

An Empirical Analysis of the Fed's Term Auction Facility

Efraim Benmelech

ABSTRACT

The U.S. Federal Reserve used the Term Auction Facility to provide term funding to eligible depository institutions from December 2007 to March 2010. According to the Fed, the purpose of the TAF was to inject term funds through a broader range of counterparties and against a broader range of collateral than open market operations. The overall goal of the TAF was to ensure that liquidity provisions could be disseminated efficiently even when the unsecured interbank markets were under stress. In this paper I use the TAF micro-level loan data and find that about 60 percent of TAF loans went to foreign banks that pledged asset-backed securities as collateral for these loans. The data and analysis illustrate the major role that foreign—in particular, European—banks currently play in the U.S. financial system and the resultant currency mismatch in their balance sheets. The data suggest that foreign banks had to borrow from the Federal Reserve Bank to meet their dollar-denominated liabilities.

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1. INTRODUCTION

The Term Auction Facility program was one of the main tools used by the Federal Reserve and U.S. fiscal authorities during the recent financial crisis. The goal of this program, as described by the Federal Reserve, was to intervene in the interbank money markets in response to the difficulties experienced by banks in the United States and Europe. Initially, the Federal Reserve used open market operations to maintain the effective federal funds rate near its target rate and enacted several measures to encourage borrowing at the discount window.¹ However, these moves failed to stimulate the market as much as the Fed had expected. On December 12, 2007, therefore, the Federal Reserve introduced the TAF. The TAF provided longer-term financing to eligible depository institutions through auctions at predetermined dates. At its peak, the TAF amounted to more than \$500 billion and was the largest expansion on the Federal Reserve's balance sheet. Lending through the TAF gradually faded away, and the final TAF auction was conducted on March 8, 2010.

One of the reasons for the introduction of the TAF during the early stages of the financial crisis was to provide banks with Federal Reserve liquidity without forcing them to face the stigma of borrowing from the discount window. Indeed, according to Federal Reserve Board Chairman Ben Bernanke, the associated stigma made banks reluctant to use the discount window:

In August 2007, . . . banks were reluctant to rely on discount window credit to address their funding needs. The banks' concern was that their recourse to the discount window, if it became known, might lead market participants to infer weakness—the so-called stigma problem. (Bernanke 2009)

¹ To encourage banks to borrow at the discount window, the Federal Reserve reduced the discount window penalty rate from 100 basis points to 50 basis points on August 17, 2007, and extended the term of financing from overnight to as long as 30 days.

However, even borrowing from the TAF had a stigma attached to it. As a result, data on the loans that were made in the TAF, as well as the identity of the banks that participated in the auctions, were not disclosed initially. Later, the Federal Reserve disclosed data on the loans made under the TAF, as well as information on the other credit and liquidity programs it used during the crisis.

While the effectiveness of the TAF in reducing rates in the interbank market has been debated by both academic economists and policymakers (see e.g., McAndrews, Sarkar, and Wang 2008 and Taylor and Williams 2009), little is known about the identity of the banks that participated in the auctions, the nature of the collateral used, or the terms on the individual loans. This paper fills in that gap by using the micro-level loan dataset released by the Federal Reserve. The TAF data, which contain detailed information on the loans and the participating financial institutions, provide a rare glimpse into the injection of emergency liquidity by the Federal Reserve as well as the identity of the banks obtaining credit and, in particular, the type of assets they pledged as collateral.

I found that foreign banks accounted for 58 percent of TAF lending, with a total amount of \$2.2 trillion, compared to \$1.6 trillion for U.S. banks. During the auction of December 2007 and through most of 2008, foreign banks accounted for the vast majority of the lending, with amounts that ranged between twofold and fourfold the total lending to U.S. banks. United Kingdom-based Barclays was the largest borrower in the TAF, followed by Bank of America, Royal Bank of Scotland, Wells Fargo, and Wachovia. Out of the 10 largest borrowers, 5 are foreign banks; and out of the 50 largest borrowers, more than 30 are from foreign countries.

Next, I compared the collateral structure of domestic and foreign banks. I found that most of the banks and financial institutions that pledged asset-backed securities (ABSs) as collateral were foreign—primarily European—banks. For example, the bank that pledged the largest amount of ABSs for a given loan is Société Générale (France), followed by Norinchukin Bank (Japan), Dexia (Belgium), Barclays (UK), and UBS (Switzerland). Among the 10 banks that pledged the largest amounts of collateral, only two are American banks (State Street and U.S. Central Federal Credit Union). Why did the Federal Reserve allocate the majority of TAF loans to foreign banks? Why were foreign banks more likely to pledge

the riskier ABSs and collateralized debt obligations (CDOs) as collateral?

One potential explanation is that the meltdown of the structured finance market and the severe deterioration in the credit ratings of ABSs necessitated liquidity injections to institutions that suffered major losses because of their exposure to the structured finance market. However, U.S. banks that borrowed from the TAF and had large exposures to ABSs, such as Citibank and Bank of America, did not pledge ABSs at the same level as European banks. Thus, while some of the Federal Reserve lending was probably aimed at injecting liquidity into financial institutions that held securities that were illiquid at the time, this is unlikely to be the only reason for the dominance of European banks in the TAF.

Another explanation for the large number of loans made to foreign banks is that these banks suffered from a currency mismatch in their balance sheets. Many foreign banks were active players in the creation and issuance of structured finance products. As money markets ground to a halt, those banks required financing to roll over their short-term liabilities. Furthermore, foreign banks were subject to a currency mismatch in their assets and liabilities. The main source of funding for some of the banks was demand deposits and other forms of credit in their home countries, and these were denominated in their home currencies (mostly the British pound and the euro). However, many European banks issued liabilities in U.S. money markets that were denominated in the U.S. dollar. Thus, not only were foreign banks subject to roll-over risk, but they also suffered from a currency mismatch and had to rely on special facilities such as the currency swap lines between central banks (e.g., the European Central Bank, Bank of England, Swiss National Bank, and Federal Reserve), as well as on special lending programs such as the TAF. European banks were more likely to bid for TAF money because they were more severely affected by the financial crisis, given their exposure to a currency mismatch between assets and liabilities.

The rest of this paper is organized as follows: Section 2 provides the institutional details of the TAF. Section 3 describes the dataset and provides summary statistics on the evolution of the TAF over time. Section 4 displays the empirical analysis. Section 5 discusses the Federal Reserve's lending to foreign banks. Section 6 concludes.

2. THE TERM AUCTION FACILITY

Global money markets suffered serious disruptions in the summer of 2007 when the rates of interbank term loans rose to unusually high levels.² The TED spread—the difference between the three-month London interbank offered rate (LIBOR) and the three-month U.S. Treasury bill—rose from its typical level of 30 basis points to about 50 basis points and then to 200 basis points by the summer of 2007. This widening was a reason for major concern because the TED spread is an indicator of perceived credit risk in the general economy. Moreover, according to a New York Federal Reserve Bank research paper:

[T]he volume of transactions in the inter-bank market declined, and borrowers reportedly often could not obtain funds at the posted rates. Since the LIBOR affects interest rates on a wide variety of loans and securities (e.g., home mortgages and corporate loans), unusually high term rates can have disruptive effects on the economy. (McAndrews, Sarkar, and Wang 2008, 1)

The Federal Reserve responded to the disruptions in the money markets with the traditional tool of monetary policy: open market operations to maintain the effective federal funds rate near its target rate. However, despite the Federal Reserve's efforts in the overnight funding market, the rates on term loans in the interbank market kept rising. In an attempt to ease the strains in the money markets, the Federal Reserve resorted to nontraditional tools of monetary policy. Perhaps the most important tool used for this purpose was the TAF.

The TAF was introduced on December 2007 in the early stages of the financial crisis to provide Federal Reserve liquidity funding by auctioning off short-term funding without forcing banks to face the stigma of borrowing from the Federal Reserve's discount window. Under the TAF, the Federal Reserve auctioned term funds to depository institutions. All depository institutions that were eligible to borrow under the primary credit program of the Federal Reserve were eligible to participate in TAF auctions. All loans extended under the TAF were fully collateralized. The funds were allocated through an auction in which participating depository institutions placed bids specifying an amount of funds, up to a pre-specified limit, and an

² Term funding is typically made with maturity terms of one month or longer.

interest rate that they would be willing to pay for such funds. The funds were allocated beginning with the highest interest rate offered until either all funds were allocated or all bids were satisfied. All borrowing institutions paid the same interest rate: either the rate associated with the bid that would fully subscribe the auction or, in the case that total bids were less than the amount of funds offered, the lowest rate that was bid. The TAF was created under the Federal Reserve's standard discount window lending authority granted under Section 10B of the Federal Reserve Act. The auctions were administered by the Federal Reserve Bank of New York, with loans granted through the 12 Federal Reserve banks.

TAF funding supplemented the U.S. dollar funding received by global banks around the world under the central bank swap facilities between the Federal Reserve banks and the Banco Central do Brasil, Bank of Canada, Denmark's Nationalbank, Bank of England, European Central Bank, Bank of Japan, Bank of Korea, Banco de Mexico, Reserve Bank of New Zealand, Norges Bank, Monetary Authority of Singapore, Sveriges Riksbank, and Swiss National Bank.

From the first TAF auction on December 17, 2007, to the last on March 8, 2010, the Federal Reserve conducted 60 auctions. The amount of term loans auctioned was initially between \$20 billion and \$30 billion, but was later increased to between \$50 billion and \$75 billion. The size increased to \$150 billion in October 2008 and remained at that level until June 2009. During the second half of 2009 and the first three months of 2010, the amount auctioned gradually declined, and by the final auction in March 2010, only \$3.4 billion was loaned out.

Whether the TAF was effective in reducing rates in the interbank market has been debated by both academic economists and policy-makers. McAndrews, Sarkar, and Wang (2008) provide empirical evidence that the TAF has helped to ease strains in the interbank market. In contrast, according to Taylor and Williams (2009), the TAF had no impact on interest rate spreads. According to McAndrews, Sarkar, and Wang, the major problem in the money markets in 2007–2008 was lack of liquidity; hence the TAF was effective because it provided central bank liquidity to the banking system when the interbanking system collapsed. In contrast, Taylor and Williams (2009) argue that the main problem in the market was not liquidity but rather counterparty risk, which TAF funding could not have solved.

3. DATA AND SUMMARY STATISTICS

The data analyzed here come from Federal Reserve disclosure of each of the individual term loans provided under the TAF.³ The dataset lists 4,214 individual loans spanning the auctions from December 12, 2007, to March 8, 2010.

The dataset includes micro-level detailed information for each loan contract on the contract terms, the borrower's identity, and the broad categories of the securities against which the loans were made. The loan contract terms include the interest rate on the loan (in percent), the loan maturity (in days), and the loan amount (in millions of dollars). The dataset also provides information on the borrower that includes the borrower's name, city, and state.⁴ In addition, the Federal Reserve discloses information on the underlying collateral against which the loan was granted. In particular, it reports the amount of unencumbered collateral (defined as the lendable value of the borrower's collateral), as well as the broad categories of the assets used as collateral. The data comprise 12 asset-type categories: commercial loans, residential mortgages, commercial real estate loans, consumer loans, U.S. Treasury/Agency securities, municipal securities, corporate securities, mortgage-backed securities (MBSs) and collateralized mortgage obligations (CMOs) issued by government-sponsored enterprises, MBSs and CMOs issued by private corporations, ABSs, international securities, and other collateral. Finally, the dataset breaks down the dollar value of collateral by broad credit rating categories.

3.1 Loan Characteristics

Table 1 displays descriptive statistics for the main loan characteristics. The average loan amount (in millions) is \$906.1 million, and the median is \$125.0 million. The dispersion in loan amount ranges widely, from a minimum of \$1.4 million (First Merchant Bank of Indiana) to the largest loans of \$15 billion (to Bank of America, Barclays, Citibank, JP Morgan Chase, Wachovia, and Wells Fargo). The average loan term is 45.6 days and ranges from 13 days to 85 days. The average annualized interest rate is 0.900 percent and ranges from

³ The data can be downloaded at http://www.federalreserve.gov/newsevents/reform_taf.htm#datadesc.

⁴ For foreign borrowers, the dataset lists the city and state of their U.S. branch, which in most cases is New York City.

Table 1
Loan Characteristics

	Mean	25th Percentile	Median	75th Percentile	Standard Deviation	Minimum	Maximum	Observations
Loan amount (millions)	\$906.1	\$22.0	\$125.0	\$1,000.0	\$1,922.5	\$1.4	\$15,000.0	4,214
Loan term (days)	45.6	28	28	84	25.6	13	85	4,214
Interest rate	0.900%	0.250%	0.250%	1.390%	1.093%	0.200%	4.670%	4,214
Collateral (millions)	\$4,284.5	\$79.3	\$571.0	\$4,157.9	\$10,544.7	\$5.1	\$185,410.1	4,214
Loan-to-collateral ratio	0.334	0.150	0.286	0.477	0.227	0.004	1.001	4,214

0.200 percent to 4.670 percent. As I explained in Section 2, the TAF was conducted through auctions in which all successful bids were subject to the same interest rate and loan terms. Thus, although loan amounts varied across banks and over time, all banks borrowing in the same auction obtained loans with the same interest rates and loan maturities.

In addition to the loan amount, there is strong heterogeneity in the amounts and types of collateral posted by the borrowing banks. Borrowers pledged unencumbered collateral with an average value of \$4,285.4 million. Collateral values range from \$5.1 million (Timberwood Bank) to \$185,410.0 million (Bank of America); the median collateral value is \$571.0 million. I also calculated the ratio of the face amount of the loan to the value of the unencumbered collateral and report it in the last row of Table 1. As the table shows, the average loan-to-collateral ratio is 0.334 and the median is 0.286. Loan-to-collateral rates increased after the peak of the crisis as collateral values increased and haircuts on collateral declined. For example, the average loan-to-value in 2008 was 0.255 compared to 0.370 and 0.460 in 2009 and 2010, respectively. Although the loan-to-collateral ratios appear to be low and conservative, it is not clear whether these numbers are based on market values or on face values of the underlying collateral.

3.2 The Collateral Structure of TAF Loans

Next I analyzed the composition of collateral in TAF loans. Given that loan terms as well as loan rates were determined at the auction level, the only sources of interbank variation were the amount of the loan and the amount and type of the collateral. Indeed, banks pledged different types of assets as collateral for their loans, and most TAF loans were secured by numerous securities from different asset types. Table 2 provides a detailed analysis of collateral structure for the 4,214 TAF loans. The table reports summary statistics for the dollar amount (in millions) as well as the number of loans for which collateral was pledged in each asset category.

The largest collateral category (based on the dollar amount of the assets pledged) is residential mortgages. The mean amount of residential mortgages used as collateral is \$3,786.3 million, and it was used as collateral in 465 individual loans. The next largest category is ABSs, which according to the Federal Reserve definitions include

Table 2
Collateral Composition by Security Type
(Millions, except observations)

	Mean	25th Percentile	Median	75th Percentile	Standard Deviation	Minimum	Maximum	Observations
Residential mortgages	\$3,786.3	\$7.9	\$27.5	\$402.9	\$11,070.0	\$0.0	\$76,847.5	465
ABSs	\$2,562.8	\$91.5	\$780.6	\$2,513.4	\$4,486.9	\$0.4	\$25,953.7	1,301
Commercial loans	\$2,232.1	\$40.1	\$338.0	\$1,544.4	\$6,911.8	\$0.1	\$76,784.0	2,291
Consumer loans	\$1,462.5	\$8.8	\$86.1	\$1,194.1	\$3,875.5	\$0.0	\$32,679.2	1,087
Private MBSs/CMOs	\$1,154.9	\$69.6	\$241.7	\$922.5	\$2,378.8	\$0.0	\$14,599.2	1,045
Commercial real estate	\$1,091.0	\$35.9	\$104.3	\$718.9	\$2,471.5	\$0.0	\$30,469.6	1,624
Corporate	\$747.6	\$43.6	\$209.3	\$1,115.9	\$1,090.0	\$0.1	\$6,840.6	1,507
International securities	\$703.1	\$28.7	\$129.7	\$580.4	\$1,492.0	\$0.1	\$11,302.5	1,138
Agency MBSs/CMOs	\$567.9	\$12.2	\$80.2	\$498.7	\$1,681.2	\$0.0	\$26,679.8	1,151
Municipals	\$370.3	\$7.0	\$20.1	\$93.6	\$1,180.6	\$0.0	\$8,911.9	1,099
U.S. Treasury / Agency	\$348.8	\$11.3	\$48.5	\$241.6	\$968.7	\$0.0	\$8,762.4	833

securities collateralized by assets other than first-lien mortgages, including CDOs. More than 1,301 loans were backed by ABSs and the mean collateral pledged in this category is \$2,562.8 million and ranges from \$0.4 million to \$25,953.7 million.

The most popular asset class based on the number of loans that used it as collateral is commercial loans, which were used in 2,291 loans, followed by commercial real estate and corporate securities, which were used in 1,624 and 1,507 loans, respectively. Finally, U.S. Treasury/Agency securities were used in 833 loans, with a mean collateral value of \$348.8 million.

The dataset also breaks down the collateral pool by credit rating categories.⁵ Table 3 reports summary statistics for the collateral assets by the major credit rating classifications. AAA-rated U.S. Treasury/Agency securities (including agency MBSs and CMOs) amounted, on average, to \$650.3 million. The amount of other AAA-rated securities pledged as collateral was on average \$1,845.8 million per loan, and these were used in 1,859 loans. AA-rated and A-rated securities were used in 1,681 and 1,817 loans, respectively, and accounted for about \$380 million each of the collateral pool. Other rating categories include BBB-rated (mean \$238.0 million) and “other investment grade” securities (mean \$1,232.6 million).

4. EMPIRICAL ANALYSIS

4.1 Determinants of Loan Characteristics

I began the empirical analysis of TAF loans by analyzing the characteristics of the loans. The eight ordinary least-squares regressions reported in Table 4 use different specifications to predict the determinants of the loan terms. For each of the four loan determinants, I report results from regressions that do not include bank fixed-effects (between analysis) and regressions that utilize variation over time using bank fixed-effects (within analysis). As explanatory variables I used collateral dummy variables that take the value of “1” if a particular asset is included in the collateral pool and “0” otherwise. All regressions include year $\times$ month fixed-effects to account for time-varying effects.⁶

⁵ The dataset reports asset types and credit ratings separately and hence does not enable classification that is based on both credit ratings and asset class.

⁶ Although I used collateral dummy variables, the analysis yields similar results when using the actual share of collateral in each asset category.

Table 3
Collateral Composition by Credit Rating
(Millions, except observations)

	Mean	25th Percentile	Median	75th Percentile	Standard Deviation	Minimum	Maximum	Observations
AAA-rated								
U.S. Treasury/Agency and Agency MBS-CMOs	\$650.3	\$13.4	\$106.1	\$555.8	\$1,709.2	\$0.0	\$26,679.8	1,375
Other AAA-rated	\$1,845.8	\$22.2	\$352.9	\$1,801.7	\$3,532.8	\$0.0	\$22,364.7	1,859
AA-rated	\$381.6	\$7.9	\$74.2	\$370.9	\$857.8	\$0.0	\$8,505.2	1,681
A-rated	\$386.5	\$13.3	\$96.3	\$420.8	\$783.3	\$0.1	\$7,775.7	1,817
BBB-rated	\$238.0	\$12.2	\$68.5	\$296.8	\$422.9	\$0.1	\$4,881.4	1,694
Other investment-grade	\$1,232.6	\$42.3	\$295.7	\$1,088.1	\$2,714.3	\$0.0	\$22,726.2	1,417

Table 4
Determinants of Loan Terms

	Log (loan amount)		Interest Rate		Loan Term		Loan to Collateral	
	Between	Within	Between	Within	Between	Within	Between	Within
ABS dummy	1.570*** (0.084)	-0.001 (0.088)	0.008 (0.006)	-0.016 (0.020)	0.444 (1.152)	0.544 (2.708)	-0.150*** (0.010)	-0.052*** (0.019)
Commercial real estate dummy	0.446*** (0.061)	0.220*** (0.068)	-0.004 (0.004)	-0.010 (0.009)	-1.079 (0.813)	-0.680 (1.859)	-0.069 (0.007)	-0.034 (0.014)
International dummy	0.850*** (0.082)	0.047 (0.069)	-0.007 (0.007)	-0.008 (0.014)	2.417** (1.122)	-0.775 (1.967)	0.004 (0.011)	-0.005 (0.016)
Municipal dummy	-0.242*** (0.059)	-0.017 (0.059)	0.002 (0.004)	0.017 (0.011)	-1.396 (0.899)	-2.951* (1.762)	0.011 (0.008)	-0.022 (0.014)
Treasury dummy	0.279*** (0.067)	0.217*** (0.062)	-0.004 (0.005)	-0.005 (0.010)	-1.170 (0.998)	-2.762 (1.899)	0.051*** (0.009)	0.030** (0.014)
Private MBS dummy	0.881*** (0.087)	0.275*** (0.086)	0.001 (0.010)	-0.017 (0.016)	-0.214 (1.152)	-1.899 (2.268)	-.045*** (0.010)	-0.019 (0.016)
Agency dummy	0.046 (0.062)	0.048 (0.057)	-0.003 (0.004)	-0.008 (0.009)	0.088 (0.960)	-3.398** (1.673)	0.004 (0.009)	0.002 (0.013)

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Residential mortgage dummy	Log (loan amount)		Interest Rate		Loan Term		Loan to Collateral	
	Between	Within	Between	Within	Between	Within	Between	Within
Consumer loans dummy	0.035 (0.095)	0.324*** (0.108)	-0.000 (0.005)	0.024 (0.020)	-6.267*** (1.105)	-7.223*** (2.549)	0.052*** (0.012)	-0.037* (0.022)
	0.454*** (0.070)	0.203** (0.103)	-0.003 (0.004)	-0.005 (0.017)	0.959 (0.865)	-4.037* (2.401)	-0.073*** (0.008)	-0.063*** (0.020)
Corporate securities dummy	Log (loan amount)		Interest Rate		Loan Term		Loan to Collateral	
	Between	Within	Between	Within	Between	Within	Between	Within
Fixed-effects	0.111 (0.077)	0.340*** (0.082)	0.007 (0.006)	0.007 (0.015)	-1.613 (1.091)	1.740 (2.192)	0.047*** (0.011)	-0.034* (0.020)
	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank	No	Yes	No	Yes	No	Yes	No	Yes
Pseudo / Adjusted R ²	0.41	0.93	0.99	0.99	0.39	0.39	0.19	0.59
Observations	4,214	4,214	4,214	4,214	4,214	4,214	4,214	4,214

Note: Omitted collateral category is commercial loans. * = 10% significance level; ** = 5% significance level; *** = 1% significance level. Standard errors in parentheses.

The table reports results for the following loan characteristics: loan amount (in logs), interest rate, loan term, and loan-to-collateral ratio. However, it should be noted that, because TAF loans were granted at auction, the same interest rate and loan term applied to all banks participating in each auction. In contrast, the loan amount, the ratio of loan to collateral (the inverse of the loan “haircut”), and the nature of the assets pledged as collateral varied across banks within an auction. As Table 4 shows, the composition of the collateral has little explanatory power in bearing on loan outcomes. First, few if any of the explanatory variables turn out to be significant in regressions that use the interest rate or loan term as dependent variables. Second, the R-squared in the regressions shows that the addition of bank fixed-effects does not change the adjusted R-squared in the interest rate and loan term regressions, indicating that bank-specific effects had no impact on the loan rate and maturity.⁷

In contrast, collateral composition significantly affected both loan amount and loan-to-collateral ratio. As the first column shows, ABSs, commercial real estate, international securities, Treasuries, private MBSs, and consumer loans are associated with larger loans, whereas municipal securities are correlated with smaller loans. However, given that the regressions do not control for bank characteristics, it is likely that some of the collateral results are driven by omitted variables. For example, if larger banks are more likely to hold ABSs or international bonds, then the positive coefficient in column one might be capturing the simple correlation between bank size and loan amount. In an attempt to address this concern, the regression specification reported in column two adds bank fixed-effects to the analysis and hence uses variation within a bank from repeated loans in several TAF auctions over time. Indeed, as the second column of the table demonstrates, only commercial real estate, Treasury, and private MBSs survive the addition of fixed-effects and are still positive and significant. In addition, residential mortgages and corporate bonds turn out to be positive and significant when fixed-effects are added.

Turning to the last two columns of the table, I find that loans secured by ABSs obtained loan-to-collateral ratios between -0.150

⁷ The high R-squared in the interest rate is completely driven by the year $\times$ month fixed-effects since there was an overall trend of declining interest rates throughout the TAF time period.

and -0.052 lower. Likewise, consumer loans led to lower loan-to-value ratios, while loans secured by Treasuries had loan-to-collateral ratios that were higher by 0.030 . The results are consistent with the notion that haircuts on collateral are an important tool for monetary policy. This is important especially when nontraditional monetary policy is conducted through auctions in which the interest rate and loan terms do not vary across borrowers.

4.2 The Evolution of TAF over Time

Figure 1 displays the evolution of the TAF lending facility size over time. As described in Section 2, the Federal Reserve announced the offering amount in advance of each auction. As Figure 1 shows, the initial auctions were smaller, with amounts between \$20 and \$30 billion. The offering amount was raised to \$50 billion in the March 10, 2008, auction and was further increased to \$75 billion on May 5, 2008. While the amounts fluctuated between \$25 billion and \$75 billion in August and September 2008, the lending facilities increased dramatically to \$150 billion on October 6, 2008, during the peak of the financial crisis, and remained at that level until the end

Figure 1
Facility Size

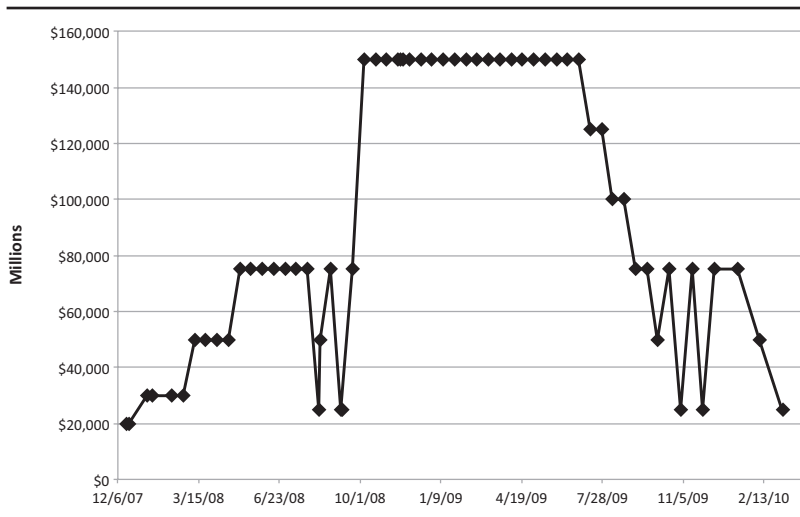
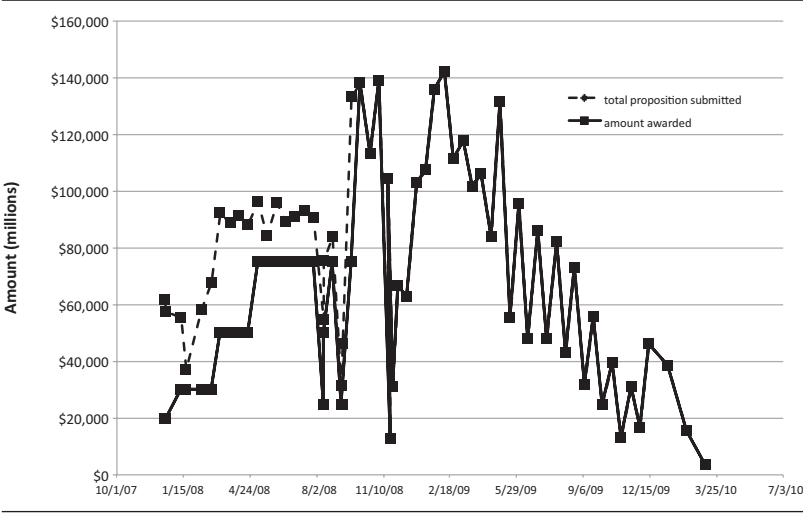


Figure 2
Total Proposition Submitted and Amount Awarded



of June 2009. The offering amount gradually declined to \$125 billion and then \$100 billion in July and August 2009, and later fluctuated between \$75 billion and \$25 billion. The final auction was held on March 8, 2010 for \$25 billion.

Although Figure 1 plots the offering amounts in each of the auctions and hence the potential (the supply of funds), it does not show the amount demanded by banks that submitted bids for TAF money or the amount that was actually loaned. Figure 2 supplements the information in Figure 1 by plotting both the total amount of proposition submitted by banks (the demand for loans) and the amount that was actually awarded.⁸ As the figure illustrates, the demand for funds exceeded the supply from the first auction in December 2007 until the auction of September 22, 2008. For example, on December 12, 2007, the offering amount by the Federal Reserve was \$20 billion, but the amount demanded by the 93 banks that submitted bids

⁸ I use the notion of demand and supply here fairly loosely. Of course, given the auction structure, there was no excess demand at a given rate.

was \$61.6 billion. In the auction of September 22, 2008, the facility was increased to \$75 billion, but 85 banks submitted bids totaling \$133.6 billion.

Following the Federal Reserve's increase of the facility size to \$150 billion in October 2008, the amount of propositions submitted by banks dropped below the amount offered by the Federal Reserve until the end of the TAF. In the October 8, 2008, auction—the first auction with a facility size of \$150 billion—71 banks submitted bids totaling \$138.1 billion. The largest amount requested by banks was \$142.5 billion, when 117 banks participated in the auction of February 9, 2009. The largest number of banks participating in a single auction was 124 (May 4, 2009), compared to only 16 banks on November 24, 2008.

4.3 TAF Lending to Foreign Banks

Table 5 lists the number of loans, average loan size, and total amount loaned in each month from the first auction in December 2007 through the final auction in March 2010. The table further breaks down monthly lending by whether the borrowing bank is a U.S. depository institution or a foreign bank.⁹ Overall, foreign banks received 58 percent of the total amount lent over time, with a total amount of \$2,214,688 million, compared to only \$1,603,723 for U.S. banks. From December 2007 through most of 2008, foreign banks accounted for the vast majority of the lending, with amounts that were two to four times the total lending to U.S. banks. However, during the peak of the crisis and following the collapse of Lehman Brothers, and especially in October and November 2008, lending to U.S. banks exceeded borrowing by foreign banks. By April 2008 and until the end of the TAF, foreign banks again accounted for the majority of TAF lending.

Table 6 and Figure 3 present the 50 largest borrowers (measured by the total amount borrowed). For each of the largest borrowers, Table 6 lists the total loan amount, the average loan size, the number of loans obtained under the TAF, and the home country of the bank. Likewise, Figure 3 displays the largest 50 borrowers in a bar chart. As both Table 6 and Figure 3 show, UK-based Barclays is the largest borrower, with a total amount of \$232,283 million in 49 loans, followed by Bank

⁹ Foreign banks were eligible to participate in the TAF through their agencies or branches in the United States.

Table 5
Evolution of the TAF over Time: Domestic Banks vs. Foreign Banks

	Domestic Banks			Foreign Banks		
	Number of Loans	Average Loan Size	Total Amount	Number of Loans	Average Loan Size	Total Amount
December 2007	13	\$374.9	\$4,873	42	\$836.4	\$35,127
January 2008	46	\$460.3	\$21,172	35	\$1,109.4	\$38,828
February 2008	41	\$423.6	\$17,368	34	\$1,253.9	\$42,632
March 2008	45	\$615.2	\$27,683	41	\$1,763.8	\$72,318
April 2008	32	\$487.5	\$15,560	44	\$1,918.2	\$84,400
May 2008	76	\$729.2	\$55,418	56	\$1,669.0	\$94,581
June 2008	57	\$848.0	\$48,335	50	\$2,033.3	\$101,665
July 2008	105	\$821.2	\$86,230	79	\$1,756.6	\$138,770
August 2008	73	\$912.7	\$66,627	55	\$1,515.9	\$83,373
September 2008	40	\$1,064.9	\$42,595	46	\$1,791.4	\$82,405
October 2008	86	\$1,730.4	\$148,818	61	\$1,681.1	\$102,545
November 2008	113	\$1,394.4	\$157,561	60	\$1,430.9	\$85,856
December 2008	124	\$608.2	\$75,412	61	\$1,602.9	\$97,776
January 2009	185	\$1,062.8	\$196,617	89	\$1,687.2	\$150,160
February 2009	150	\$1,025.6	\$153,838	66	\$1,519.7	\$100,302

An Empirical Analysis of the Fed's Term Auction Facility

March 2009	149	\$689.6	\$102,743	71	\$1,643.3	\$116,672
April 2009	136	\$608.4	\$82,743	67	\$1,602.8	\$107,386
May 2009	159	\$568.8	\$90,446	61	\$1,584.1	\$96,633
June 2009	140	\$258.5	\$36,195	62	\$1,723.5	\$107,416
July 2009	210	\$240.1	\$50,417	87	\$1,908.8	\$166,062
August 2009	132	\$192.2	\$25,371	56	\$1,624.5	\$90,974
September 2009	109	\$210.2	\$22,912	49	\$1,321.6	\$64,759
October 2009	116	\$192.5	\$22,326	42	\$1,001.7	\$42,070
November 2009	104	\$160.7	\$16,713	31	\$889.0	\$27,558
December 2009	110	\$155.8	\$17,140	41	\$1,112.8	\$45,625
January 2010	98	\$111.2	\$10,893	23	\$1,201.7	\$27,638
February 2010	89	\$64.8	\$5,763	14	\$690.2	\$9,663
March 2010	49	\$39.1	\$1,915	4	\$373.8	\$1,495
December 2007 – March 2010	2,787	\$575.4	\$1,603,723	1,427	\$1,552.0	\$2,214,688

Table 6
50 Largest Borrowers

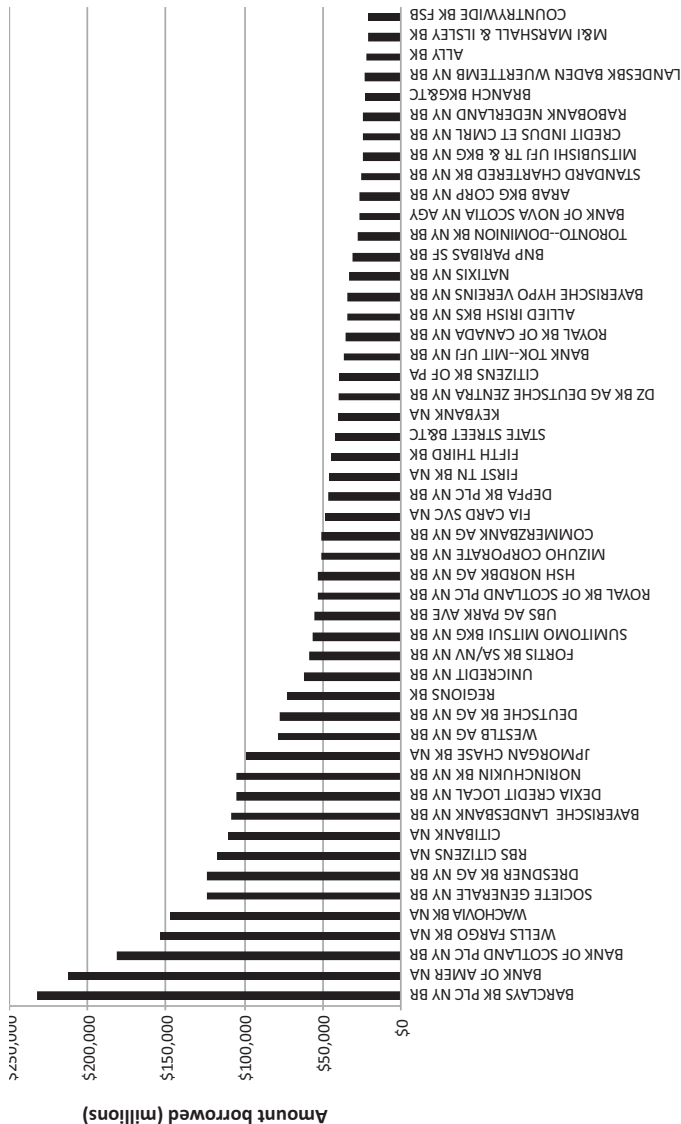
Rank	Bank	Total Loan Amount (Millions)	Average Loan Size (Millions)	Number of Loans	Country
1	Barclays	\$232,283	\$4,740.5	49	UK
2	Bank of America	\$212,617	\$14,144.5	15	U.S.
3	Royal Bank of Scotland	\$180,920	\$4,523.0	40	UK
4	Wells Fargo	\$153,953	\$8,102.9	19	U.S.
5	Wachovia	\$147,025	\$6,392.4	23	U.S.
6	Société Générale	\$124,377	\$4,442.0	28	France
7	Dresdner Bank	\$123,328	\$3,333.2	37	Germany
8	RBS Citizens	\$117,510	\$4,039.7	29	U.S.
9	Citibank	\$110,350	\$4,244.2	26	U.S.
10	Bayerische Landesbank	\$108,190	\$2,924.1	37	Germany
11	Dexia	\$105,167	\$4,382.0	24	Belgium
12	Norinchukin Bank	\$105,010	\$3,281.6	32	Japan
13	JP Morgan Chase	\$98,782	\$4,939.1	20	U.S.
14	WestLB	\$78,406	\$2,178.0	36	UK
15	Deutsche Bank	\$76,882	\$3,844.1	20	Germany
16	Regions Bank	\$72,444	\$3,149.7	23	U.S.
17	Unicredit	\$62,210	\$2,592.1	24	Italy
18	Fortis Bank	\$58,650	\$1,725.0	34	Belgium
19	Sumitomo	\$56,400	\$1,151.0	49	Japan
20	UBS	\$55,500	\$3,468.8	16	Switzerland
21	Bank of Scotland	\$53,500	\$8,916.7	6	UK
22	HSH Nordbank	\$52,550	\$1,545.6	34	Germany
23	Mizuho	\$51,284	\$1,091.2	47	Japan
24	Commerzbank	\$51,161	\$2,046.5	25	Germany
25	Debfa Bank	\$46,798	\$2,600.0	18	Ireland
26	First Tennessee	\$45,419	\$1,297.7	35	U.S.
27	Fifth Third Bank	\$44,478	\$1,533.7	29	U.S.

(continued)

Table 6
(continued)

Rank	Bank	Total Loan Amount (Millions)	Average Loan Size (Millions)	Number of Loans	Country
28	State Bank	\$42,000	\$2,100.0	20	U.S.
29	Keybank	\$40,214	\$1,827.9	22	U.S.
30	DZ Bank	\$39,477	\$1,038.9	38	Germany
31	Citizens Bank	\$39,380	\$1,790.0	22	U.S.
32	Bank of Tokyo Mitsubishi	\$35,900	\$1,087.9	33	Japan
33	Royal Bank of Canada	\$34,734	\$1,085.4	32	Canada
34	Allied Irish	\$34,700	\$1,927.8	18	Ireland
35	Bayerische Hypo	\$34,390	\$802.1	43	Germany
36	Natixis	\$32,817	\$1,131.6	29	France
37	BNP Paribas	\$31,275	\$1,303.1	24	France
38	Toronto Dominion	\$27,465	\$1,445.5	19	Canada
39	Bank of Nova Scotia	\$26,465	\$661.6	40	Canada
40	Arab Banking Corporation	\$26,350	\$572.8	46	Bahrain
41	Standard Chartered	\$25,100	\$896.4	28	UK
42	Mitsubishi UFJ	\$24,457	\$444.7	55	Japan
43	Crédit Industriel et Commercial	\$23,910	\$703.2	34	France
44	Rabobank	\$23,751	\$2,375.0	10	Netherlands
45	BB&T	\$22,700	\$2,522.2	9	U.S.
46	Landesbank Baden	\$22,580	\$1,411.3	16	Germany
47	Ally Bank	\$21,600	\$1,963.6	11	U.S.
48	Marshall & Ilsley	\$21,045	\$841.8	25	U.S.
49	Countrywide	\$20,750	\$6,916.7	3	U.S.
50	Union Bank	\$20,100	\$1,182.4	17	U.S.

Figure 3
Largest TAF Borrowers



of America, with a total amount of \$212,617 million in 15 loans. The next largest borrowers are Royal Bank of Scotland (\$180,920 million), Wells Fargo (\$153,953 million), and Wachovia (\$147,025 million). Furthermore, out of the 10 largest borrowers, five are foreign banks, and out of the 50 largest borrowers, 33 are from foreign countries.

4.4 The Collateral Structure of Foreign Banks

As I argued previously, the loan term and interest rate were determined at the auction level regardless of the identity of the borrowing bank participating in the auction. In contrast, the size of the loan and the collateral pledged by the bank were the only margins that both the bank and the Federal Reserve could adjust at the loan level. Given the importance of collateral in general, and in particular given the unique setup of the TAF, I compared the collateral structure of domestic banks to the collateral used by foreign banks. Table 7 presents summary statistics on the use of collateral by domestic and foreign banks. For each asset category reported by the Federal Reserve, the table lists the mean share of the asset category in the collateral pool, the standard deviation of the share, and the number of loans pledging that asset as part of their collateral.

The summary statistics are reported separately for domestic and foreign banks, and a two-sample T-test for equal means is also presented. As Table 7 shows, foreign banks rarely used residential mortgages as collateral; only 5 loans made to foreign banks were secured by residential mortgages, compared to 460 loans to domestic banks. Conversely, ABSs were used in 983 loans to foreign banks, compared to 318 loans to domestic banks. Furthermore, ABSs account for a larger share of the overall collateral pool in foreign banks (9.323 versus 0.151, significant at the 1 percent level). As in the case of residential mortgages, foreign banks rarely used consumer loans (only 44) as collateral, while U.S.-based banks used consumer loans in 1,043 loans. Private MBSs and CMOs were more prevalent among foreign banks (although their share is slightly lower than in U.S. banks), and commercial real estate loans were used in only 222 foreign loans. Other significant differences between foreign and domestic banks are that foreign banks were less likely to use Agency MBSs and CMOs, U.S. Treasury / Agency securities, and U.S. municipal bonds and were much more likely to pledge international securities as collateral.

Table 7
Collateral Share: Domestic Banks vs. Foreign Banks

	Domestic Banks			Foreign Banks			Two-Sample T-test
	Mean	Standard Deviation	Number of Loans	Mean	Standard Deviation	Number of Loans	
Residential mortgages	0.280	0.01	460	0.733	0.01	5	-3.37
Asset-backed securities	0.151	0.01	318	0.323	0.01	983	-11.34
Commercial loans	0.470	0.01	1,656	0.427	0.02	635	2.83
Consumer loans	0.358	0.01	1,043	0.477	0.07	44	-2.15
Private MBSs/CMOs	0.183	0.01	349	0.141	0.01	696	3.19
Commercial real estate	0.563	0.01	1,402	0.159	0.01	222	20.37
Corporate securities	0.192	0.01	428	0.263	0.01	1,079	-4.74
International securities	0.133	0.02	194	0.208	0.01	944	-3.83
Agency MBSs/CMOs	0.392	0.01	673	0.225	0.01	478	8.82
Municipals	0.233	0.01	611	0.055	0.01	488	12.26
U.S. Treasury/Agency	0.238	0.01	384	0.149	0.01	449	0.089

Table 8 supplements the results in Table 7 using regression analysis of the collateral composition of foreign banks. For each of the main asset categories, I use two dependent variables. The first dependent variable is a dummy variable for whether a security type is pledged as collateral for a particular loan. This variable captures the average tendency to use an asset as collateral. The second dependent variable is the actual share of the collateral in each asset group conditional on the asset being used as collateral. That is, while the first variable uses information on all loans, the second variable captures only the cross-sectional variation within an asset category conditional on its use. All regressions include year $\times$ month fixed-effects as well as a control for the loan amount (in logs) and a dummy variable that takes the value of "1" for foreign banks, and "0" otherwise. Regressions for which the dependent variable is a dummy variable are estimated using probit where marginal effects are reported. Table 8 confirms the univariate findings. Foreign banks are more likely to use ABSs, international assets, and Treasuries, and are less likely to use commercial real-estate.

5. WHY FOREIGN BANKS?

Given that more than 58 percent of TAF lending went to foreign banks, it is important to understand why the Federal Reserve allocated its lending to foreign banks that are not under its direct supervision. In addition, the information contained in the collateral structure of these banks suggests that the collateral pledged by the foreign banks consisted of harder-to-value, riskier assets such as ABSs. In particular, the ABSs held by the foreign banks are—according to the data definitions provided by the Federal Reserve Board—collateralized debt obligations secured by ABSs, which were the securitized assets that declined the most during the crisis (Benmelech and Dlugosz 2009).

5.1 Exposure to Asset-Backed Securities

One potential explanation for both the elevated lending to foreign banks and their use of ABSs as collateral is that foreign banks were hit harder than U.S. banks and hence required more liquidity. Given that many foreign banks had exposure to assets that deteriorated in value (mostly ABSs and CDOs), these banks had weaker balance sheets.

Table 8
Collateral Composition of Foreign Banks

	Asset-Backed Securities		Commercial Real Estate		International Securities		Treasury Securities	
	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive
Log (loan amount)	0.090*** (0.004)	0.025*** (0.005)	0.034*** (0.004)	-0.072*** (0.003)	0.018*** (0.004)	-0.008* (0.005)	0.006* (0.004)	-0.064*** (0.005)
Foreign dummy	0.393*** (0.018)	0.143*** (0.015)	-0.403*** (0.015)	-0.231*** (0.018)	0.611*** (0.017)	0.136*** (0.021)	0.178*** (0.016)	0.082*** (0.015)
Fixed-effects								
year × month	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo / Adjusted R2	0.39	0.13	0.11	0.41	0.39	0.09	0.05	0.26
Observations	4,214	1,301	4,214	1,624	4,214	1,138	4,214	833

Note: * = 10% significance level; ** = 5% significance level; *** = 1% significance level. Standard errors in parentheses.

However, foreign banks were not the only banks exposed to ABS CDOs. Table 9 provides information on aggregate crisis-related write-downs as well as write-downs for some of the largest financial institutions in the world.¹⁰ As the table demonstrates, as of October 2008, Citigroup had written down \$34.1 billion as a result of exposure to ABS CDOs, followed by Merrill Lynch (\$26.1 billion) and Bank of America (\$9.1 billion). As of February 2009, the total value of write-downs by financial institutions around the world was \$520.1 billion, out of which \$218.2 billion were due to exposure to ABS CDOs, representing 42 percent of total write-downs by the financial sector. Write-downs driven by ABS CDOs were more than four times the size of corporate credit-related write-downs. North American banks accounted for the largest share of ABS CDO write-downs, followed by European banks. The European bank with the largest exposure to ABSs was UBS (\$21,870 million), followed by Fortis Bank (\$4,359 million), Royal Bank of Scotland (\$3,609 million), and Deutsche Bank (\$2,092 million).

If banks that had worse balance sheets because of exposure to structured finance products were more likely to participate in the TAF, we should expect the institutions with the most exposure to ABS CDOs to borrow more under the TAF and pledge those securities as collateral. However, mere exposure to structured finance assets does not seem to explain either the amount of borrowing or the collateral used by the banks.

Table 10 lists the 50 banks that pledged the largest amounts of ABSs per loan. As the table clearly shows, and consistent with Tables 7 and 8, most of the banks and financial institutions that pledged ABSs as collateral were foreign—mostly European—banks. For example, the bank that pledged the largest amount of ABSs for a given loan was Société Générale (France), followed by Norinchukin Bank (Japan), Dexia (Belgium), Barclays (UK), and UBS (Switzerland). Among the 10 banks that pledged the largest amounts of ABSs as collateral, only two were American banks (State Street and U.S. Central Federal Credit Union).

In contrast, the American banks that had the largest exposure and write-downs because of ABS CDOs—Citigroup and Bank of America—had only modest borrowing secured by ABSs. For

¹⁰ The data are from Creditflux, a leading information source globally for credit trading and investing, credit derivatives, structured credit, distressed credit, and credit research. This table is based on the results presented in Benmelech and Dlugosz (2009).

Table 9
ABS CDOs and Write-Downs

Panel A: Crisis-Related Write-Downs for Selected Banks (Millions)

	ABS CDOs	Corporate Credit	RMBS	Other	Total
<i>North American Banks</i>					
Bank of America	\$9,089	\$932	–	\$2,834	\$12,855
Bear Stearns	\$2,300	–	–	–	\$2,300
Citigroup	\$34,106	\$4,053	\$1,319	\$15,904	\$55,382
Goldman Sachs	–	\$4,100	\$1,700	\$1,400	\$7,200
JP Morgan	\$1,300	\$5,467	\$5,305	–	\$12,072
Chase					
Lehman Brothers	\$200	\$1,300	\$4,100	\$3,400	\$9,000
Merrill Lynch	\$26,100	\$2,845	\$12,998	\$13,125	\$55,068
Morgan Stanley	\$7,800	\$3,810	\$3,781	\$1,992	\$17,383
<i>European Banks</i>					
Credit Suisse	\$3,427	\$3,057	\$530	\$2,523	\$9,357
Deutsche Bank	\$2,092	\$5,820	\$3,386	\$3,677	\$14,974
Fortis Bank	\$4,359	\$3,660	\$144	–	\$8,163
ING	\$565	–	\$8,028	\$25	\$8,617
Royal Bank of Scotland	\$3,609	\$1,849	\$2,566	\$4,122	\$12,146
UBS	\$21,870	\$348	\$1,716	\$13,871	\$37,805
<i>Asian and Emerging Market Banks</i>					
Aozora Bank	\$510	–	–	–	\$510
Mitsubishi UFJ	\$360	\$2,348	\$921	\$11	\$3,640
Mizuho	\$3,898	\$629	\$2,539	\$584	\$7,650
National	\$670	–	–	–	\$670
Australia Bank					
Sumitomo Mitsui	\$562	–	–	–	\$562

Panel B: Aggregate Crisis-Related Write-Downs (Millions)

	ABS CDOs	Corporate Credit	RMBS	Other	Total
North American	\$84,319	\$23,702	\$42,272	\$59,011	\$209,305
European	\$63,464	\$18,579	\$26,423	\$62,634	\$171,100
Asian & Emerging Markets	\$9,358	\$4,724	\$5,728	\$3,743	\$23,553
TOTAL	\$218,216	\$53,324	\$84,810	\$163,735	\$520,084

Table 10
Banks Pledging Most Asset-Backed Securities

Rank	Bank	ABS Amount (Millions)	Country
1	Société Générale	\$16,532.0	France
2	Norinchukin Bank	\$14,607.9	Japan
3	Dexia	\$11,429.7	Belgium
4	Barclays	\$9,805.1	UK
5	UBS	\$9,419.0	Switzerland
6	State Street	\$9,125.6	U.S.
7	Royal Bank of Scotland	\$8,227.8	UK
8	Bank of Scotland	\$6,518.5	UK
9	U.S. Central Federal Credit Union	\$5,293.2	U.S.
10	Bank of Tokyo Mitsubishi	\$4,650.5	Japan
11	Depfa Bank	\$3,405.0	Ireland
12	Abbey National Treasury	\$3,143.3	UK
13	Bayerische Landesbank	\$2,605.4	Germany
14	Deutsche Bank	\$2,590.0	Germany
15	Landesbank Baden	\$2,505.4	Germany
16	WestLB	\$2,096.3	UK
17	HSH Nordbank	\$2,028.8	Germany
18	Calyon	\$1,904.7	France
19	Shinkin Central Bank	\$1,824.0	Japan
20	DZ Bank	\$1,496.5	Germany
21	Skandinaviska Enskilda	\$1,444.3	Sweden
22	Dresdner Bank	\$1,436.3	Germany
23	PNC Bank	\$1,390.9	U.S.
24	Natixis	\$1,308.3	France
25	Sumitomo	\$959.0	Japan
26	Washington Mutual	\$920.2	U.S.
27	Erste Bank	\$884.1	Austria
28	Standard Chartered	\$869.3	UK
29	Fortis Bank	\$838.4	Belgium
30	Royal Bank of Canada	\$802.0	Canada
31	Allied Irish	\$770.5	Ireland
32	HSBC	\$761.0	UK
33	Citibank	\$760.8	U.S.
34	Fifth Third Bank	\$736.8	U.S.
35	Bank of Montreal	\$667.7	Canada
36	Commerzbank	\$565.0	Germany
37	Mizuho	\$510.3	Japan
38	Metlife	\$504.3	U.S.
39	Sallie Mae	\$503.0	U.S.

(continued)

Table 10
(continued)

40	Zions First National Bank	\$426.3	U.S.
41	RBC Bank	\$417.5	U.S.
42	Advanta	\$236.6	U.S.
43	Crédit Industriel et Commercial	\$226.3	France
44	Ally Bank	\$194.8	U.S.
45	Mitsubishi UFJ	\$192.1	Japan
46	First Hawaiian Bank	\$155.0	U.S.
47	Bank Hapoalim	\$149.3	Israel
48	California National Bank	\$113.0	U.S.
49	Norddeutsche Landesbank	\$92.2	Germany
50	M&T Bank	\$89.7	U.S.

example, as Table 9 demonstrates, Citibank had the largest write-downs due to ABS CDOs borrowed against \$760.8 million of ABSs, compared to Société Générale with \$16,352.0 million and UBS with \$9,419.0 million. Thus, despite their exposure to ABSs and structured finance assets, American banks were less likely to obtain term funding through the TAF or to pledge ABSs as collateral.

5.2 The European Banks' Dollar Crisis

Another explanation for the large number of loans made to foreign banks is that these banks suffered from a currency mismatch in their balance sheets. Many foreign banks were active players in the creation and issuance of structured finance products. As money markets came to a halt, these banks required financing to meet the needs of rolling over their short-term liabilities. Foreign banks were also subject to a currency mismatch in managing their assets and liabilities. Although the main source of funding for some of these banks was demand deposits and other forms of credit in their home countries that were denominated in their home currencies (mostly the British pound and the euro), many European banks issued liabilities in U.S. money markets that were denominated in the U.S. dollar. Thus, not only were foreign banks subject to a roll-over risk, but they also suffered from a currency mismatch and had to rely on special facilities such as the currency swap lines between central banks, including the European

Central Bank, Bank of England, Swiss National Bank, and Federal Reserve, as well as special lending programs such as the TAF.

Foreign banks played an important role in American financial markets during the years leading up to the financial crisis. According to Shin (2011, p. 3): "The U.S. dollar-denominated assets of banks outside the United States are comparable in size to the total assets of the U.S. commercial banking sector, peaking at over \$10 trillion prior to the crisis. The [Bank for International Settlements] banking statistics reveal that a substantial portion of external U.S. dollar claims are the claims of European banks against U.S. counterparties." Likewise, studies from the Bank for International Settlements by Baba, McCauley, and Ramaswamy (2009) and McGuire and von Peter (2009) show that U.S. dollar wholesale deposits and money market funds were an important source of funding for European global banks in the years leading to the crisis.

Moreover, Shin (2011) provides evidence that European global banks raised their assets in the United States in the years leading to the crisis, increasing their claims against U.S. borrowers by almost 40 percent from 2005 to 2007. Although European banks had access to U.S. credit markets, they still had their core funding in their home countries in European currencies. This currency mismatch between their assets—many in the form of private-label ABSs and CDOs—and their liabilities is what made them vulnerable to the halt in U.S. short-term lending markets.

According to this view, European banks were more likely to bid for TAF money because they were affected more severely by the financial crisis, given their exposure to a currency mismatch between assets and liabilities. Shin draws similar conclusions from the fact that a large fraction of TAF lending went to European banks. He writes:

Two features stand out from the charts in Figure 11. The first is that the non-U.S. banks' total borrowing is large relative to U.S. banks' borrowing. The relative magnitudes are roughly comparable at the peak. The second feature that stands out is the preponderance of European banks in the list of non-U.S. recipients of TAF funding. The UK banks are especially prominent, led by Barclays, RBS, and Bank of Scotland. The list also reveals some unlikely names, such as Norinchukin (the Agricultural Savings Bank of Japan) and the German landesbanks, who are likely to have ventured into U.S. dollar lending in their search for higher yielding assets to deploy their large domestic deposit bases. (Shin 2011, 17–18)

Thus, the elevated lending to foreign banks and in particular to European banks likely reflects their prominent role in the U.S. financial system, their involvement in the structured finance markets (especially the private-name ABSs and CDOs), and the currency mismatch in their balance sheets.

6. CONCLUSION

This paper provides detailed analysis of the TAF plan using micro-level data on the individual loans, the assets posted as collateral, and the identity of the borrowing banks. I found that foreign banks accounted for about 60 percent of TAF lending and that the largest borrowers in the program were mostly European banks. Moreover, most of the banks that pledged ABSs as collateral were European banks.

I argue that the main reason for the large number of loans made to foreign banks was the currency mismatch in European banks' balance sheets. Many European banks were active players in the creation and issuance of structured finance products, and as money markets came to a halt, these banks required financing to roll over their short-term liabilities. These European banks also faced a currency mismatch in managing their assets and liabilities. Although the main source of funding for some of these banks was based on demand deposits and other forms of credit in their home countries that were denominated in their home currencies, they issued liabilities in U.S. money markets that were denominated in the U.S. dollar. Thus, foreign banks not only were subject to a roll-over risk but also suffered from a currency mismatch and had to rely on special facilities such as the TAF.

The data illustrate the scale of the operation of foreign—in particular European—banks in U.S. financial markets. What precise role do European banks play in the American economy? What led to their involvement in the U.S. financial system? These questions are left for future research.

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Comment

Simon Gilchrist

Efraim Benmelech's paper presents a welcome overview and analysis of the Federal Reserve's Term Auction Facility (TAF) based on the micro lending data recently made available by the Federal Reserve. The paper documents both the size of loans received and the forms of collateral that were pledged. It also highlights the fact that foreign banks were large recipients of TAF funds throughout the financial crisis.

The TAF was one of many policy initiatives put in place by the Federal Reserve to combat financial market turmoil since the onset of the financial crisis. Some of these programs represent conventional monetary policy measures, aimed directly at increasing overall market liquidity and reducing interest rates via the purchase of safe-asset securities such as Treasury bonds, mortgage-backed securities, and agency debt. In the early stages of the crisis, interest rates were reduced via standard open market operations combined with reductions in the primary credit rate obtained through borrowing at the discount window. In later stages of the crisis, with the effective Fed funds rate at the zero lower bound, the Federal Reserve conducted large-scale asset purchases (quantitative easing) to reduce long-term interest rates relative to short-term interest rates. It also provided extensive guidance on the future path of short-term interest rates.

In contrast, other programs pursued by the Federal Reserve are better viewed as unconventional, in the sense that they are more closely linked to credit than to monetary policy. These include the extension of liquidity to primary dealers (through the Term Securities Lending Facility and the Primary Dealer Credit Facility), the provision of liquidity to the private sector (through direct lending

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programs such as the asset-backed commercial paper/money market funds liquidity facility, the commercial paper funding facility, the money market investor funding facility, and the term asset-backed securities loan facility), and the direct bailout of financial institutions such as Bear-Stearns and AIG.

The TAF is a straightforward extension of discount window lending and therefore should be understood as part of the traditional tool kit of the monetary authority. It differed from discount window lending in the anonymous nature of the auction, which was designed to reduce any perceived stigma associated with such borrowing. It also potentially differed from discount window lending in that the primary credit rate was the minimum bid rate but not necessarily the effective borrowing rate. Thus, the TAF gave the Federal Reserve the potential to “price-discriminate” between the two forms of borrowing. Indeed, one of the interesting facts documented in the paper is that the auctions were over-subscribed prior to September 2008 but under-subscribed thereafter. In effect, prior to September 2008, the Fed controlled the aggregate quantity of borrowing and let the price adjust to market conditions. Because the borrowing rate was higher than the primary (minimum bid) rate during this period, banks effectively viewed discount window borrowing as carrying a stigma. Indeed, the difference between the bid rate and the primary rate provides a lower bound on the premium placed on anonymity during this time period. Post-September 2008, the Fed set the price at the primary rate and effectively let banks borrow freely at that rate via the TAF program.

As emphasized by Benmelech’s paper, another important aspect of the TAF program is the amount and type of collateral that was posted. The paper documents that the amount and type is bank-specific, with foreign banks more likely to post what appears to be riskier collateral. Because one cannot observe the haircuts applied to different asset classes when determining eligible collateral, it is not really feasible to infer the risk structure of such loans based on posted collateral. The paper also suggests that the collateral requirements may be an important tool that the Fed could use in its conduct of monetary policy. Two reasons for caution emerge: First, the available collateral, and therefore haircuts, are determined in the same manner as borrowing at the discount window; and both are therefore set by the individual Reserve Banks within whose district a bank would

borrow. It is unlikely that the Federal Reserve actively manipulated these requirements from one auction to the next or sought to apply haircuts differentially across foreign versus domestic banks. Second, in nearly all cases, the amount of collateral posted greatly exceeds the amount borrowed. Thus, it is difficult to view the collateral postings as representative of the marginal value of an additional unit of collateral that may vary systematically across banks. Indeed, differences in the type of collateral posted across foreign versus domestic banks likely reflect the type of assets held by the banks. Thus, for example, the relatively low usage of residential mortgages as collateral by foreign banks simply reflects the fact that these banks are not actively engaged in the residential mortgage business in the United States.

The main thrust of the paper is to highlight the importance of borrowing by foreign banks under the TAF program. Any foreign bank that is regulated as a foreign branch or U.S. subsidiary is eligible to borrow at the discount window and therefore through the TAF program. As emphasized in the paper, the fact that foreign banks found it desirable to do so must, to a great extent, reflect the overall need for dollar funding in international money markets. Such funding became increasingly scarce as the interbank markets ceased to function during the depth of the financial crisis. The extent of borrowing by foreign banks may also indicate that, relative to the alternative, the TAF program offered a good deal in terms of lending against collateral that would otherwise not be accepted in the marketplace or, for that matter, as collateral by the European Central Bank during this time period.

From this perspective, it is useful to ask what are the consequences and policy tradeoffs associated with the TAF program. The Federal Reserve clearly decided that providing dollar funding was an important tool in its tool kit during the crisis. Indeed, the provision of dollar funding through swap lines to the European Central Bank and other central banks accounted for the largest share of the Federal Reserve's balance sheet at the height of the crisis. Are swap lines the desirable alternative? To the extent that haircuts were not sufficient, the heavy use of the TAF program by foreign banks likely exposed the Federal Reserve to additional risk from European banks. Swap lines reduce the Federal Reserve's exposure to foreign-bank risks but increase its exposure to sovereign risk. The costs and benefits of such a tradeoff are highly relevant to policymakers in today's environment where markets perceive little difference between bank and sovereign risk.

Comment

Ross Levine

During an extraordinary period in the economic and financial history of the United States, a period when the familiar tools of monetary policy did not function, the Federal Reserve developed and implemented new procedures for addressing the liquidity problems plaguing banks. In particular, by the end of 2007, banks had become worried about the creditworthiness of other banks, uncertain about their own ability to borrow in the future, and consequently exceedingly reluctant to lend to other banks. This breakdown in interbank lending disrupted the normal functioning of open market operations, which relies on banks that sell securities to the Federal Reserve to then lend excess funds to other banks instead of simply accumulating excess reserves at the Fed.

With one monetary policy tool malfunctioning, the Fed attempted to employ another traditional tool: lending funds directly to banks through the discount window. But the stigma associated with borrowing from the Fed—the view that only weak banks use the discount window—meant that banks were disinclined to use the discount window, hindering the efficacy of this monetary policy tool as well. Thus, the Fed faced a challenge: it viewed the burgeoning financial crisis as emanating from the liquidity problems plaguing banks, but its traditional tools for addressing the problem did not work. So it created new tools.

One of the first new tools that the Fed developed to ease liquidity problems was the Term Auction Facility (TAF), which started in December of 2007 and ceased operations in March of 2010. At its peak, the TAF was almost a \$500 billion item on the Fed's balance sheet. Under the TAF, the Fed would choose a quantity of money to auction to banks. All banks that were eligible to borrow under the Fed's traditional

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primary credit program were also eligible to participate in the new TAF. Banks would submit quantity /interest rate offers. Subject to its traditional collateral requirements, TAF funds would then be allocated in a mechanical manner beginning with those banks offering the highest rates. Initially, the Fed kept the identity of borrowing banks secret so as to avoid any stigma associated with borrowing from the Fed.

In a valuable contribution to understanding Federal Reserve policies during the recent financial crisis, Efraim Benmelech provides detailed information on how individual banks used the TAF program. In particular, Benmelech documents that

- Almost 60 percent of TAF funds flowed to foreign banks.
- The foreign banks pledged a larger proportion of asset-backed securities as collateral than did domestic banks.

Benmelech also provides suggestive evidence that foreign banks were more aggressive in bidding for TAF funds than domestic banks were; the foreign banks needed to meet their dollar-denominated liabilities and were more limited in their options for obtaining dollar funds. Benmelech does a superb job of documenting which banks used the TAF and the conditions of that use. His work provides vital inputs into the long process of evaluating the Fed's response to the crisis.

Many questions remain. In terms of Benmelech's specific analyses, while it is interesting to know that more than half of TAF funds flowed to foreign banks, what are the policy implications of this observation? And while it is noteworthy that foreign banks pledged different types of collateral than those pledged by U.S. banks, what does this mean for bank behavior? At a broader level, did the TAF ease liquidity constraints and, if so, was it a cost-effective tool for achieving this goal?

Moreover, since the TAF was only one of the many new tools developed by the Fed in response to the novel circumstances of the period from 2007 to 2009, it should be evaluated within the broader context of the Fed's overall response to the crisis. Indeed, the massive purchase of agency and agency-guaranteed mortgage-backed securities was several times larger than the TAF; and other programs—such as the term asset-backed securities loan facility and the central bank liquidity swaps—were more narrowly targeted at specific segments of the financial system. Thus, looking at the TAF in particular might yield misleading information about the Fed's overall strategy for addressing the problems facing banks during the period from 2007 through 2010.