Emergency Liquidity Facilities, Signalling and Funding Costs[1]

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Introduction

- As Lender-of-Last Resort, the Federal Reserve has used the Discount Window (DW) to provide liquidity support to banks.

- In 2007, the Fed created or improved a number of liquidity facilities designed to respond to the financial crisis.

- TAF was much less flexible liquidity facility than the DW. However, banks were willing to pay a high premium to participate in the TAF at the height of the crisis.

Our agenda

- We provide a rationale for offering two different liquidity facilities, which helps banks signalling their type and decrease asymmetric information

- We propose a simple signalling model where banks balance the trade-off of paying higher (lower) costs of accesing a liquidity facility but having a lower (higher) funding cost in the future.

- We test the implications of this model:
  - In the pre-Lehman period, banks that access the TAF pay a higher rate than banks that access the DW.
  - However, in the post-Lehman period, banks that access the TAF experience a lower funding cost (up to 31 basis points).

Basic facts (I)

- The Discount Window
    - Collateralized loans.
    - Very flexible facility: Any amount, any time.
    - Term:
        - From March 16th, 2008 to January 14th, 2010: Up to 90 days.
        - From January 14th, 2010 to March 18th 2010: Up to 28 days
        - After March 18th 2010: Overnight
- The Term-auction Facility (TAF):
    - Provided credit to depositary institutions through auctions every 2 weeks.
    - Collateralized loans, with minimum amount of 10 M.
    - Terms: 28-day. After august 2008, 84-day loans (later on scaled back).
    - Final TAF auction was held on March, 2010.
    - Less flexible than DW.
- Both facilities have identical eligibility requirements for banks.

Basic facts (II)
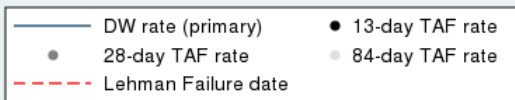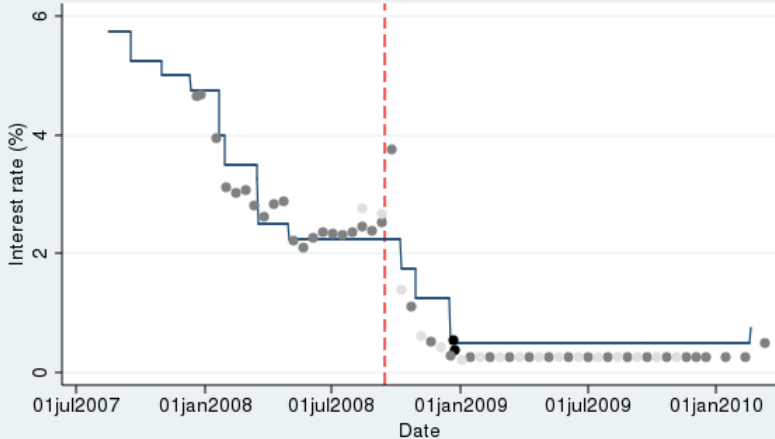
Turbulence and access to liquidity facilities during the crisis
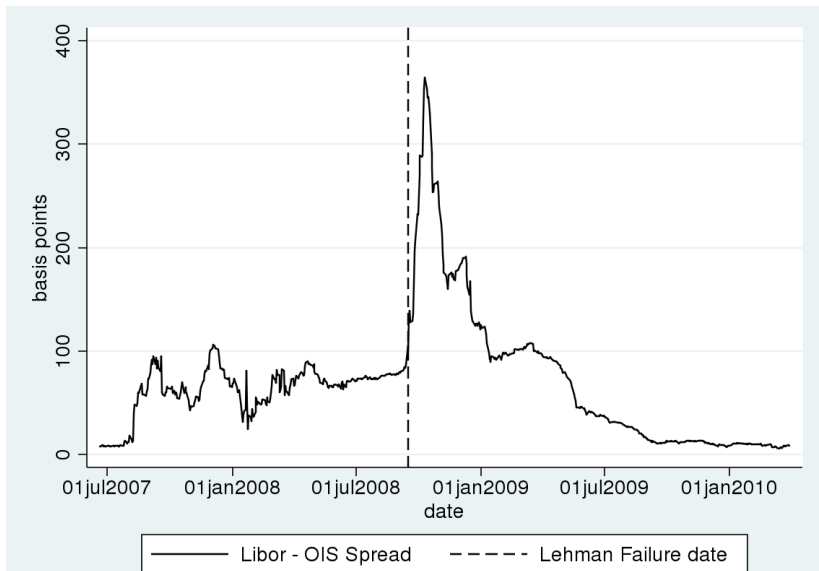
Turbulence and access to liquidity facilities during the crisis

- Clear differences observed in the months around and before the failure of Lehman Brothers, versus 2009 and later

- Given these facts, we conjecture that there are two periods
  - Pre Lehman period: High turbulence in markets, high asymmetric information
  - Post Lehman period: Low turbulence in markets, low asymmetric information

- We use this temporal differences between the two periods in the theoretical model we propose

Model outline (I)

- Banks have access to a two period investment project that can yield a net return of R at the end of the second period.
- Two types of banks (private information):
    - good banks realize return with certainty
    - bad banks obtain R only with probability $1 - \theta$
- Ex-ante probability of a bank being good: α.
- The project is financed through two consecutive periods of short term borrowing.
- In first period (pre-Lehman period), banks may use a liquidity facility (TAF or DW).
- In the second period (post-Lehman period), markets work frictionless and banks can borrow from a competitive financial market at the fair market rate given the market's belief about their type.

Model outline (II)

- Refinancing needs during the first period arise from either liquidity shocks or bank runs.

- All banks can receive a liquidity shock with probability λ. After the shock is realized, banks can access the DW or TAF.

- Bad banks that do not have a liquidity shock can be subject to a run with probability ρ at the end of period.while good banks will never be run.

- DW is fully flexible: Can be accessed all time. TAF can only be accessed at the beginning of the period. Therefore, bad banks that have a run need to access DW if they did not secure funds from TAF.

- Bank make their decisions after they learn about the liquidity shock but before (bad banks) learn about the run.

Timeline of model
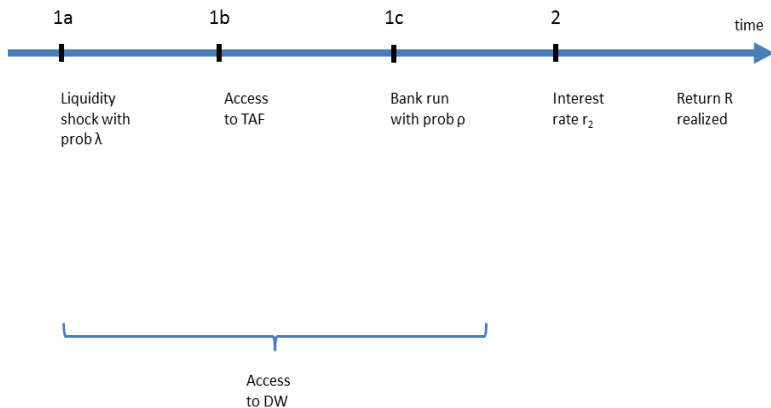
Trade-offs of the model

- First period:
  - Banks that have a liquidity shock can acces the TAF or the DW.
  - Bad banks that did not have a liquidity shock can access the TAF to borrow money just in case they have a future run. Or they can wait to access the DW if they have a run.
  - Therefore, access the TAF is costly (because it is less flexible than DW)
  - Good banks that do not receive the liquidity shock do not need to access any facility.

- Second period:
  - Funding markets react to what banks did in the first period.

Separating equilibrium

We propose the following separating equilibrium:

1. TAF: Accessed by banks with a liquidity shock (good and bad)
2. DW: Only used by bad banks with a run.
3. The rest of the banks (without a liquidity shock/run): Do not go to TAF or DW.

In this equilibrium:

- TAF rates are higher than DW rates: $r_t \geq r_d$ (when r_d low enough)
- Second period rates for banks that access the DW are higher than for banks that access the TAF.

Graphical solution of separating equilibrium
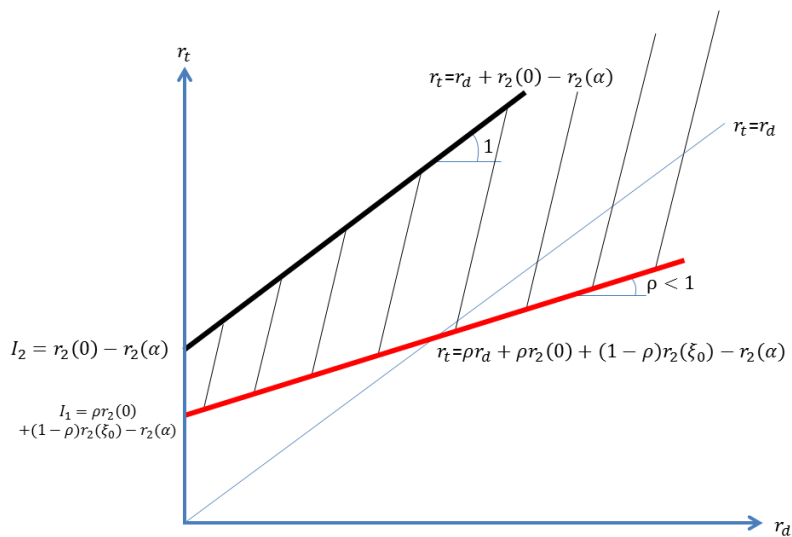
Empirical predictions

We want to test a number of predictions from the model:

- We divide time in two periods: Before the failure of Lehman, and after the failure of Lehman.

- Statistics about solvency and liquidity of banks that accessed DW

- TAF rates should be higher than DW rates (stigma effect):
  > ▸ Graph with DW and TAF rates

- Funding cost ex-post: Regression analysis

Statistics banks pre-Lehman

| | Pre-Lehman (2007) | | | | | | Test | | |
| | DW banks | | TAF banks | | Other banks | | DW>TAF | DW>Other | TAF>Other |
	mean	se	mean	se	mean	se	p-value	p-value	p-value
Return on assets (%)	0.99	0.04	1.27	0.06	0.89	0.02	0.01	0.86	0.91
Return on equity (%)	10.24	0.27	11.80	0.47	8.72	0.07	0.03	1.00	1.00
Tier 1 capital ratio (%)	13.76	0.40	16.58	1.85	21.73	0.59	0.02	0.00	0.26
z-score	225.07	13.69	252.57	33.08	238.22	3.37	0.25	0.20	0.62
Liquidity ratio (%)	4.87	0.33	4.56	0.37	55.19	12.34	0.63	0.19	0.38
Observations	1,524		188		34,385				

Access pre-Lehman and default post-Lehman

	Total access	Total fail	% fail
DW main	387	50	12.9%
TAF main (%)	45	3	6.67%

Bank fixed effects regressions for funding cost (I)

$$\text{FundingCost}_{i,t} = \alpha_{TAF}\, TAF_{i,pre} \times Post_t + \alpha_{DW}\, DW_{i,before} \times Post_t + \alpha_X\, X_{i,t} + c_t + \mu_i + \varepsilon_{i,t},$$

where

- $t \in [2007q1, ..., 2007q4, 20010q1, ..., 2010q4]$
- $B_{i,t}$ are bank-level variables in period t
- $X_{i,t}$ are market-level variables in period t
- $TAF_{i,pre}$: Equal to 1 if bank i was a borrower in TAF in pre-Lehman period
- $DW_{i,pre}$: Equal to 1 if bank i was a borrower in DW in pre-Lehman period
- $Post_t$: Equal to 1 if post-Lehman period (2010)
- μ_i : Bank fixed effects. c_t : Quarterly fixed effects

Bank fixed effects regressions for funding cost (II)

$$\text{FundingCost}_{i,t} = \alpha_{TAF}\, TAF_{i,pre} \times Post_t + \alpha_{DW}\, DW_{i,before} \times Post_t + \alpha_X\, X_{i,t} + c_t + \mu_i + \varepsilon_{i,t},$$

FundingCost: Interest expenses from Call Reports (expressed as %)

Hypothesis testing:

- We want to verify if $\alpha_{TAF} < \alpha_{DW}$ which is consistent with our model predictions

Funding cost regressions

	Total funding	Domestic deposits	Foreign deposits	Interbank borrowing	Subordin. debt	Other borrowing
Regressors	(1)	(2)	(7)	(8)	(9)	(10)
$DW_{pre} \times Post$	-0.0337***	-0.0270***	-0.162**	-0.0294	-0.0175	-0.0464*
	(0.00784)	(0.00783)	(0.0806)	(0.0358)	(0.161)	(0.0274)
$TAF_{pre} \times Post$	-0.0999***	-0.0769**	-0.287**	-0.246**	-0.00662	-0.177
	(0.0219)	(0.0336)	(0.140)	(0.0959)	(0.229)	(0.115)
Bank controls	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES
Quarterly fixed effects	YES	YES	YES	YES	YES	YES
Observations	64,490	64,483	672	21,945	1,906	41,862
Number of banks	8,763	8,762	103	4,718	362	6,698
R squared	0.890	0.890	0.769	0.380	0.245	0.118

H_1 : Funding cost DW banks post Lehman ($DW_{pre} \times Post$) $\leq$ Funding cost TAF banks post Lehman ($TAF_{pre} \times Post$)

10% significance	REJECT	REJECT	ACCEPT	REJECT	ACCEPT	ACCEPT
5% significance	REJECT	ACCEPT	ACCEPT	REJECT	ACCEPT	ACCEPT

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Funding cost regressions (intensive margin)

- Is the use of these facilities important for all banks?
- In August 2007, Citigroup, Bank of America, JPMorgan Chase and Wachovia each borrowed $500 million from the DW
- Joint statement, JPMorgan, Bank of America and Wachovia alleged that they were using the discount window in an effort to *"encourage its use by other financial institutions."* (August 23rd, 2007)
- Bank of America *"we participated at the request of the Federal Reserve to help stabilize the global banking system in a period of unprecedented stress [...] At the time we were participating, we weren't experiencing liquidity issues."*

Funding cost regressions (intensive margin)

	Total funding	Domestic deposits	Foreign deposits	Interbank borrowing	Subordin. debt	Other borrowing
Regressors	(1)	(2)	(7)	(8)	(9)	(10)
$AmtDW \times Post$	-0.00957***	-0.00376	0.00440	-0.0347**	-0.0449	-0.0325***
	(0.00359)	(0.00354)	(0.0171)	(0.0148)	(0.0456)	(0.0107)
$AmtTAF \times Post$	-0.0296**	-0.0168	-0.0809*	-0.107***	0.0449	-0.107**
	(0.0123)	(0.0152)	(0.0449)	(0.0293)	(0.0958)	(0.0442)
Bank controls	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES
Quarterly fixed effects	YES	YES	YES	YES	YES	YES
Observations	64,490	64,483	672	21,945	1,906	41,862
Number of banks	8,763	8,762	103	4,718	362	6,698
R squared	0.890	0.889	0.766	0.381	0.248	0.119

H_1 : Funding cost DW banks post Lehman ($DW_{pre} \times Post$) $\leq$ Funding cost TAF banks post Lehman ($TAF_{pre} \times Post$)

10% significance	REJECT	ACCEPT	REJECT	REJECT	ACCEPT	REJECT
5% significance	ACCEPT	ACCEPT	REJECT	REJECT	ACCEPT	ACCEPT

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Funding cost regressions, bank characteristics pre-Lehman

Regressors	Total funding (1)	Domestic deposits (2)	Foreign deposits (7)	Interbank borrowing (8)	Subordin. debt (9)	Other borrowing (10)
$DW_{pre} \times Post$	-0.0299*	-0.00151	-0.0550	-0.0345	0.103	-0.0405
	(0.0161)	(0.0148)	(0.0852)	(0.0670)	(0.160)	(0.0525)
$TAF_{pre} \times Post$	-0.120***	-0.100**	-0.183*	-0.0355	-0.388	-0.157
	(0.0271)	(0.0435)	(0.106)	(0.133)	(0.240)	(0.138)
$DW_{pre} \times Post \times HighRisk$	-0.0565***	-0.0609***	-0.277**	0.129*	0.307	-0.0301
	(0.0156)	(0.0149)	(0.116)	(0.0754)	(0.423)	(0.0568)
$TAF_{pre} \times Post \times HighRisk$	-0.00872	-0.0459	-0.333	-0.451***	0.215	-0.285
	(0.0451)	(0.0735)	(0.228)	(0.130)	(0.284)	(0.278)
$DW_{pre} \times Post \times LowL$	-0.0588***	-0.0879***	0.179	0.0364	-0.892**	0.0486
	(0.0188)	(0.0177)	(0.126)	(0.0761)	(0.388)	(0.0583)
$TAF_{pre} \times Post \times LowL$	0.0443	0.0167	0.390***	0.0741	1.107**	0.0648
	(0.0480)	(0.0636)	(0.0940)	(0.209)	(0.435)	(0.165)
$DW_{pre} \times Post \times Small$	0.0365**	0.0162		-0.0633	-0.102	-0.0115
	(0.0168)	(0.0154)		(0.0716)	(0.357)	(0.0559)
$TAF_{pre} \times Post \times Small$	0.0421	0.154**		-0.316**		0.344*
	(0.0615)	(0.0691)		(0.140)		(0.200)
Bank controls	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES
Quarterly fixed effects	YES	YES	YES	YES	YES	YES
Observations	63,999	63,992	672	21,866	1,902	41,680
Number of banks	8,639	8,638	103	4,688	361	6,643
R squared	0.891	0.890	0.776	0.381	0.275	0.118

Funding cost regressions, bank characteristics pre-Lehman

Regressors	Total funding (1)	Domestic deposits (2)	Foreign deposits (7)	Interbank borrowing (8)	Subordin. debt (9)	Other borrowing (10)
H_1 : Cost DW banks post Lehman ($DW_{pre} \times Post$) $\leq$ Cost TAF banks post Lehman ($TAF_{pre} \times Post$)						
10% significance	REJECT	REJECT	ACCEPT	ACCEPT	REJECT	ACCEPT
5% significance	REJECT	REJECT	ACCEPT	ACCEPT	REJECT	ACCEPT
H_1 : Cost small DW banks post Lehman ($DW_{pre} \times Post \times Small$) $\leq$ Cost small TAF banks post Lehman ($TAF_{pre} \times Post \times Small$)						
10% significance	ACCEPT	ACCEPT	ACCEPT	REJECT	ACCEPT	ACCEPT
5% significance	ACCEPT	ACCEPT	ACCEPT	ACCEPT	ACCEPT	ACCEPT
H_2 : Cost high risk DW banks post Lehman ($DW_{pre} \times Post \times HighRisk$) $\leq$ Cost high risk TAF banks in post Lehman ($TAF_{pre} \times Post \times HighRisk$)						
10% significance	ACCEPT	ACCEPT	ACCEPT	REJECT	ACCEPT	ACCEPT
5% significance	ACCEPT	ACCEPT	ACCEPT	REJECT	ACCEPT	ACCEPT
H_2 : Cost low liq. DW banks post Lehman ($DW_{pre} \times Post \times LowL$) $\leq$ Cost low liq. TAF banks post Lehman ($TAF_{pre} \times Post \times LowL$)						
10% significance	ACCEPT	ACCEPT	ACCEPT	ACCEPT	ACCEPT	ACCEPT
5% significance	ACCEPT	ACCEPT	ACCEPT	ACCEPT	ACCEPT	ACCEPT

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Matching estimator with fixed effects

Regressors	Total funding (1)	Domestic deposits (2)	Foreign deposits (7)	Interbank borrowing (8)	Subordin. debt (9)	Other borrowing (10)
$DW_{pre} \times Post$	-0.0207***	-0.0130	0.00972	0.00241	0.0740	-0.0505*
	(0.00801)	(0.00804)	(0.0925)	(0.0376)	(0.164)	(0.0286)
$TAF_{pre} \times Post$	-0.0637***	-4.03e-05	0.0279	-0.148	-0.0372	-0.0883
	(0.0241)	(0.0328)	(0.134)	(0.112)	(0.230)	(0.0978)
Bank controls	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES
Quarterly fixed effects	YES	YES	YES	YES	YES	YES
Observations	20,621	20,621	605	9,522	1,496	15,666
Number of banks	2,804	2,804	93	1,775	278	2,433
R squared	0.889	0.888	0.784	0.431	0.329	0.129

H_1 : Funding cost for DW banks post Lehman ($DW_{pre} \times Post$) $\leq$ Funding cost TAF banks post Lehman period ($TAF_{pre} \times Post$)

10% significance	REJECT	ACCEPT	ACCEPT	REJECT	ACCEPT	ACCEPT
5% significance	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT	ACCEPT

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Endogenous treatment: First stage

- In our regressions, we control for any time-invariante bank characteristic that may be correlated with the decision to access the DW or TAF (bank fixed effects)
- There could be unobserved time-variant characteristics correlated with the decision of access DW or TAF, and create biases
- We follow the dummy-endogenous variable literature from Heckman and use an instrument for access to DW/TAF
- Following previous literature that studied access to TARP, we use membership at the Board of the Fed as instrument
- Board members are elected by the members banks based on their prestige and knowledge of the local economy

Endogenous treatment: First stage

	DW access	TAF access
Regressors	(1)	(2)
Member of the board of the Fed	-0.179***	-0.222**
	(0.049)	(0.091)
Bank controls	YES	YES
Quarterly fixed effects	YES	YES
Observations	64,627	64,627
Pseudo R squared	0.115	0.384

Robust standard errors in parentheses

*** p<0.01, **p<0.05, *p<0.1

Endogenous treatment: Second stage

	Total funding	Domestic deposits	Foreign deposits	Interbank borrowing	Subordin. debt	Other borrowing
Regressors	(1)	(2)	(7)	(8)	(9)	(10)
$DW_{pre} \times Post$	-0.034***	-0.028***	-0.184**	-0.030	-0.009	-0.048*
	(0.008)	(0.008)	(0.071)	(0.035)	(0.160)	(0.028
$TAF_{pre} \times Post$	-0.100***	-0.077***	-0.228**	-0.184	0.065	-0.151*
	(0.021)	(0.032)	(0.121)	(0.102)	(0.238)	(0.107
Bank controls	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES
Quarterly fixed effects	YES	YES	YES	YES	YES	YES
Observations	64,490	64,483	672	21,945	1,906	41,862
Number of banks	8,763	8,762	103	4,718	362	6,698
R squared	0.891	0.890	0.790	0.381	0.260	0.119

H_1 : Funding cost for DW banks post Lehman ($DW_{pre} \times Post$) $\leq$ Funding cost TAF banks post Lehman ($TAF_{pre} \times Post$)

10% significance	REJECT	REJECT	ACCEPT	REJECT	ACCEPT	ACCEPT
5% significance	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT	ACCEPT

Robust standard errors in parentheses

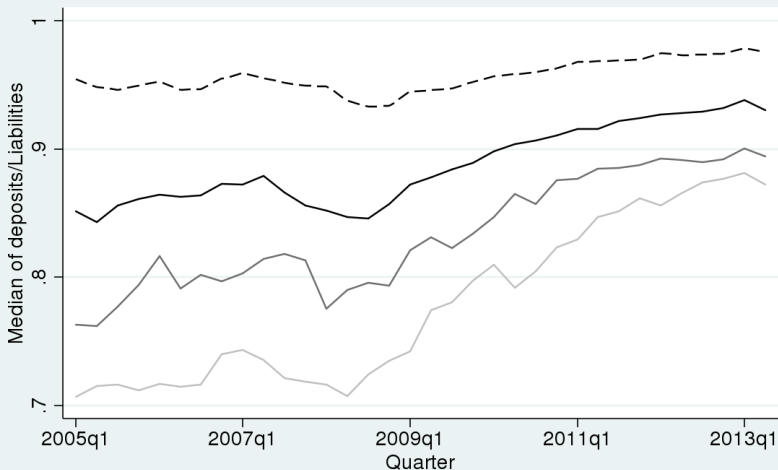*** p<0.01, ** p<0.05, * p<0.1

Sources of funding

$$\text{SourceFunding}_{i,t} = \beta_{TAF}\, TAF_{i,pre} \times Post_t + \beta_{DW}\, DW_{i,before} \times Post_t + \beta_X X_{i,t} + c_t + \mu_i + \xi_{i,t}$$

SourceFunding: % of type of funding over total liabilities

Hypothesis testing:

- We want to verify if $\beta_{TAF} > \beta_{DW}$ which is consistent with our model predictions

Sources of funding: Deposits

Sources of funding regressions

Regressors	Wholesale funding (1)	All deposits (3)	Transaction accounts (4)	Saving accounts (5)	Time depos. (<100) (6)	Time depos. (>100) (7)	Foreign deposits (8)	Interbank borrowing (9)	Subordin. debt (10)
$DW_{pre} \times Post$	-2.738***	0.897**	0.268	0.198	1.627***	-1.219**	-0.0765	-0.325	-0.00931
	(0.613)	(0.354)	(0.395)	(0.573)	(0.566)	(0.479)	(0.0671)	(0.225)	(0.0153)
$TAF_{pre} \times Post$	-1.568	5.957**	1.559	4.070**	3.449***	-2.993*	0.196	-3.991**	-0.389**
	(2.632)	(2.832)	(1.009)	(1.715)	(0.986)	(1.761)	(0.745)	(1.970)	(0.198)
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Bank fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Quarterly fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	64,598	64,627	64,627	64,627	58,548	64,627	64,627	64,625	64,627
Number of banks	8,763	8,763	8,763	8,763	7,960	8,763	8,763	8,763	8,763
R squared	0.497	0.0710	0.0427	0.119	0.168	0.0388	0.00190	0.0424	0.00589

H_3 : Funding for TAF banks in post Lehman period ($TAF_{pre} \times Post$) $\leq$ Funding for DW banks in post Lehman period ($DW_{pre} \times Post$)

10% significance	ACCEPT	REJECT	ACCEPT	REJECT	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT
5% significance	ACCEPT	REJECT	ACCEPT	REJECT	REJECT	ACCEPT	ACCEPT	ACCEPT	ACCEPT

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Conclusion

- We have discussed the importance of having an alternative liquidity facility, the TAF, with different characteristics than the traditional more flexible Discount Window.

- We have shown that banks will use these facilities as a signalling tool, and that the access to these facilities will have consequences in terms of the rates paid to access to them, and ex-post.

- Our results contribute to understand better how to design a liquidity facility during a financial crisis.
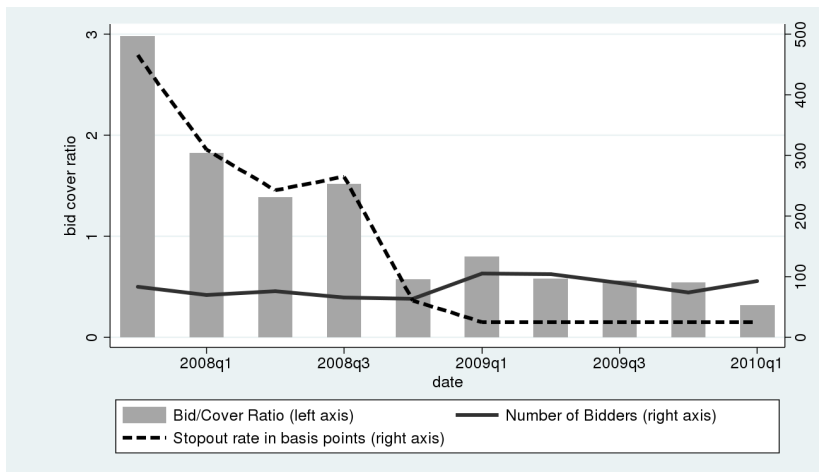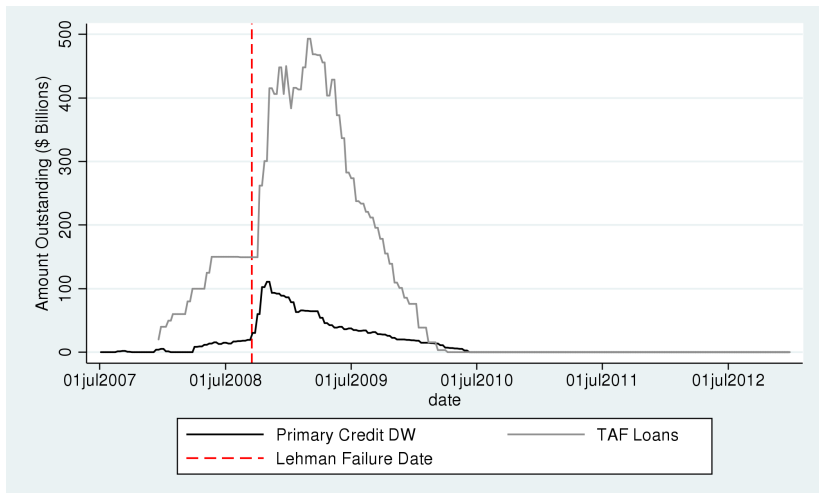
Bank failures and problem banks
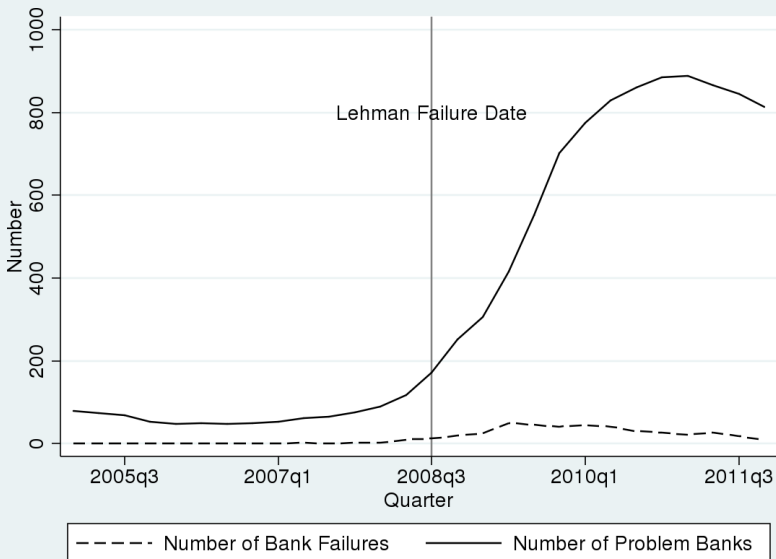
Funding cost evolution
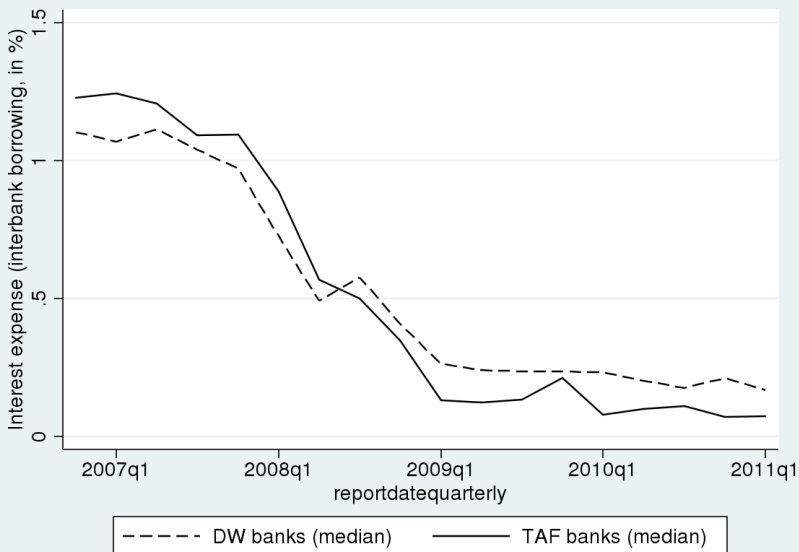
TAF auctions

Access to TAF and DW

Access to DW