Online Appendices for:
Discount Window Stigma
During the 2007-2008 Financial Crisis [*]

Olivier Armantier[†]   Eric Ghysels[‡]   Asani Sarkar[†]   Jeffrey Shrader[§]

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In this online appendix, we report results that were discussed in the paper but not reported in the main tables. In section A, we compare the ABCP and DW collateral pools. In section B, we report on trading activity in the ABCP and repo markets during the crisis. In section C, we explore a possible endogeneity issue, whereby the mere introduction of the TAF may have affected DW stigma. Finally, in section D, we report additional results about the realized DW stigma premium and the economic costs of DW stigma, as well as the determinants of the incidence and magnitude of DW stigma.

A   Comparison of DW and ABCP Collateral Pools

In the text, we mentioned that the ABCP collateral pool appeared to be similar but riskier than the DW collateral during the crisis period. Since the publicly available data is limited, a full comparison of the collateral pools is not possible. Instead, we have snapshots of the ABCP and DW collateral pools as follows: data for both the ABCP and DW collateral pools during September 2009, for ABCP collateral during March 2007 and for DW collateral during December 2007. As reported in Table A.1, it appears that the ABCP collateral pool was riskier than that of DW as it contained higher shares of risky, illiquid loans. For example, in September 2009, the shares of loans in total collateral for ABCP and the DW were 76% and 55%, respectively.

Table A.1: Collateral Pledged at DW and ABCP

The table shows the distribution of collateral pledged at the DW and used for ABCP issuances on specific dates for which data is available. Collateral categories include loans, securities and other. Loans include commercial loans, consumer loans, and residential mortgage loans. ABCP commercial loans include credit card and trade receivables, as well as equipment loans and leases. DW commercial loans also include commercial real estate loans. ABCP and DW consumer loans include student and auto loans. ABCP securities include commercial debt obligations (CDO). DW securities include Treasury and agency securities, municipal securities, corporate market instruments, asset backed securities (ABS), MBS/CMO and international securities. The data source for DW collateral pools is http: //www.federalreserve.gov/newsevents/reform_taf.htm#data. For ABCP collateral pools, we use Moody's and S&P reports.

Percent of Total Collateral Value (%), DW and ABCP

|	ABCP March 2007	DW December 2007	ABCP September 2009	DW September 2009
Loans	67	36	76	55
Securities	13	64	15	45
Other	20	0	9	0

B   Activity in ABCP and Repo Markets during the 2007-2008 Crisis

As further justification for considering the repo and ABCP markets as alternative funding sources to the DW, we note that there remained substantial issuance and volume activity in these markets during our sample period, as compared to pre-crisis levels (see Figure B.1).[1] For example, ABCP issuances of 21 to 40 days maturity were close to \$60 billion from January to July 2007 (the pre-crisis period) and almost \$40 billion between December 2007 and September 2008 (the sample period in our paper). Repo volume peaked in March 2008 at \$3 trillion and then fell by about 10% between April and September 2008. In other words, there appears to have been sufficient activities in these markets even during the crisis to provide meaningful price and quantity data.

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[1]To construct Figure B.1 we use ABCP issuances data from Haver and repo data from the 2013 Annual Report of the Financial Stability Oversight Council (the ABCP and repo data used in the paper are different). The repo data used in Figure B.1 are for primary dealers' overnight agreements that include both bilateral and triparty repo transactions. However, it is estimated that a majority of the repo transactions likely occur in the triparty repo market (see Copeland et al. (2012), http://libertystreeteconomics.newyorkfed.org/2012/06/mapping-and-sizing-the-us-repo-market.html).

Figure B.1: Activity in Repo and ABCP Markets During the Crisis

The plot shows ABCP issuances of 21-40 days maturity and the repo volume from January 2007 to September 2008. ABCP issuances data is from Haver and repo data is from the 2013 Annual Report of the Financial Stability Oversight Council.
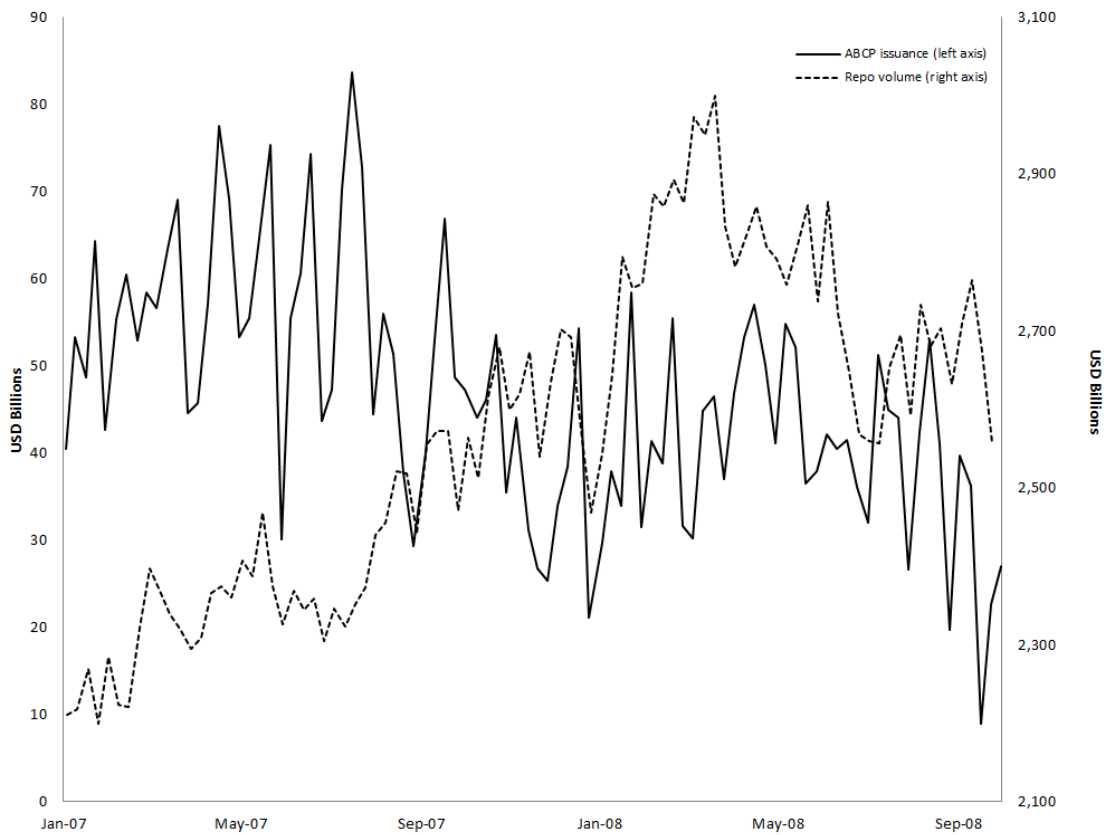
C   Endogeneity

We now explore the possible endogeneity issue whereby the mere introduction of the TAF may have affected DW stigma. In principle, the effect could go either way. In particular, recall that the TAF was introduced because DW stigma was perceived to create a coordination problem: collectively banks should have been better off borrowing from the Fed, but individually each bank was reluctant to do so out of fear it would be the only one. By having banks borrow simultaneously from the Fed, the TAF solved the coordination problem, possibly reducing the stigma of borrowing from the Fed at the DW. Figure 1 in the paper provides prima facie evidence consistent with this hypothesis, as the amount borrowed at the DW increased sharply in the months that followed the implementation of the TAF. Conversely, it is possible that the introduction of the TAF may have exacerbated or even created DW stigma. Indeed, now that banks with predictable funding needs can borrow from the Fed at the TAF, borrowing at the DW could be perceived as further evidence of immediate financial problems, even more so than in normal times.

To explore the endogeneity issue, we extend Figure 3 in the paper by plotting in Figure C.1 below the average realized DW stigma premium with respect to the repo and ABCP markets prior to the implementation of the TAF, starting in January 1, 2007. We compare the magnitude of DW stigma with respect to these markets before and after the announcement (on December 12, 2007) or the implementation (on December 17, 2007) of the TAF program. Four points are worth noting on Figure C.1. First, the data reveal no evidence of DW stigma with respect to the repo and ABCP markets before August 20, 2007, consistent with the fact that the start of the financial crisis is often placed in early August 2007.[2] Second, there is evidence of DW stigma prior to the TAF as the realized DW stigma with respect to the ABCP and repo markets are strictly positive between August 2007 and the announcement of the TAF program. Thus, we find evidence that the TAF did not create DW stigma. Third, the magnitude of DW stigma with respect to the

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[2]This result need not imply that there was no DW stigma prior to the crisis. As discussed in the introduction of the paper, the result may simply reflect the fact that DW stigma is difficult to identify in normal times when market funding rates are below the DW rate.

repo market is remarkably stable in the months that preceded and followed the implementation of the TAF program. Fourth, the magnitude of DW stigma with respect to the ABCP market increased sharply in the week that preceded the announcement of the TAF and then decreased as abruptly following the announcement of the TAF. The last two points therefore provide clear evidence against the hypothesis that the introduction of the TAF increased the magnitude of DW stigma. Instead, the evidence from the repo and ABCP markets suggests that the introduction of the TAF either did not affect or lowered DW stigma. Thus the estimates presented in the paper can be considered valid lower bounds.

Figure C.1: Average Realized DW Stigma Premium Before and After TAF Program Implementation

The figure illustrates the average realized stigma with respect to ABCP and repo markets before and after the announcement of the TAF program, and with respect to TAF since the first TAF auction. For a bank that bids above the DW rate, the realized DW stigma premium with respect to TAF is the bank's highest TAF bid rate minus the DW rate. The realized DW stigma premium with respect to ABCP is the 1-month ABCP rate minus the DW rate, conditional on the spread being positive. For collateral that is pledgeable for both repos and DW loans, the realized DW stigma premium with respect to repo is the repo rate minus the DW rate, conditional on the spread being positive. The announcement of the TAF program on December 12, 2007 is indicated by the first vertical line and the date of the first TAF auction on December 17, 2007, by the second vertical line. The reduction in the DW penalty from 50 to 25 basis points on March 16, 2008 is indicated by the third vertical line and the date of the Lehman Brothers bankruptcy, September 15, 2008, by the final vertical line.
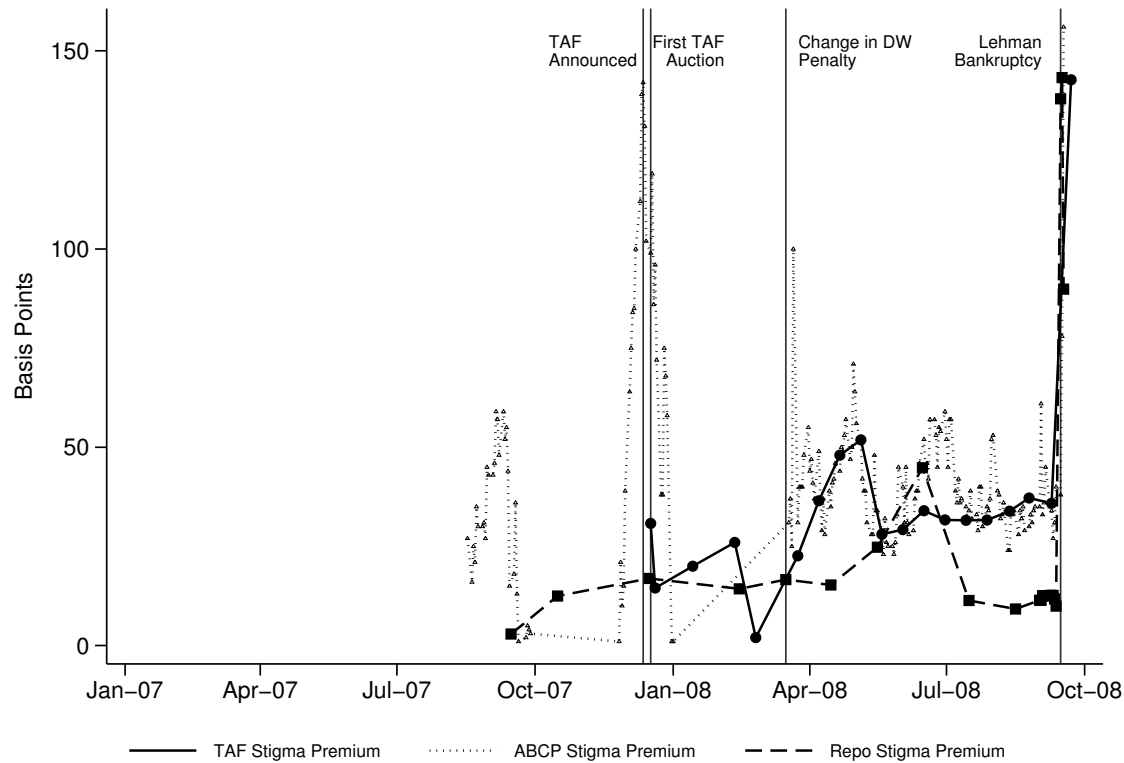
D   Additional Results

Table D.1 reports reduction in pre-tax earnings before taxes (EBT) that is due to stigma. Table D.2 reports realized DW stigma premium and the economic cost of DW stigma using the 3-month ABCP rate. Table D.3 reports the realized DW stigma premium for banks with positive ABCP outstanding and for banks whose dealer affiliates borrowed in the repo market. Table D.4 shows results on the determinants of the incidence of DW stigma using probit and OLS models with random effects. Table D.5 shows results on the determinants of the magnitude of the realized DW stigma premium using panel data models with random effects. Table D.6 shows results on the determinants of the incidence and magnitude of the realized DW stigma controlling for stock returns in the subsample of publicly-traded banks.

Table D.1: Reduction in Pre-Tax EBT From Stigma Cost

We report opportunity costs for banks with DW stigma relative to TAF in Panel A and relative to the market in Panel B. In Panel A, potential cost is the bank's bid amount times the Bid-DW rate spread, conditional on the spread being positive. Realized cost is the bank's award amount times the stop-out-DW rate spread, conditional on the spread being positive. In Panel B, the cost relative to ABCP is the bank's ABCP outstanding per quarter times the ABCP-DW rate spread, conditional on the spread being positive. The cost relative to repo is the amount of a bank's repo funding for a collateral times the Repo-DW rate spread, conditional on the spread being positive. In all panels, $Cost/EBT$ is the cost divided by the absolute value of earnings before tax (EBT) per quarter and $Cost/EBT_{2006}$ is the cost in quarter q of 2008 divided by the absolute value of EBT in quarter q of 2006 for q=1, 2, 3. In Panel A, the full sample is from December 17, 2007 to September 22, 2008. In Panel B, "Full Sample" indicates the first three quarters of 2008.

Panel A: Cost of borrowing from TAF instead of from DW

	Potential Cost Full Sample	Realized Cost Full Sample
$Cost/EBT$ (%)	29.67	9.90
$Cost/EBT_{2006}$ (%)	34.99	7.66

Panel B: Cost of borrowing from markets instead of from DW

	ABCP market			Repo market		
	Full Sample	Q2 2008	Q3 2008	Full Sample	Q2 2008	Q3 2008
$Cost/EBT$ (%)	15.29	14.28	20.60	11.82	1.82	31.30
$Cost/EBT_{2006}$ (%)	9.69	10.28	10.93	15.05	7.25	33.25

Table D.2: Realized DW Stigma Premium and Opportunity Cost Using 3-Month ABCP Rate

The table shows the mean and standard deviation (in parentheses) for the estimates of the realized DW stigma premium (Panel A) and the average opportunity costs of DW stigma (Panel B) using the 3-month ABCP rate. The realized DW stigma premium is the 3-month ABCP rate minus the DW rate, conditional on the spread being positive. The opportunity cost is the bank's ABCP outstanding per quarter times the realized DW stigma premium. Cost/Interest Paid is the cost divided by the interest that banks would have paid if charged the ABCP market rate on their ABCP outstanding. *Reduction in Pre − Tax ROA due to stigma* is the cost divided by total assets. The sample used in this table starts from January 1, 2008 and ends in September 17, 2008.

Panel A: Magnitude of Realized DW Stigma Premium

	Obs	Premium (basis points)
Full sample	142	50.32 (14.10)
Summer 2008, Pre-Lehman	122	51.85 (12.31)
Lehman	2	70.50 (7.78)

Panel B: Cost of borrowing from 3-month ABCP market instead of from DW

	3-month ABCP market		
	Full Sample	Q2 2008	Q3 2008
Observations	96	32	30
Ave per Auction (Mil. USD)	2,171.69	2,471.41	2,689.20
Ave per Bank per Auction (Mil. USD)	67.87	77.23	89.64
Cost / Interest Paid (%)	13.89	16.96	20.41
Reduction in Pre − Tax ROA due to stigma (%)	0.39	0.44	0.50

Table D.3: Magnitude of Realized DW Stigma Premium: Alternate Subsamples

The table shows the mean and standard deviation (in parentheses) for the estimates of the realized DW stigma premium in basis points for banks with positive ABCP outstanding (Panel A) and banks whose dealer affiliates borrowed in the repo market (Panel B). For a bank that bids above the DW rate, the realized DW stigma premium relative to TAF (heading "TAF") is the bank's highest TAF bid rate minus the DW rate. The realized DW stigma premium relative to the ABCP market is the 1-month ABCP rate minus the DW rate, conditional on the spread being positive (heading "ABCP"). The realized DW stigma premium relative to the repo market for a particular collateral is the daily repo rate minus the DW rate, conditional on the spread being positive. The table reports the average over all collateral eligible at the DW (column heading "Repo"). The full sample is from December 17, 2007 to September 22, 2008. The repo sample used in this table starts on January 1, 2008. The Summer 2008 sample is from March 24, 2008 through September 9, 2008, except for the repo rate calculations for which it extends monthly from April to August 2008 and daily from September 1 to 9, 2008. Lehman is the single auction on September 22, 2008 for "TAF", and September 16 and 17, 2008, for the ABCP and repo market estimates.

Panel A: Banks with positive ABCP outstanding

	TAF		ABCP		Repo	
	Obs	Premium (basis points)	Obs	Premium (basis points)	Obs	Premium (basis points)
Full sample	271	45.01 (48.53)	145	42.30 (19.19)	240	47.61 (57.10)
Summer 2008, Pre-Lehman	230	33.10 (17.48)	122	39.51 (9.84)	117	16.47 (14.37)
Lehman	27	155.01 (84.91)	2	117.00 (55.15)	44	122.42 (40.97)

Panel B: Banks whose dealer affiliates borrowed in the repo market

	TAF		ABCP		Repo	
	Obs	Premium (basis points)	Obs	Premium (basis points)	Obs	Premium (basis points)
Full sample	77	45.62 (47.53)	145	42.30 (19.19)	383	46.29 (57.00)
Summer 2008, Pre-Lehman	65	33.05 (16.52)	122	39.51 (9.84)	193	17.16 (14.56)
Lehman	9	146.67 (78.67)	2	117.00 (55.15)	71	116.94 (44.28)

Table D.4: Determinants of the Incidence of DW Stigma with Random Effects

The dependent variable equals 1 when a bank bids above the DW primary credit rate and zero otherwise. The sample includes all bank-auction pairs for 28-day TAF auctions from December 17, 2007 to September 22, 2008. The estimation methods are either a probit model or OLS, accounting for random effects (RE). Each model includes month fixed effects (not reported).The specification of the model is given in equation (7). The standard errors are corrected for heteroskedasticity. Standard errors associated with the estimated coefficients are in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Para.	VARIABLES	(1) Probit Bank RE	(2) Probit Auction RE	(3) OLS	(4) OLS Bank RE	(5) OLS Auction RE
a_1	Log of assets	-0.02 (0.02)	-0.01 (0.01)	-0.00 (0.00)	-0.00 (0.01)	-0.00 (0.00)
a_2	Non US	0.48*** (0.12)	0.40*** (0.07)	0.17*** (0.04)	0.16*** (0.05)	0.17*** (0.04)
a_3	NY District Bank	-0.24 (0.15)	-0.21*** (0.07)	-0.10*** (0.04)	-0.09* (0.05)	-0.10** (0.04)
b_1	# of days in last week bank had DW loan	-0.24*** (0.07)	-0.19*** (0.04)	-0.11*** (0.01)	-0.10*** (0.02)	-0.11*** (0.01)
b_2	DW and TAF	-0.13 (0.09)	-0.05 (0.05)	-0.02 (0.02)	-0.05* (0.03)	-0.02 (0.02)
c_1	Bank bid at previous auction	-0.20*** (0.06)	-0.30*** (0.05)	-0.19*** (0.03)	-0.12*** (0.03)	-0.19*** (0.04)
c_2	Awarded funds at previous auction	0.07 (0.07)	0.18*** (0.06)	0.10*** (0.02)	0.04 (0.03)	0.10*** (0.04)
c_3	Bid above DW at previous auction	0.40*** (0.07)	0.51*** (0.05)	0.34*** (0.03)	0.25*** (0.04)	0.34*** (0.06)
d_1	Libor-OIS spread	1.45*** (0.55)	1.58** (0.80)	0.29*** (0.08)	0.29*** (0.06)	0.29* (0.15)
d_2	VIX	8.10*** (1.89)	5.07** (2.35)	3.75*** (0.48)	3.64*** (0.42)	3.75*** (1.25)
d_3	CDX	0.20*** (0.05)	0.13* (0.07)	0.11*** (0.01)	0.11*** (0.01)	0.11*** (0.04)
	Constant			-10.77*** (1.26)	-10.46*** (1.15)	-10.77*** (3.74)
	Observations	1,418	1,418	1,418	1,418	1,418
	# of Unique Banks	172	172	172	172	172
	Log Likelihood	-336.12	-385.87			
	Adj R-sq.			0.62	0.59	0.96

Table D.5: Determinants of the Magnitude of DW Stigma with Random Effects

The dependent variable is the magnitude of realized DW stigma premium. The sample includes all bank-auction pairs for 28-day TAF auctions from December 17, 2007 to September 22, 2008. The estimation method is OLS accounting for random effects (RE). Each model includes month fixed effects (not reported). The standard errors are corrected for heteroskedasticity. Standard errors associated with the estimated coefficients are in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Para.	VARIABLES	(1) OLS Bank RE	(2) OLS Auction RE
a_1	Log of assets	-2.51* (1.32)	-2.95*** (0.80)
a_2	Non US	14.64** (6.25)	5.39 (8.74)
a_3	NY District Bank	-1.53 (6.37)	0.67 (2.41)
b_1	# of days in last week bank had DW loan	-11.22 (6.93)	-7.26 (5.70)
b_2	DW and TAF	17.26*** (5.15)	10.13*** (2.85)
c_1	Bank bid at previous auction	2.13 (3.25)	-8.50** (3.70)
c_2	Awarded funds at previous auction	1.31 (3.93)	15.67*** (4.79)
c_3	Bid above DW at previous auction	2.63 (3.48)	5.94 (4.03)
d_1	Libor-OIS spread	99.71*** (11.02)	110.70*** (16.92)
d_2	VIX	112.56*** (40.55)	139.17** (56.30)
d_3	CDX	-0.96 (1.21)	-0.39 (1.23)
d_4	Lehman failure	99.61*** (11.77)	94.95*** (4.41)
	Constant	56.85 (122.13)	4.97 (127.15)
	Observations	823	823
	# of Unique Banks	136	136
	Adj R-sq.	0.36	0.98

Table D.6: Incidence and Magnitude of DW Stigma With Stock Returns

The dependent variable is either an indicator that equals 1 when a bank bids above the DW primary credit rate and zero otherwise (*incidence*), or the magnitude of realized DW stigma premium (*magnitude*). The sample includes all bank-auction pairs for 28-day TAF auctions from December 17, 2007 to September 22, 2008. The estimation method is a Probit model when the dependent variable is *incidence* and OLS when the dependent variable is *magnitude*. Models (1) and (2) use *Return yesterday*, a bank's excess stock returns on the day prior to a TAF auction. Models (3) and (4) use *Cumulative return for last week* a bank's excess stock returns cumulated over the five business days prior to a TAF auction. Excess stock returns are equal to the bank's returns minus the returns on the S&P 500 index. Each model includes month fixed effects (not reported). The standard errors are corrected for heteroskedasticity. Standard errors associated with the estimated coefficients are in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Para.	VARIABLES	(1) incidence	(2) magnitude	(3) incidence	(4) magnitude
a_1	Log of Assets	-0.01	-2.70***	-0.00	-2.67***
		(0.02)	(0.88)	(0.01)	(0.89)
a_2	Non US	0.38***	8.10*	0.38***	8.16*
		(0.08)	(4.90)	(0.07)	(4.83)
a_3	NY District Bank	-0.20**	-3.60	-0.20**	-4.39
		(0.09)	(4.44)	(0.08)	(4.47)
b_1	# of days in last week	-0.17***	-2.52	-0.17***	-1.65
	bank had DW loan	(0.04)	(4.99)	(0.04)	(5.02)
b_2	DW and TAF	0.03	11.52***	0.03	11.13***
		(0.06)	(2.88)	(0.06)	(2.88)
c_1	Bank bid at	-0.33***	-12.55***	-0.33***	-12.85***
	previous auction	(0.06)	(4.39)	(0.06)	(4.21)
c_2	Awarded funds at	0.21***	13.38***	0.21***	13.74***
	previous auction	(0.07)	(4.57)	(0.07)	(4.51)
c_3	Bid above DW at	0.54***	8.53*	0.54***	8.64*
	previous auction	(0.06)	(4.62)	(0.06)	(4.72)
d_1	Libor-OIS	2.31***	125.96***	2.35***	133.36***
		(0.34)	(23.49)	(0.34)	(23.61)
d_2	VIX	4.11**	111.68	4.14**	103.89
		(1.81)	(83.79)	(1.79)	(84.19)
d_3	CDX	0.07*	-0.68	0.07*	-1.12
		(0.04)	(2.17)	(0.04)	(2.19)
d_5	Lehman failure		82.05***		85.20***
			(13.46)		(13.21)
d_5	Return yesterday	0.81	38.22		
		(0.59)	(49.72)		
d_6	Cumulative return for last week			0.26	-19.36
				(0.31)	(21.20)
	Constant		23.00		65.24
			(213.40)		(215.83)
	Observations	818	449	818	449
	# of Unique Banks	92	74	92	74
	Adj R-sq.		0.36		0.98
	Log Likelihood	-240.6		-240.9	