance of an efficient estimator with its difference from an inefficient (OLS) estimator is zero. Rejection of the null hypothesis suggests that the fixed-effects model is more appropriate.

[19] The three most likely causes of endogeneity are omitted variables, simultaneity, and measurement errors. Of these, the most plausible cause of endogeneity for this study is simultaneity since borrowings are possibly jointly determined. The 3SLS model estimated here defines the change in borrowing programs for each program as endogenous and the other independent variables as exogenous.

Table 7 Cross model correlation from the 3SLS system of equations

	dTAFA	dDWA	dPDA	dAMLFA
dTAFA	1.0000			
dDWA	**−0.3093**	1.0000		
dPDA	0.0022	0.0021	1.0000	
dAMLFA	−0.0023	0.00007	0.0020	1.0000

The correlation matrix is from the 3SLS model with dTAF, dDW, dPD, and dAML the daily percentage changes in TAF, discount window, primary dealer, and AMLF respectively, with each scaled by total assets

Estimates significant at the 5 % level or less are in bold

Despite chairman Bernanke's assertion of solving "the stigma problem," Blau et al. (2016) show that the market responded quickly and negatively to TAF borrowings and, their results suggest that market was aware of which banks participated in TAF, so it is unlikely that anonymity plays a major role in a bank's decision to participate in TAF.

5 Summary and conclusions

In this study, we examine discount window and term auction facility (TAF) borrowings. Specifically, we address the following questions:

1. Was the TAF program a stigma-free substitute for discount window borrowing for all banks?
2. Was there a difference in TAF borrowing behavior between publicly traded banks and privately held banks?
3. Does the nature and extent of collateral influence TAF borrowing, and are there differences across publicly traded and privately held banks?

In period-specific OLS regression models and a 3SLS model, there is strong support that TAF borrowings were used as a substitute for discount window borrowings. Our regression results indicate that after banks borrowed under the TAF program, they borrowed less at the discount window. Our findings also indicate our sample is representative and supports findings by Berger et al. (2014) and Armantier et al. (2013).

The principal focus of our paper is in answering question 2: whether or not there is a difference in TAF borrowings between publicly traded and privately held banks. We hypothesize that publicly traded banks are more subject to attention and market scrutiny, and especially so if they are investment banks or large banks declared too-big-to-fail. If publicly traded banks borrowed more than privately held banks, the hypothesis that large banks benefitted at the expense of traditional banks is supported. If publicly traded banks borrowed less, it suggests that a stigma exists for TAF or similar borrowings that could be perceived as a bailout, thereby reducing the efficacy of the TAF program.

In general, we find that while publicly traded banks are several orders of magnitude larger and borrowed more in dollar terms under the TAF program than privately held institutions, the latter borrowed considerably more on a relative basis (more than twice as much as a proportion of assets) even though they had a higher deposit base, a higher capitalization ratio, higher returns on assets, higher net interest margin, higher growth,

greater collateral and fewer off balance-sheet liabilities. Only past-due loans are weaker for the privately held banks.

An alternate explanation for the increased borrowings by privately held banks lies in the assertion made by Ivashina and Scharfstein (2010) that after the Lehman Brothers failure in September 2008, banks found it difficult to roll over their short-term debt while many borrowers drew down their credit lines. In this case, privately held banks may have attempted to acquire as much liquidity as possible in light of the ongoing crisis. Similarly, since Berger et al. (2014) find that banks that borrowed more subsequently engaged in more lending, privately held banks may have viewed TAF borrowings as reliable and inexpensive liquidity to be used for growth purposes.

Both I-banks and TBTF banks borrow even less (relatively) than other publicly traded banks consistent with the increased scrutiny received by these banks, as well as these large banks having other sources of borrowing that smaller banks do not have. However, since privately held banks borrow more, ceteris paribus, and since these institutions are subject to less market discipline, managers of these institutions likely would have fewer concerns about perceived stigma effects. Privately held banks not only borrow more as a percentage of assets, but also as a percentage of non-deposit borrowed funds in every time period. Our findings on higher proportions of borrowings for privately held banks indicate that policymakers need to carefully consider how to reduce or remove the stigma imposed upon large, publicly traded banks borrowing in these programs to help mitigate future crises.

Lastly, the incentive for banks to maintain flexibility through adequate collateral to pledge in times of crises is shown since those banks with higher proportions of collateral borrow more in the TAF program. As shown by Berger et al. (2014), banks that borrowed funds during the 2008 crisis were able to lend more, however the increased lending does not translate into higher stock returns as shown by Cyree et al. (2013). Consistent with our expectations however, we find that publicly traded banks pledge the least liquid collateral acceptable to maintain financial flexibility in case additional borrowing is required in the future.

Our finding that publicly traded banks in general borrowed relatively less than privately held banks, and TBTF and I-banks even less in the TAF program suggests that success in TAF was constrained for the most vulnerable and systemically important banks at the height of the crisis, likely due to the stigma of a perceived bailout. Publicly traded banks pledge less collateral than privately held banks, and therefore their reluctance to borrow should be based less on collateral constraints. TAF borrowing is substantial for foreign banks as shown by the number pledging collateral, and this raises questions about the participation of foreign banks in TAF, but we leave this policy question to others.

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