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## Federal Reserve financial crisis lending programs and bank stock returns

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## ABSTRACT

We use an E-GARCH model to estimate the wealth effects of Federal Reserve lending during the financial crisis to Investment banks (I-Banks), “Too Big to Fail” (TBTF) banks, and “traditional” commercial banks. Borrowing from the Term Auction Facility program has negative wealth effects for all banks and I-banks in particular. We also find that the market view of the liquidity programs changed across the sample sub-periods. I-Bank and TBTF bank borrowing from the discount window is initially viewed positively, however continued use of the discount window and the Term Auction Facility was generally (though not universally) viewed negatively. Commercial Paper Funding Facility program participation is consistently positive only for traditional banks and programs that focus on the purchase of specific securities (e.g., commercial paper) to address specific problems also appear to primarily benefit traditional banks. The inconsistency of results across the time periods of the crisis is telling as market participants struggled to discern what access to these programs meant.

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## 1. Introduction

The financial crisis of 2007 and 2008 in the US was caused by the sudden realization of valuation issues in the subprime mortgage-backed securities market, but the crisis in the banking system centered on the short-term debt markets. In particular, bank financing in recent years has been characterized by the funding of long-term assets with short-term liabilities with the majority of short-term financing supplied by the repurchase agreement (repo) market. From the second quarter of 2007 to the first quarter of 2009, net repo financing provided to US banks and broker-dealers fell by about \$1.3 trillion – more than half of its pre-crisis total (Gorton and Metrick, 2012). Importantly, as Gorton and Metrick (2012) report, a significant portion of the collateral underlying the repos was comprised of mortgage-backed securities.

Two additional prominent examples of the collapse in the short-term debt market are: (1) the collapse of the *Asset-Backed*

*Commercial Paper* (ABCP) market following the suspension of redemptions by BNP Paribas<sup>1</sup> from three of their money market funds holding ABCP and (2) the bankruptcy of Lehman Brothers caused by its inability to retain continued access to the short-term debt market. With the financial crisis centered on the short-term debt markets, the *Federal Reserve* (Fed) took unprecedented actions, largely through the creation of new programs, to intervene in an attempt to establish stability. This paper examines the impact of the Fed's short-term bank liquidity programs on US bank stock returns.

In the attempt to provide access to short-term debt funding, the Fed implemented a variety of crisis management programs. Banks were given access to funds through several programs: increased access to the *Discount Window* (DW), the *Term Auction Facility* (TAF), the *Asset-backed Commercial Paper Money Market Mutual Fund Liquidity Facility* (AMLF), the *Primary Dealer Credit Facility* (PDCF), and the *Commercial Paper Funding Facility* (CPFF). Using a dataset available from Bloomberg L.P. of individual bank's borrowing activity in the crisis programs; we analyze investors' reaction to banks accessing these crisis programs.

At first glance, one might expect that access to additional short-term credit through Fed programs during a crisis would increase

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<sup>1</sup> BNP Paribas is global bank headquartered in Paris and in 2012 it was the third largest bank in the world based on total assets. It was formed through the merger of Banque Nationale de Paris (BNP) and Paribas.

bank stock returns. However, accessing Fed credit facilities could be viewed negatively by investors. For example, one of the four primary functions of the Federal Reserve is to be the lender of last resort through access to the discount window. During the real estate crisis of the mid-1970s through the early 1980s, some banks visited the discount window frequently. Repeated visits to the discount window, while necessary and successful during this period, came to be viewed negatively and progressed to the level of a perceived stigma (Furfine (2003)), such that banks continue to this day to avoid discount window borrowing.<sup>2</sup> A second example of the potential negative impact of participating in a crisis management program comes from a large Texas bank participating in the *Troubled Asset Relief Program* (TARP).<sup>3</sup> Once TARP participation was made public, two competitors sponsored ads identifying the TARP participant and asking if depositors want their funds in a TARP bank.<sup>4</sup> Accordingly, whether access to short-term credit under a Fed crisis program enhances or reduces participant bank returns is an open and important empirical question.

Veronesi and Zingales (2010) estimate that the (US Department of Treasury Secretary Henry) Paulson plan for banks under TARP announced on October 13, 2008 increased the value of bank financial claims by \$130 billion through the reduction in the probability of bankruptcy. This plan provided \$125 billion in preferred equity to the nine largest US commercial banks along with an increase in the *Federal Deposit Insurance Corporation* (FDIC) deposit insurance limit and a three-year guarantee on all new unsecured bank debt. Our analysis extends this line of inquiry by examining the impact on bank stock returns of access to additional Federal Reserve crisis facilities.

Using an E-GARCH model to estimate a market model on three types of publicly traded banks: *Investment banks* (I-Banks), *“Too Big to Fail” banks* (TBTF), and *traditional commercial banks*, we find participation in TAF was negative for all banks and for I-banks in particular. We also find that the market view of the liquidity programs changes across the sub-periods of our analysis. Specifically, I-Bank and TBTF bank participation in the discount window in the first stage of the crisis (which is generally perceived as a liquidity crisis) is initially viewed positively. As the crisis progressed and it became increasingly apparent that liquidity programs would not solve the market's problems, continued use of the discount window and TAF by the I-Banks and TBTF banks was generally (although not universally) viewed negatively. Second, CPFF program participation is consistently positive for traditional banks, but not for I-Banks and TBTF banks. Latter stage programs, such as CPFF which focus on the purchase of specific securities (commercial paper) to address specific problems generally appear to benefit the traditional banks more than larger TBTF and investment banks. This finding is consistent with those of Gao and Yun (2012) who find that CPFF “significantly reduced the cost of debt financing while having little impact on the amount of CP borrowing.” The inconsistency of results across the time periods of the crisis is telling as market participants struggle to discern what access to these programs meant for the solvency of various types of financial institutions.

The paper proceeds as follows: Section 2 provides background on the Fed crisis management facilities along with our

expectations of how markets will respond. Section 3 contains a description of our sample and methods including the details of our E-GARCH model. Section 4 provides descriptive statistics of bank borrowings under the different Fed crisis programs. Section 5 reports the results of the estimations of the E-GARCH model on bank stock returns. These results are presented separately for the different time periods within the financial crisis and the recession that follows to include the conclusion of the various crisis management programs. Section 6 concludes our paper.

## 2. Background on Federal Reserve crisis facilities

In this section, we identify and describe the Fed's financial crisis facilities under which banks could access short-term credit. This is not a complete list of Fed crisis programs, but rather addresses only the facilities that provided for short-term debt to banks.<sup>5</sup> In addition, we provide our expectations about the effect that each program should have on bank returns. Our discussion covers the following Fed crisis facilities:

- DW *discount window,*
- TAF *Term Auction Facility,*
- AMLF *Asset-backed commercial paper Money market mutual fund Liquidity Facility,*
- PDCF *Primary Dealer Credit Facility, and*
- CPFF *Commercial Paper Funding Facility.*

The discount window (DW) facility has been in operation for decades as a means of implementing the Fed's lender-of-last-resort function. However, the Fed made substantial policy changes during the crisis to increase and expand access.

In 2003, discount window policy was modified to become a standing facility with *Primary credit operations* for depository institutions in solid financial condition and, *Secondary credit operations* for depository institutions not eligible for primary credit. Before the crisis, Primary credit was available at 100 basis points above the target Federal funds rate. During the crisis, this spread was decreased on August 17, 2007 to 50 bps and decreased again on March 16, 2008 to 25 bps. The second decrease to a 25 bps spread was accompanied by a maturity increase from a maximum of 30 days to a maximum of 90 days. 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.

Adrian et al. (2009, Chart 4) show that discount window (primary credit) usage increased from approximately zero to roughly \$10 billion in April 2008 following the decrease to 25 bps. They also show 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. We do not have an expected sign for bank returns relative to discount window borrowing. The discount window provides funds to liquidity constrained banks so access could be viewed positively by markets during a crisis, but the potential stigma attached to discount window borrowing could result in a negative response by from the market.

TAF is the acronym for the *Term Auction Facility*. This program provides short-term (28-day or 84-day) funds for depository institutions.<sup>6</sup> 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

<sup>2</sup> The avoidance of this negative stigma is one reason the TAF program was created. Armentier et al. (2011) use TAF data to empirically show the existence of the discount window stigma.

<sup>3</sup> TARP was originally envisioned to purchase troubled (toxic) assets from insolvent banks. However, the program quickly moved to equity injections for banks. TARP is not a lending program and therefore is not included the Bloomberg data on bank borrowing.

<sup>4</sup> The CEO of PlainsCapital Bank argued that the TARP funds were not taken as a bailout, but rather was viewed as an opportunity. The competitors running the anti-Tarp (and anti-PlainsCapital) ads and billboards were the Fort Worth based Worthington National Bank and the First Financial Bank of Abilene.

<sup>5</sup> More details on the Fed's financial crisis programs is available at: [http://www.federalreserve.gov/monetarypolicy/bst\\_crisisresponse.htm](http://www.federalreserve.gov/monetarypolicy/bst_crisisresponse.htm).

<sup>6</sup> The Federal Reserve's FAQ on TAF states: “28-day or 84-day term as specified in the announcement may differ slightly to reflect holiday scheduling issues.”

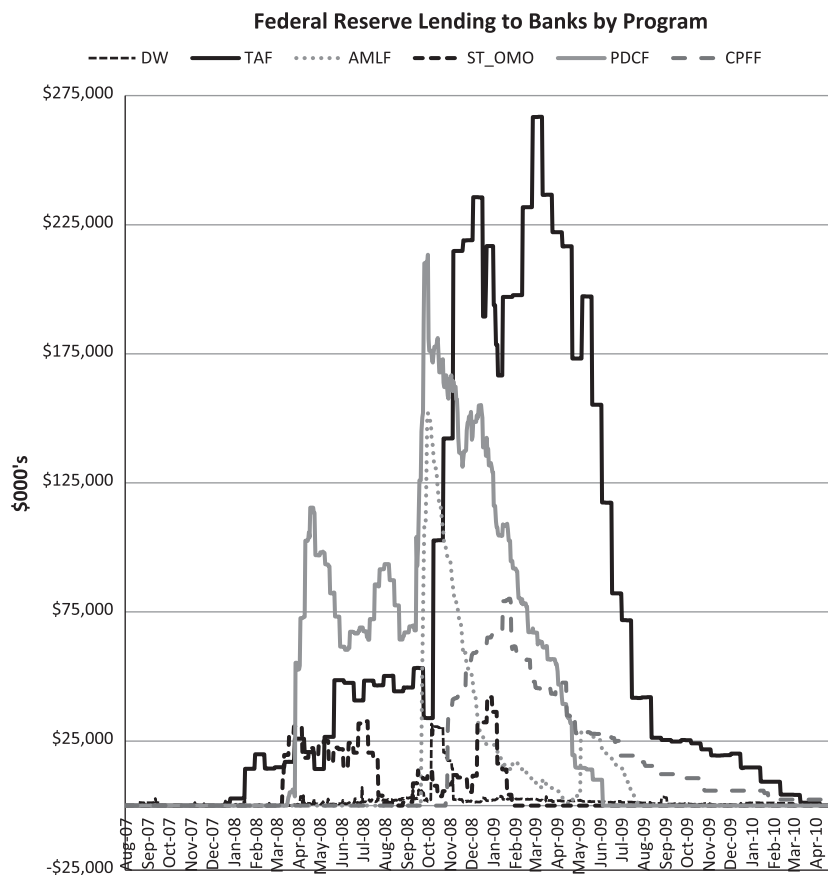


Fig. 1. Data Source: Bloomberg Financial Services.

was thought to allow depository institutions to avoid the stigma of discount window borrowing (Cecchetti (2009, p. 66), Armentier et al. (2011)). 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. The first loan under TAF was made in December 2007 and the last loan was executed in March 2010. The program extended a total of \$3.8 trillion with \$2.6 trillion at maturities of 28 days or less and \$1.2 trillion with maturities between 35 days and 85 days.<sup>7</sup> The maximum in TAF loans outstanding was about \$266 billion in February and March 2009 as shown in Fig. 1. TAF was designed to infuse liquidity into banks, so borrowing under this program would be seen by the market as admission of serious structural problems and hence should have a significantly negative effect on bank returns.<sup>8</sup>

AMLF is the *Asset-backed commercial paper Money market mutual fund Liquidity Facility* which provides 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.

<sup>7</sup> Footnote 3 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. 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.

<sup>8</sup> 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.

Duygan-Bump et al. (2013) find that AMLF was effective in its dual roles of (1) stabilizing MMF outflows and (2) improving ABCP market liquidity. 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. Akay et al. (2013) report that participants in this program had a tendency to purchase ABCP for which they were the issuer, guarantor or market maker. As a result, we expect the market to view participation in this program negatively as a sign of financial weakness.

PDCF is the *Primary Dealer Credit Facility*,<sup>9</sup> 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. In effect, this program played the role of a dealer “discount window” (Acharya et al. (2012)). PDCF began in March 2008 with loans reaching a maximum of \$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. Loans under PDCF decline to zero in the second quarter of 2009 and the facility was closed in February 2010. Access to this program would be indicative of financial weakness and we hypothesize the sign of this variable to be negative especially for I-Banks and TBTF banks.

CPFF is the *Commercial Paper Funding Facility* and was somewhat unique in that the Fed created and funded a limited liability company (SPV) with the Federal Reserve Bank of New York as the sole beneficiary of the new company. The vehicle purchased three-month unsecured and asset-backed commercial paper from eligible issuers. The CPFF began in October of 2008 and was closed in February of 2010.

<sup>9</sup> For a more complete discussion of PDCF see Adrian et al. (2009).

**Table 1**  
Descriptive statistics of publicly traded US banks that participated in at least one Federal Reserve lending program from 8/1/2007 to 4/30/2010.

Variable	Traditional Banks (N = 64)		Too-big-to-fail Banks (N = 10)		Investment Banks (N = 5)	
	Mean	Median	Mean	Median	Mean	Median
Daily Returns	0.04% <sup>b,c</sup>	0.11% <sup>b,c</sup>	0.44% <sup>a</sup>	0.30% <sup>a</sup>	0.40% <sup>a</sup>	0.23% <sup>a</sup>
TAF Borrowings Outstanding (Millions \$)	1330.0 <sup>b,c</sup>	252.5 <sup>b,c</sup>	12635.8 <sup>a,c</sup>	9500.0 <sup>a,c</sup>	63000.0 <sup>a,b</sup>	63000.0 <sup>a,b</sup>
Discount Window (DW) Borrowings (Millions \$)	781.4	64.5 <sup>b,c</sup>	1061.8	516.5 <sup>a</sup>	2125.0	2475.0 <sup>a</sup>
Primary Dealer (PDCF) Borrowings (Millions \$)	4350.0	4350.0	46200.0	46200.0	26676.9	28851.5
CPFF Borrowings (Millions \$)	0.9	0.0	8586.28	4460.6	6423.2	4328.6
AMLF Borrowings (Millions \$)	–	–	26402.4	1009.7	24774.2	10960.0
Market Value	1694.35	384.48	33263.86	16800.69	80743.32	68705.11
TAF/MKTVAL	1.62	0.88	2.59	1.39	0.94	0.00
DW/MKTVAL	0.47 <sup>b,c</sup>	0.09	0.03 <sup>a</sup>	0.02	0.07 <sup>a</sup>	0.01
PDCF/MKTVAL	0.02	0.00 <sup>c</sup>	0.67	0.00 <sup>c</sup>	0.84	0.60 <sup>a,b</sup>
CPFF/MKTVAL	0.94	0.00	0.41	0.00	0.18	0.00
AMLF/MKTVAL	–	–	0.42	0.00	0.16	0.01
Avg. no. of days TAF borrowing outstanding	220.2 <sup>c</sup>	207.0 <sup>c</sup>	266.9 <sup>c</sup>	317.0 <sup>c</sup>	84.8 <sup>a,b</sup>	0.0 <sup>a,b</sup>
Avg. no. of days DW borrowing outstanding	38.6 <sup>c</sup>	4.5	45.2	2.5	14.2 <sup>a</sup>	18.0
Avg. no. of days PDCF borrowing outstanding	1.2 <sup>c</sup>	0.0 <sup>c</sup>	30.7 <sup>c</sup>	0.0	202.0 <sup>a,b</sup>	256.0 <sup>a</sup>
Avg. no. of days CPFF borrowing outstanding	242.5 <sup>b,c</sup>	237.0 <sup>b,c</sup>	51.5 <sup>a</sup>	0.0 <sup>a</sup>	41.4 <sup>a</sup>	60.0 <sup>a</sup>
Avg. no. of days AMLF borrowing outstanding	–	–	48.7	0.0	87.6	102.0

MKTVAL is the average market value of the bank's equity within the specific category of the sample. Term Auction Facility (TAF) was a substitute for the discount window; the Term Security Lending Facility (TSLF) lending to primary dealers to create liquidity in Treasury markets and the Primary Dealer Credit Facility to provide overnight loans to primary dealers are summed as PDCF; AMLF is the Asset-backed Commercial Paper liquidity facility for providing liquidity to money market funds; and CPFF is the Commercial Paper Funding Facility to support high quality and asset-backed Commercial Paper. These programs were in addition to the Federal Reserve Discount Window (DW). The data are from Bloomberg L.P. For two-tailed *t*-tests

<sup>a</sup> Significantly different than traditional banks at 5% level or better.

<sup>b</sup> Significantly different than too-big-to-fail banks at 5% level or better.

<sup>c</sup> Significantly different than investment banks at 5% level or better.

Griffiths et al. (2011) examine the commercial paper market across the financial crisis and include an analysis of the impact of Fed crisis facilities on CP rates. They show that the CPFF program was successful in reducing CP rates on three-month unsecured and asset-backed commercial paper while the other facilities they examine were not successful. We hypothesize that investors have a negative view of the I-Banks and TBTF banks that participated in CPFF since the large amounts borrowed by these banks reflects an admission of financial weakness in the face of the higher market-determined rates.<sup>10</sup> Accordingly, we anticipate significant negative returns for the I-Banks and TBTF banks that relied most heavily on this short-term funding source.

In general, there are two major competing hypotheses. First, one would expect that the more directly a program addresses a specific issue, the better it should work thereby generating positive returns. However, as Acharya et al. (2012) point out, there may be a stigma effect in accessing specially designed programs in that participation might be considered by the markets as a sign of weakness resulting in negative returns.

### 3. Data and empirical method

#### 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. We have Fed lending data from 8/1/2007 to 4/30/2010 and restrict our sample to those banks which accessed one or more of the Fed programs during the crisis period. The end date on the Fed lending data is not a data collection restriction, but instead represents the end of lending to banks under the crisis programs. The equity return data are from the Center for Research in Securities Prices.

<sup>10</sup> Of the \$4.4 trillion of agency and government sponsored entity (GSE) backed securities held by financial institutions in the second quarter of 2007, \$1.1 trillion was held by banks.

Table 1 provides details on the different loan facilities. We separate the sample into investment banks (I-Banks), banks named too-big-to-fail (TBTF), and the banks that were not in either group, which we term traditional banks. We categorize 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. We categorize banks as too-big-to-fail banks based on whether or not the Federal Reserve publicly announced their requirement to be "stress tested" in April 2009, and they 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.<sup>11</sup>

These descriptive statistics provide prima facie evidence that the different sectors of the banking community accessed different Fed programs in differing amounts and for different lengths of time and provides initial ex-post justification for the development of different programs designed to address different economic challenges. We discuss Table 1 in greater depth below.

#### 3.2. Empirical method

Our goal is to study the market reaction to the various short-term Fed lending facilities to banks under the Fed crisis management programs. The traditional approach, as discussed by Brown and Warner (1985), estimates a market model using OLS. However, there are several problems with using OLS regressions for event studies, although they have been widely shown to work well on average. In our study period, equity returns are highly volatile, and this is especially true for bank stocks as the extent of the crisis and effects are unknown throughout most of our sample period.

<sup>11</sup> 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.

Thus, it is important to control for increased volatility and the possibility of persistence in returns. The model we choose to handle these effects is an Exponential General Auto-regressive Conditional Heteroskedasticity (E-GARCH) model that accounts for time-varying variance as originally proposed by Engle (1982) and generalized by Bollerslev (1986) with the exponential addition as in Nelson (1991). The E-GARCH equation allows for asymmetric treatment of the prior error on this period's variance.

The E-GARCH(1,5) model used is specified as:

$$R_{i,t} = \alpha_1 TRADBANK + \alpha_2 TBTF + \alpha_3 IBANK + \beta R_{M,t} + \lambda_1 FINPREM + \lambda_2 VIX\_CLOSE + \lambda_3 QTREND + \lambda_4 YEAREND + \delta_1 TAFSIZE + \delta_2 DWSIZE + \delta_3 PDSIZE + \delta_4 CPFFSIZE + \delta_5 AMLFSIZE + \gamma_1 IBTAF + \gamma_2 IBDW + \gamma_3 IBCPFF + \gamma_4 IBAMLF + \gamma_5 TBTAF + \gamma_6 TBDW + \gamma_7 TBCPFF + \gamma_8 TBAMLF + \sum_{k=1}^5 Return_{i,t-k} + \varepsilon_{i,t} \quad (3)$$

We also use auto-regressive lagged returns (with five lags) to account for persistence during this volatile period. The variance is exponential to account for asymmetry and is specified as:

$$\log(\sigma_t^2) = a_0 + a_1 \log(\sigma_{t-1}^2) + a_2 g_{t-1} \quad (4)$$

where  $g_t = \text{abs}(\varepsilon_t/\sigma_t) - \sqrt{2/\pi} - \theta(\varepsilon_t/\sigma_t)$ .

The E-GARCH model thus provides econometric controls to improve the estimation of the true variance to account for the large swings in returns during the period. Our statistical tests indicate that the E-GARCH model is well-suited to handle the econometric problems in this volatile time period.<sup>12</sup>

We operationalize the variables as follows:

$R_{i,t}$	the daily stock return from CRSP
TRADBANK	an indicator variable for traditional banks that are neither too-big-to-fail nor investment banks
TBTF	an indicator variable for the too-big-to-fail banks that were stress tested by federal regulators. Stress tested non-banks are excluded and investment banks are segregated into a separate group
IBANK	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
$R_{M,t}$	the equally-weighted stock return index from CRSP
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
QTREND	an indicator variable for the last two days of the quarter except for the fourth quarter
YEAREND	an indicator for the last two trading days of the year end
TAFSIZE	bank borrowings through the Term Auction Facility (TAF) scaled by market value
DWSIZE	bank borrowings at the Discount Window (DW) scaled by market value
PDSIZE	bank borrowings through Primary Dealer (PDCF) loans scaled by market value
CPFFSIZE	bank borrowings through the Commercial Paper Funding Facility (CPFF) scaled by market value
AMLFSIZE	bank borrowings through the Asset-backed Commercial Paper Loan Facility (AMLF) scaled by market value
IBTAF, IBCPFF, IBDW, IBAMLF	interaction terms between I-BANK and TAFSIZE, CPFFSIZE, DWSIZE, and AMLFSIZE respectively
TBTAF, TBCPFF, TBDW, TBAMLF	interaction terms between TBTF and TAFSIZE, CPFFSIZE, DWSIZE, and AMLFSIZE respectively

The AR terms are autoregressive parameters, and variances are calculated using the Newey and West (1987) procedure.

Due to a large sample size, the correlations among some variables is statistically significant, although very few are above a correlation coefficient of 50% (results available upon request). An analysis using variance inflation factors (VIF) shows that none of the variables is causing severe problems with multi-collinearity. In addition, the variables are stationary which was determined through a Phillips-Ouliaris cointegration test. In every case, the null hypothesis of a unit root is strongly rejected at better than the 1% level.

We constrain the coefficients for the three category indicator variables, TRADBANK, TBTF, and I-BANK, to sum to one. This restriction allows the comparison each group to the average across all groups since there is no group which may intuitively be omitted as the comparison base case. The suppression of the intercept in this specification along with the restriction results in the interpretation of the *t*-tests on these categories as the difference between the group and the average bank being equal to zero. In addition, we perform pairwise *F*-tests to check for differences between each category.

#### 4. Descriptive statistics of Fed borrowing by Banks

Table 1 reports basic descriptive statistics for the sample. The banks are divided into the three categories as we hypothesize that the market will have different reactions to the support of the Fed programs for too-big-to-fail banks versus traditional banks and investment banks. We report means and medians on borrowings in millions of dollars, and borrowings as a percent of market value. The majority of the daily observations of bank borrowing across a program are zero. Thus, to provide a sense of how each program is used by banks in each category we use the maximum amount outstanding under each program by each bank and provide the summary statistics by category for a program from these maximums. The table also reports the average tenor of loans.

<sup>12</sup> The Durbin-Watson statistics range from 1.52 to 1.71 for up to five lags, indicating no auto-correlation, except in a few cases at the 10-percent level. The auto-regressive (AR) terms are added to minimize the effects of this marginal econometric problem, and the significance of the AR terms indicates these parameters are successfully handling the time-series effects in the return-generating process. Both standard Q tests and LM tests show ARCH disturbances for at least 12 lags for the entire sample period, and for each of the sub-periods. Five lags were chosen based on fit and the intuition of lagging for a period of one trading week. We examine the goodness-of-fit measures of Mean Squared Error, Akaike Information Criteria, and the model's *R*<sup>2</sup> for GARCH(1,5) and E-GARCH(1,5). Our choice is to report results from the E-GARCH(1,5) model because we believe it is the best fit, but results are similar with the GARCH(1,5) model. Results from the GARCH(1,5) are available upon request.

Conditional daily returns are positive on average, but the medians indicate substantial skewness. The *t*-statistics and median location tests indicate that traditional bank returns are significantly lower than both TBTF banks and I-Banks. The Term Auction Facility (TAF) borrowings are significantly different for all three groups, but not significantly different when measured as a percentage of the average institutional market value. Discount window (DW) borrowings are significantly different for traditional banks than both TBTF banks and I-Banks for the dollar amount borrowed (lower), and on a percentage basis (higher). Primary Dealer (PDCF) borrowings are larger as a percentage of the market value for I-Banks. The average tenor of the loans is also different across classes. Investment banks borrow on a shorter-term basis than both traditional and TBTF banks in the TAF program, but on a significantly longer-term basis in the Primary Dealer program. For those traditional banks that borrow in the CPFF program, their average loan outstanding is much smaller on a dollar value basis than TBTF banks and I-Banks, but is much larger as a percent of the market value.

There are two important insights from Table 1 relative to the division of the sample. First, traditional banks borrow in much smaller dollar amounts than TBTF banks and I-Banks – this is to be expected given the relative sizes of the institutions in each group. However, using TAF as an example, the amounts borrowed relative to market value are similar because traditional banks in the sample are much smaller than TBTF banks and I-Banks. Because the differences in dollar amounts and percentages are due to the differences in the size of the banks in the groups, we use the percentage of the loan program compared to market value to account for this size differential in our regression models. Second, usage of the programs differs across the different sets of banks. Since TAF is a substitute for discount window borrowing, the traditional banks and the TBTF banks use TAF in excess of 200 days while I-Banks use it for less than 100 days on average. PDCF is an overnight lending facility for primary dealers; hence I-Banks use this facility for over 200 days while the traditional banks and TBTF banks use this program for less than 30 days on average. This is a function of the number of primary dealers in each category.

Table 2 presents the differences in financial ratios for publicly traded traditional banks, TBTF banks, and Investment banks.<sup>13</sup> Note that while there are 324 publicly-traded traditional banks with adequate data to calculate the variables reported in Table 2, only 64 publicly-traded traditional banks borrowed from the Fed under any of the crisis programs. Accordingly, we include only these 64 traditional banks in Table 2.

Investment banks have a statistically higher ROA than both TBTF and traditional banks. ROA is negative on average over the sample period for traditional banks and is 67 and 83 basis points lower than TBTF banks and I-Banks, respectively. Some of the difference in ROA can be explained by net interest margin being much higher for I-Banks and lowest for traditional banks which is a reflection of their different business models. The equity-to-assets ratio is highest for TBTF banks, in large part due to intervention by regulators to increase capital for these banks that were stress tested, and is lowest for I-Banks. There are other differences that are more structural due to the nature of the different business models, such as I-Banks having significantly more assets and traditional banks making a higher proportion of loans and having less interest rate risk as measured by 12-month GAP.<sup>14</sup> We control for

<sup>13</sup> In a later section, we use only the quarter before the bank participated in one of the loan programs.

<sup>14</sup> GAP measures the difference between interest rate sensitive assets and liabilities. Median statistics show the same general pattern and are not reported for the sake of brevity. The most skewed variable is total assets with median assets for traditional banks who borrowed from the Fed of \$4,742,682, versus \$168,216,344 for TBTF banks and \$910,095,000 for I-banks. The median asset size is statistically different across all three groups, consistent with the means.

**Table 2**

Financial ratios for all publicly traded banks in the sample from 2008 Q1–2010 Q4.

Variable	Traditional Banks (Bank-quarters = 704) Mean	Too-Big-To-Fail Banks (Bank-quarters = 120) Mean	Investment Banks (Bank-quarters = 52) Mean
Return on Assets	-0.23% <sup>b,c</sup>	0.44% <sup>c</sup>	0.60% <sup>a,b</sup>
Net Interest Margin	3.73% <sup>c</sup>	3.65% <sup>a,c</sup>	6.37% <sup>a,b</sup>
Equity-to-assets	9.77% <sup>b</sup>	10.16% <sup>a,c</sup>	9.34% <sup>b</sup>
Loans-to-assets	71.77% <sup>b,c</sup>	58.66% <sup>a,c</sup>	24.08% <sup>a,b</sup>
Loans-to-deposits	100.62% <sup>b,c</sup>	115.77% <sup>a,c</sup>	88.00% <sup>a,b</sup>
12-month GAP	18.06% <sup>b,c</sup>	20.79% <sup>a,c</sup>	25.46% <sup>a,b</sup>
Off-balance Sheet	15.15% <sup>b,c</sup>	29.08% <sup>a</sup>	29.67% <sup>a</sup>
Liabilities-to-assets			
Past-due loans-to-assets	2.57% <sup>c</sup>	2.36% <sup>a,c</sup>	1.04% <sup>a,b</sup>
Quarterly growth rate	0.73%	2.33% <sup>a</sup>	2.36%
Total Assets (\$000s)	15,954,115 <sup>b,c</sup>	441,390,420 <sup>a,c</sup>	1,267,251,525 <sup>a,b</sup>

Income statement variables are annualized when the quarter is not at year end. 12-month GAP is an interest rate risk measure calculated as the 12-month repricing gap between assets and liabilities, scaled by assets. Past-due loans are those loans at least 90 days past due. For two-tailed *t*-tests.

Note: We use 12 quarters of call report data to generate Table 2. At the top of each column we provide the number of bank quarters of data used to generate the information in the column. In no column do we have the total possible numbers of observations. There are 64 traditional banks with a total possible number of observation of 768 (62 × 12) but have only 704 bank quarters due to missing data. Of the 11 TBTF banks, only Capital One did not participate in any of the financial crisis program reducing the TBTF column has 120 (10 × 12) bank quarters of data. The five I-Banks provide for the possibility of 60 (5 × 12) bank quarters of data however, Goldman Sachs and Morgan Stanley did not convert to bank holding companies until late 2008 and hence, we report only 52 bank quarters of data.

<sup>a</sup> Significantly different than traditional banks at 5% level or better.

<sup>b</sup> Significantly different than too-big-to-fail banks at 5% level or better.

<sup>c</sup> Significantly different than investment banks at 5% level or better.

these differences in a cross-sectional analysis, but since we have only quarterly financial statement data while stock returns are daily, these variables are omitted in the remainder of the empirical models.

## 5. E-GARCH results

Previous research has reported several important events during the financial crisis that saw significant shifts in the functioning of the short-term debt markets.<sup>15</sup> Therefore, we do not estimate a single E-GARCH model over the entire period. Instead, we estimate the model separately over the following sub-periods: (1) the BNP Paribas (8/9/07) announcement through the Bear Stearns (3/14/08) failure, (2) Bear Stearns (3/14/08) through the Lehman (9/12/08) bankruptcy, (3) Lehman (9/12/08) through the end of 2008, and (4) from 1/3/09 through 12/31/10 which covers through the termination of all the Fed crisis facilities under analysis. These are well accepted breaks in the crisis timeline.<sup>16</sup>

### 5.1. BNP to bear stearns

The initial period of the financial crisis from 8/9/2007 to 3/14/2008 can be characterized as a time when investors began to understand that problems existed, but had little idea of the extent of the difficulties or the magnitude of the threat to the financial system. Table 3 contains the results for this period. Note that we

<sup>15</sup> A timeline of the financial crisis developed by the Federal Reserve Bank of St. Louis and is available at <http://timeline.stlouisfed.org/index.cfm?p=timeline>.

<sup>16</sup> 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 market during the crisis.

**Table 3**

Regression results for effects of Federal Reserve lending to banks on returns for the first time period from BNP Paribas halting subprime fund redemptions on 8/9/2007 through the Bear Stearns failure 3/14/2008.

Variable	Exponential GARCH(1,5) AR(5) Market Model	
	Estimate	p-Value
TRADBANK	0.0305	0.3557
TBTF	-0.1411**	0.0011
I-BANK	0.1106*	0.0419
$R_M$	1.3105**	<.0001
FINPREM	-0.2788	0.4318
VIX_CLOSE	-0.0022	0.4060
QTREND	-0.4855*	0.0467
YEAREND	0.0421	0.9064
TAFSIZE	-0.8203*	0.0299
DWSIZE	2.1056	0.1123
IBDW	104.9788**	<.0001
TBTAF	0.4010	0.3078
TBDW	12.4741**	<.0001
AR1	-0.1021**	<.0001
AR2	-0.1346**	<.0001
AR3	-0.0977**	<.0001
AR4	-0.1457**	<.0001
AR5	-0.0625**	<.0001
EARCH0	0.0113**	<.0001
EARCH1	0.1020**	<.0001
EARCH2	-0.0493*	0.0255
EARCH3	0.1557**	<.0001
EARCH4	-0.0354	0.1616
EARCH5	-0.1378**	<.0001
EGARCH1	0.9950**	<.0001
THETA	0.2763**	<.0001
TRADBANK vs. TBTF <i>F</i> -stat.	7.42**	
TRADBANK vs. I-BANK <i>F</i> -stat.	632.2**	
TBTF vs. I-BANK <i>F</i> -stat.	322.26**	
Adj. R-sq.	0.3690	

The dependent variable is daily stock return from CRSP. TRADBANK is an indicator variable for banks that are neither too-big-to-fail or investment banks; TBTF is an indicator variable for the 19 Too-big-to-fail banks that were stress tested by federal regulators; and I-BANK is an indicator for investment banks, consisting of Goldman Sachs, Bank of America, Bank of New York/Mellon, JP Morgan/Chase, and Morgan Stanley. The coefficients of TRADBANK + TBTF + I-BANK = 0 so that the groups are compared to the average across all three groups.  $R_M$  is the equally-weighted index from CRSP. 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. QTREND is an indicator variable for the last two days of the quarter except for the fourth quarter, and YEAREND is an indicator for the last two trading days of the year end. TAFSIZE is bank borrowings through in the Term Auction Facility, scaled by market value; DWSIZE is borrowings at the Discount Window scaled by market value. IBDW is an interaction term between I-BANK and DWSIZE. TBTFTAF and TBDW are interaction terms between TBTF and TAFSIZE and DWSIZE respectively. AR terms are autoregressive parameters, and variances are calculated using the Newey and West (1987) procedure. EARCH, EGARCH, and THETA are variance terms for the exponential GARCH model. TRADBANK vs. I-BANK/TBTF and TBTF vs. I-BANK are *p*-values from the *F*-tests for the equality of coefficients for the pairs of indicators for bank groups.

\* Significant at 5% level.  
\*\* Significant at 1% level.

use the market control variables from this period as baseline reference points for the subsequent periods. Bank stock returns are positively related to general market movements ( $R_M$ ) and are negatively related to calendar quarter-ends (QTREND). Controls for financial sector risk (FINPERM), market volatility (VIX\_CLOSE) and the year-end (YEAREND) are not statistically significant.

Traditional banks' returns are not different for the sample average (recall that the comparison is to the average since the coefficients of TRADBANK, TBTF and I-BANK are restricted to sum to one). Investment banks have higher than average returns, while TBTF banks have lower than average returns. The *F*-tests for differences across the categories shows significant differences with TBTF banks having the lowest returns, traditional banks in the middle,

and I-Banks having the highest returns. However, we are interested in bank stock returns relative to accessing Fed crisis programs, thus we focus on the overall scaled variables for the programs (e.g., TAFSIZE) and the interactions between the bank category indicators and program size variables. Since most of the programs were not available this period, the model only includes TAFSIZE and DWSIZE and the interaction terms for I-Banks and Discount Window borrowing (IBDW), TBTF and TAF (TBTAF), and TBTF and Discount Window borrowing (TBDW).<sup>17</sup>

The overall program variable for TAFSIZE shows that increased borrowing using the TAF program is related to significantly lower stock returns. Overall, discount window borrowing does not have a statistically significant impact on returns. However, higher discount window borrowing increases stock returns for both I-Banks and TBTF banks as shown by the positive and significant coefficients for IBDW and TBDW suggesting that, on average, access to the discount window for large banks that did not yet have other crisis related alternatives during this period was viewed positively.

Since this period is a baseline, it is important to note that the 19 too-big-to-fail banks had not been explicitly named at this point, but we contend that the market was able to accurately infer which banks were likely considered too big to fail.<sup>18</sup> Similarly, Investment banks had not yet converted to Financial Holding Companies and were not subject to deposit insurance or bank regulation. Both Goldman Sachs and Morgan Stanley converted on September 21, 2008. Due to the differences in these groups and the limited availability of Fed lending programs at this time, this regression provides at best a crude benchmark and should be interpreted with caution.

## 5.2. Bear Stearns to Lehman

The period from the bailout of Bear Stearns to the Lehman bankruptcy covers 3/14/2008 through 9/12/2008. This period represents a period of growing concern about the crisis especially given media reports on increasing instability, but a relatively calm period for banks because Bear Stearns was not allowed to be dissolved under the Federal Bankruptcy Code.<sup>19</sup> Table 4 presents the regression results for this period.

The market index continues to be positively related to bank returns. The other three market control variables FINPERM, VIX\_CLOSE and QTREND are not statistically significant. YEAREND is omitted from the model for this sample period because the period does not span a year-end. None of the dummy variables for average returns is statistically significant. However, the *F*-tests indicate that traditional banks and TBTF banks have statistically similar returns with both having statistically lower returns than I-Banks.

PDCF became active during this period. However, accessing PDCF (PDSIZE) is not significantly related to stock returns, nor is there any difference for TBTF or I-Banks accessing the PDCF program.

Discount window borrowing is also insignificantly related to returns, while accessing TAF continues to be significant and negative. Estimates for I-Banks accessing the discount window and TAF are both significant and negative as indicated by the interaction terms IBDW and IBTAF. TBTF banks accessing the discount window is significant and negative while accessing TAF is insignificant. These results suggest that during this period following the rescue of Bear Stearns, investors saw discount window access and its liquidity

<sup>17</sup> Note that at the end of the period, there were some very small PDCF borrowings. We removed the PDSIZE variable from this regression since the coefficient become very large and affected the convergence of the model.

<sup>18</sup> The first mention of stress testing for banks was in May, 2007 when the FDIC announced plans to stress test the largest 118 banks for possible FDIC premium increases. Financial media reported the actual 19 banks in February, 2009. Actual stress test results were first reported May 7, 2009.

<sup>19</sup> Rather, the government guaranteed \$30 billion of Bear Stearns losses.

**Table 4**

Regression results for effects of Federal Reserve lending to banks on returns for the second time period from the Bear Stearns failure 3/14/2008 to the Lehman Bros. failure on 9/12/2008.

Variable	Exponential GARCH(1,5) AR(5) Market Model	
	Estimate	p-Value
TRADBANK	0.0030	0.9517
TBTF	-0.0117	0.8912
I-BANK	0.0087	0.9356
R <sub>M</sub>	1.7665**	<.0001
FINPREM	-0.1170	0.8229
VIX_CLOSE	-0.0050	0.5073
QTREND	-0.3006	0.3317
TAFSIZE	-0.6896**	<.0001
DWSIZE	-0.1147	0.6532
PDSIZE	-0.3272	0.2456
IBTAF	-4.1443**	<.0001
IBDW	-179.7220*	0.0199
IBPD	-1.1912	0.4177
TBTAF	0.1387	0.6715
TBDW	-3.0501**	0.0013
TBPD	-1.6916	0.3216
AR1	-0.0938**	<.0001
AR2	-0.1434**	<.0001
AR3	-0.1145**	<.0001
AR4	-0.1271**	<.0001
AR5	-0.0485**	<.0001
EARCHO	0.0074**	<.0001
EARCH1	0.0527**	0.0085
EARCH2	0.0349	0.2067
EARCH3	-0.0156	0.5519
EARCH4	0.0650**	0.0097
EARCH5	-0.0960**	<.0001
EGARCH1	0.9984**	<.0001
THETA	0.0470	0.2544
TRADBANK vs. TBTF F-stat.	0.01	
TRADBANK vs. I-BANK F-stat.	312.61**	
TBTF vs. I-Bank F-stat.	181.37**	
Adj. R-sq.	0.3570	

The dependent variable is daily stock return from CRSP. TRADBANK is an indicator variable for banks that are neither too-big-to-fail or investment banks; TBTF is an indicator variable for the 19 Too-big-to-fail banks that were stress tested by federal regulators; and I-BANK is an indicator for investment banks, consisting of Goldman Sachs, Bank of America, Bank of New York/Mellon, JP Morgan/Chase, and Morgan Stanley. R<sub>M</sub> is the equally-weighted index from CRSP. 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. QTREND is an indicator variable for the last two days of the quarter except for the fourth quarter, and YEAREND is an indicator for the last two trading days of the year end. TAFSIZE is bank borrowings through in the Term Auction Facility, scaled by market value; DWSIZE is borrowings at the Discount Window scaled by market value; PDSIZE is bank borrowings through Primary Dealer loans, scaled by market value. IBTAF and IBDW are interaction terms between I-BANK and TAFSIZE and DWSIZE respectively. TBTAF and TBDW are interaction terms between TBTF and TAFSIZE and DWSIZE respectively. AR terms are autoregressive parameters, and variances are calculated using the Newey and West (1987) procedure. EARCH, EGARCH, and THETA are variance terms for the exponential GARCH model. TRADBANK vs. I-BANK/TBTF and TBTF vs. I-BANK are p-values from the F-tests for the equality of coefficients for the pairs of indicators for bank groups.

\* Significant at 5% level.

\*\* Significant at 1% level.

substitute (TAF) as a negative signal about the overall health of the I-Banks. Investors remain neutral on TBTF banks accessing TAF, but switched their view of TBTF banks accessing the discount window from positive (in the previous period) to negative. Clearly, continued liquidity problems for large banks were being viewed with concern.

### 5.3. Lehman brothers failure

The bankruptcy of Lehman Brothers is generally viewed as the signal that the US financial markets were in a full-blown crisis. This

period saw Congress pass TARP and the Fed take unprecedented steps to address the crisis. We define this period as extending from 9/12/2008 through 12/31/2008. Table 5 reports the results of the regressions.

**Table 5**

Regression results for effects of Federal Reserve lending to banks on returns for the third time period from the Lehman Bros. failure on 9/12/2008 to the end of 2008.

Variable	Exponential GARCH(1,5) AR(5) Market Model	
	Estimate	p-Value
TRADBANK	-0.2092	0.2293
TBTF	-0.4445*	0.0477
I-BANK	0.6537*	0.0319
R <sub>M</sub>	1.1692**	<.0001
FINPREM	0.3666	0.2415
VIX_CLOSE	-0.0007	0.8768
QTREND	-0.9244	0.5979
YEAREND	-0.1041	0.8507
TAFSIZE	-0.2442*	0.0158
DWSIZE	-0.2707	0.6579
PDSIZE	-2.5392**	<.0001
CPFFSIZE	12.3627**	<.0001
AMLFSIZE	-4.3992*	0.0387
IBTAF	-2.4636*	0.0201
IBDW	8.8788**	<.0001
IBCPFF	-9.6271*	0.0209
IBAMLF	0.0000	0.4184
TBTAF	-0.2903	0.3249
TBCPFF	-21.8865**	<.0001
TBDW	0.0003*	0.0347
TBAMLF	-0.2092	0.2293
AR1	-0.0615**	<.0001
AR2	-0.1467**	<.0001
AR3	-0.0988**	<.0001
AR4	-0.0580**	<.0001
AR5	-0.0629**	<.0001
EARCHO	0.0224**	<.0001
EARCH1	-0.0183	0.5097
EARCH2	0.1524**	0.0005
EARCH3	-0.0300	0.4717
EARCH4	-0.0121	0.7587
EARCH5	-0.0020	0.9434
EGARCH1	0.9956**	<.0001
THETA	0.0812	0.1143
Small vs. TBTF F-stat.	4.71	
Small vs. I-Bank F-stat.	50.36**	
TBTF vs. I-Bank F-stat.	2.85	
Adj. R-sq.	0.3642	

The dependent variable is daily stock return from CRSP. TRADBANK is an indicator variable for banks that are neither too-big-to-fail or investment banks; TBTF is an indicator variable for the 19 Too-big-to-fail banks that were stress tested by federal regulators; and I-BANK is an indicator for investment banks, consisting of Goldman Sachs, Bank of America, Bank of New York/Mellon, JP Morgan/Chase, and Morgan Stanley. R<sub>M</sub> is the equally-weighted index from CRSP. 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. QTREND is an indicator variable for the last two days of the quarter except for the fourth quarter, and YEAREND is an indicator for the last two trading days of the year end. TAFSIZE is bank borrowings through in the Term Auction Facility, scaled by market value; DWSIZE is borrowings at the Discount Window scaled by market value; PDSIZE is bank borrowings through Primary Dealer loans, scaled by market value. CPFFSIZE is bank borrowings through the Commercial Paper Funding Facility, scaled by market value. AMLFSIZE is bank borrowings through the Asset-backed Commercial Paper Loan Facility. IBTAF, IBCPFF, and IBAMLF are interaction terms between I-BANK and TAFSIZE, CPFFSIZE, and AMLFSIZE respectively. TBTAF, TBCPFF, TBDW, and TBAMLF are interaction terms between TBTF and TAFSIZE, CPFFSIZE, DWSIZE, and AMLFSIZE respectively. AR terms are autoregressive parameters, and variances are calculated using the Newey and West (1987) procedure. EARCH, EGARCH, and THETA are variance terms for the exponential GARCH model. TRADBANK vs. I-BANK/TBTF and TBTF vs. I-BANK are p-values from the F-tests for the equality of coefficients for the pairs of indicators for bank groups.

\* Significant at 5% level.

\*\* Significant at 1% level.



Traditional banks' returns continue at the average (the test statistic is not different from zero) while TBTF bank returns are negative and I-Bank returns are positive. The *F*-tests confirm significant differences with TBTF banks having the lowest returns, traditional banks in the middle, and I-Banks the highest returns. Banks' returns continue to be significantly positively related to the general market index. The other market controls continue to be statistically insignificant.

AMLF and CPFF are opened during this period.<sup>20</sup> Accessing TAF has a negative effect on returns as it has in all previous periods while accessing the discount window continues to be statistically insignificant as predicted. PDSIZE is significant and negative which is different from being statistically insignificant in the previous period. AMLF is significantly negative on average, while CPFF is significantly positive on average. The negative parameters for PDSIZE and AMLF are consistent with the popular view that blamed the largest financial institutions with creating the crisis, while the positive parameter on CPFF suggests that investors had a positive view of a program designed to provide borrowers access to needed funds at lower than current market rates.

The interaction terms provide interesting and important insights because the programs to assist the commercial paper markets come online at this time. First, the liquidity programs continue with mixed results. When I-Banks and TBTF banks access general credit through the discount window (IBDW and TBDW) returns are significant and larger as shown by the positive coefficients. However, when I-Banks access TAF the impact on their returns continues to be significantly negative and the effect of TBTF banks accessing TAF continues to be neutral. These results are generally consistent with our hypothesis on the market view of banks' access to liquidity facilities. Second, the Fed started both AMLF and CPFF during this period. AMLF was designed to purchase illiquid ABCP from money market funds to provide liquidity to the funds to meet redemptions. The interaction with both I-Banks and TBTF banks is not significant, which is not surprising since the program focused in assisting money market mutual funds.<sup>21</sup> CPFF was designed to provide an alternative to the market for CP and ABCP issuers during a period when these markets were viewed as constricted. Both IBCPFF and TBCPFF are significant and negative consistent with our hypotheses. Figure 5 of Griffiths et al. (2011) show that the borrowers under the CPFF program had difficulty accessing the market at competitive rates.

Note that the model does not include interaction terms with the PDCF program. Limited participation during this period by the banks created severe econometric problems since a linear combination existed due to the lack of participation in the program by some of the groups. We chose to omit those interaction terms due to this econometric issue.

#### 5.4. Post crisis recession

In 2009, the economy went into a general decline after the crisis was blunted. The Fed continued their crisis facilities through the

<sup>20</sup> The *Term Securities Lending Facility* (TSLF) also opened during this period, but it is not separated in our analysis because it is mostly used by I-banks and would create econometric problems due to an extremely high correlation with PDCF and IBANK. Where access to TSLF is indicated, we include the dollar amounts with PDCF, although we later dropped these variables from the analysis. The focus of the Bloomberg data is loans to financial institutions under Fed crisis management programs. TSLF helps primary dealers with liquidity, but is technically not a loan. Instead, it is a program where primary dealers swap illiquid collateral with the Fed for liquid Treasury securities that were then used to access liquidity through the repo market.

<sup>21</sup> Akay et al. (2013) examine bank returns across the first seven days of AMLF and find that JP Morgan and State Street earn significantly positive returns. JP Morgan is in the I-Bank sample while State Street is in the TBTF sample and the regression covers the period from 9/12/08 through 12/31/08. Accordingly, our lack of significance is not surprising on the AMLF interaction parameters.

**Table 6**

regression results for effects of Federal Reserve lending to banks on returns for the post-crisis time period from 1/3/2009 through 12/31/2010.

Variable	Exponential GARCH(1,5) AR(5) Market Model	
	Estimate	p-Value
TRADBANK	−0.0047	0.8893
TBTF	−0.0503	0.3157
I-BANK	0.0550	0.3642
R <sub>M</sub>	1.5199**	<.0001
FINPREM	−2.6465**	<.0001
VIX_CLOSE	−0.0026**	<.0001
QTREND	0.2357	0.2447
YEAREND	0.3867	0.2143
TAFSIZE	−0.1252**	<.0001
DWSIZE	−0.0668	0.5469
PDSIZE	−0.6425	0.0523
CPFFSIZE	0.5114	0.3731
AMLF SIZE	−1.3398	0.3550
IBTAF	−0.0575	0.8944
IBPD	1.7180	0.1525
IBCPFF	−3.4903	0.1920
TBTAF	−0.0062	0.9533
AR1	−0.0706**	<.0001
AR2	−0.0861**	<.0001
AR3	−0.0642**	<.0001
AR4	−0.0608**	<.0001
AR5	−0.0574**	<.0001
EARCH0	0.0163**	<.0001
EARCH1	0.0519**	<.0001
EARCH2	0.0520**	0.0002
EARCH3	−0.0979**	<.0001
EARCH4	0.0064	0.6311
EARCH5	0.0274**	0.0082
EGARCH1	0.9964**	<.0001
THETA	0.1526**	<.0001
Small vs. TBTF <i>F</i> -stat.	0.99	
Small vs. I-Bank <i>F</i> -stat.	807.80**	
TBTF vs. I-Bank <i>F</i> -stat.	512.35**	
Adj. <i>R</i> -sq.	0.2972	

The dependent variable is daily stock return from CRSP. TRADBANK is an indicator variable for banks that are neither too-big-to-fail or investment banks; TBTF is an indicator variable for the 19 Too-big-to-fail banks that were stress tested by federal regulators; and I-BANK is an indicator for investment banks, consisting of Goldman Sachs, Bank of America, Bank of New York/Mellon, JP Morgan/Chase, and Morgan Stanley. R<sub>M</sub> is the equally-weighted index from CRSP. 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. QTREND is an indicator variable for the last two days of the quarter except for the fourth quarter, and YEAREND is an indicator for the last two trading days of the year end. TAFSIZE is bank borrowings through in the Term Auction Facility, scaled by market value; DWSIZE is borrowings at the Discount Window scaled by market value; PDSIZE is bank borrowings through Primary Dealer loans, scaled by market value; CPFFSIZE is bank borrowings through the Commercial Paper Funding Facility, scaled by market value. AMLFSIZE is bank borrowings through the Asset-backed Commercial Paper Loan Facility. IBTAF, IBCPFF, and IBAMLF are interaction terms between I-BANK and TAFSIZE, CPFFSIZE, and AMLFSIZE respectively. TBTAF, TBCPFF, TBDW, and TBAMLF are interaction terms between TBTF and TAFSIZE, CPFFSIZE, DWSIZE, and AMLFSIZE respectively. AR terms are autoregressive parameters, and variances are calculated using the Newey and West (1987) procedure. EARCH, EGARCH, and THETA are variance terms for the exponential GARCH model. TRAD-BANK vs. I-BANK/TBTF and TBTF vs. I-BANK are *p*-values from the *F*-tests for the equality of coefficients for the pairs of indicators for bank groups.

\* Significant at 5% level.

\*\* Significant at 1% level.

early part of 2010, even though some were not actively used. For example, AMLF continued to February 2010 but the last transaction occurred in May of 2009. In this section, we complete our analysis with the period from January 2009 through December 2010. Results are shown in Table 6.

Average conditional bank returns continue to be insignificant in this period although the *F*-test suggests that I-banks performed better than both TBTF banks and traditional banks. The market index remains significant and positive. Further, the volatility proxy is

**Table 7**  
Summary of results from Tables 3–6 for Fed program parameter estimates.

Dates	8/8/2007– 3/14/2008	3/14/2008– 9/12/2008	9/12/2008– 12/31/2009	1/3/2009– 12/31/2010
Variable	Table 3	Table 4	Table 5	Table 6
TAFSIZE	–	–	–	–
DWSIZE	0	–	0	0
PDSIZE		0	–	0
CPFFSIZE			+	0
AMLSIZE			–	0
Investment Banks (I-Bank)				
IBTAF		–	–	0
IBDW	+	–	+	
IBPD		0		0
IBCPFF			–	0
IBAMLF			0	
Too Big to Fail Banks (TBTF banks)				
TBTAF	0	0	0	0
TBDW	+	–	+	
TBPD		0		
TBCPFF			–	
TBAMLF			0	

The cells in this table are defined as follows: (–) means that parameter estimate from the original table is significant and negative, (+) means that parameter estimate from the original table is significant and positive, (0) means that parameter estimate from the original table is not different from zero, and a blank cell means the variable was not included in the model report in the original table.

significant and positive for the first time in our analysis. The financial rate spread is also significantly negative for the first time. Because a larger spread should hurt bank returns, this result is suggestive of the markets exiting crisis mode. The quarter-end and the year-end coefficient estimates are insignificant.

The discount window variable is insignificant while the coefficient for the TAF program is significant and negative. These results are consistent across our analysis and suggest that the market views discount window borrowing as normal, while it views TAF as a form of crisis management with its corresponding negative connotations. PDCF, AMLF and CPFF are all insignificant during this period although all of these programs had significant parameter estimates in the previous period. The insignificant results here are consistent with the economy exiting crisis mode.

During this period, the I-Banks participated in TAF, CPFF and AMLF, but none of the interaction terms are significant. This too suggests a return to more normal market conditions. The TBTF banks participated in DW, TAF, CPFF and AMLF.<sup>22</sup> Using the TAF facility for TBTF banks has an insignificant effect on returns. In general, these results indicate a return to normalcy during this period and are, at some level, an indication that the liquidity and capital programs were successful in mitigating the crisis. However, we leave the causality in this area to future research on the financial crisis.

## 6. Conclusion

The objective of this study is to examine the wealth effects for banks relative to their participation in Federal Reserve financial crisis lending programs. We investigate stock returns for the Investment banks (I-Banks), too-big-to-fail (TBTF) banks, and traditional banks through the period of the Fed crisis lending programs. Both univariate and regression analyses indicate that the three groups have dramatically different characteristics and differing reactions to participation in Fed sponsored crisis liquidity programs.

<sup>22</sup> The participation in these programs during this time was very small, and the interaction terms for both IB and TBTF banks created large multi-collinearity problems, thus they were dropped from the regressions.

While traditional banks borrowed a significantly higher percentage of funds at the Discount Window, their stock returns were statistically indistinguishable from the average bank returns in our sample during the crisis. One possible interpretation of this result is that the Fed publicized that such borrowing would be viewed as a sign of strength applied to this group of lenders. Both TBTF banks and I-Banks also relied on the Term Auction Facility (TAF) and Primary Dealer program (PDCF) which substituted as the discount window for these groups. Again, borrowing from the 'quasi-discount window' was not viewed negatively for this group. Our market model results provide additional insights. For ease in tracking these insights the results are summarized in Table 7.

First, the market view of the liquidity programs appears to have differentiated between normal and crisis liquidity programs. The typical case is that programs were viewed differently depending on the stage of the crisis. Discount window borrowing effects for I-banks and TBTF banks changes from positive, to negative, and back to positive (zero) across the first three periods in our sample. During the first period of our sample, many believed that the economy was experiencing a liquidity crisis. Following the failure of Bear Stearns, it became increasingly apparent that liquidity programs alone would not solve the market's problems, and we contend that at this stage market participants began to view the access of specially designed Fed liquidity programs as confirmation that the financial crisis was more serious than originally thought. For example, in the second and third periods of the crisis (after the Bear Stearns and Lehman failures) TAF borrowing by I-banks had the hypothesized negative wealth effects, consistent with our argument that access to such liquidity programs would be viewed as a sign of financial weakness.

Second, CPFF program participation is positive for traditional banks, but negative for TBTF banks. This result is consistent with our argument that CPFF participation by TBTF banks is seen as an admission of structural weakness while participation by traditional banks is seen as access to low cost funding (Gao and Yun (2012)). This could be the case because traditional banks have fewer funding sources than TBTF banks, but causality of this market reaction is beyond the scope of this study.

Finally, our *F*-test for differences in average returns across the groups of banks showed that in each period I-Banks had the highest returns, and when traditional banks and TBTF banks had statistical differences, the TBTF banks had lower returns. During the height of the crisis following the Lehman bankruptcy, I-Bank participation in the crisis programs of TAF and CPFF is viewed negatively. Although TAF was designed to allow banks to avoid the discount window stigma and CPFF was designed to help CP borrowers that had difficulty accessing the short-term debt market, both appear to have borne the stigma of indicating financial weakness. The effect on I-Banks accessing these specially designed crisis programs while resulting in generally positive returns is consistent with the oft-expressed view that Wall Street was being bailed out at a cost to Main Street.

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