Settlement Liquidity and Monetary Policy Implementation:

Lessons from the Financial Crisis

Morten Bech, Antoine Martin, and James McAndrews, BIS and FRBNY
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Liquidity

liquidity [li'kwidity] *n*

- **1.** (Economics, Accounting & Finance / Banking & Finance) the possession of sufficient liquid assets to discharge current liabilities
- **2.** the state or quality of being liquid

We explore the liquidity of the payment activity on the Fedwire Funds Service, before and during the period in which the Federal Reserve injected massive reserve balances.

We find that the presence of those balances, remunerated at the policy rate, improved the liquidity on Fedwire significantly.

Different types of liquidity

- Funding liquidity: <u>ease</u> with which financial institutions can take on leverage/credit
- Market liquidity: <u>ease</u> with which market participants can transact
- ***Settlement Liquidity***: <u>ease</u> by which market participants can discharge their settlement and payment obligations
- Different types are interlinked
    - Brunnermeier and Petersen (2009)
   - Tri-party repos and clearing banks

USD clearing and settlement network

- Nodes and funding links
 - Direct and indirect links

USD clearing and settlement network
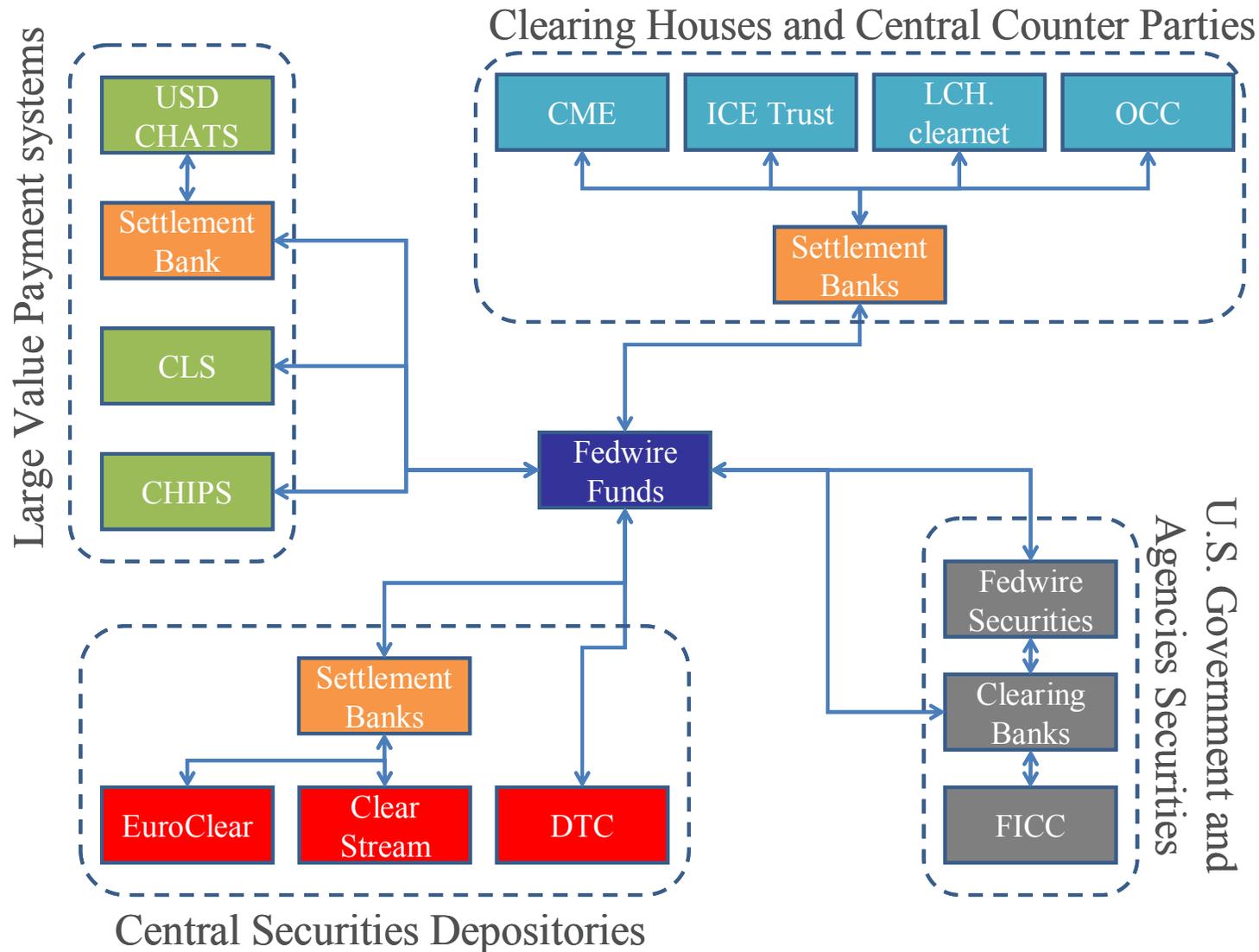
Direct Funding Links
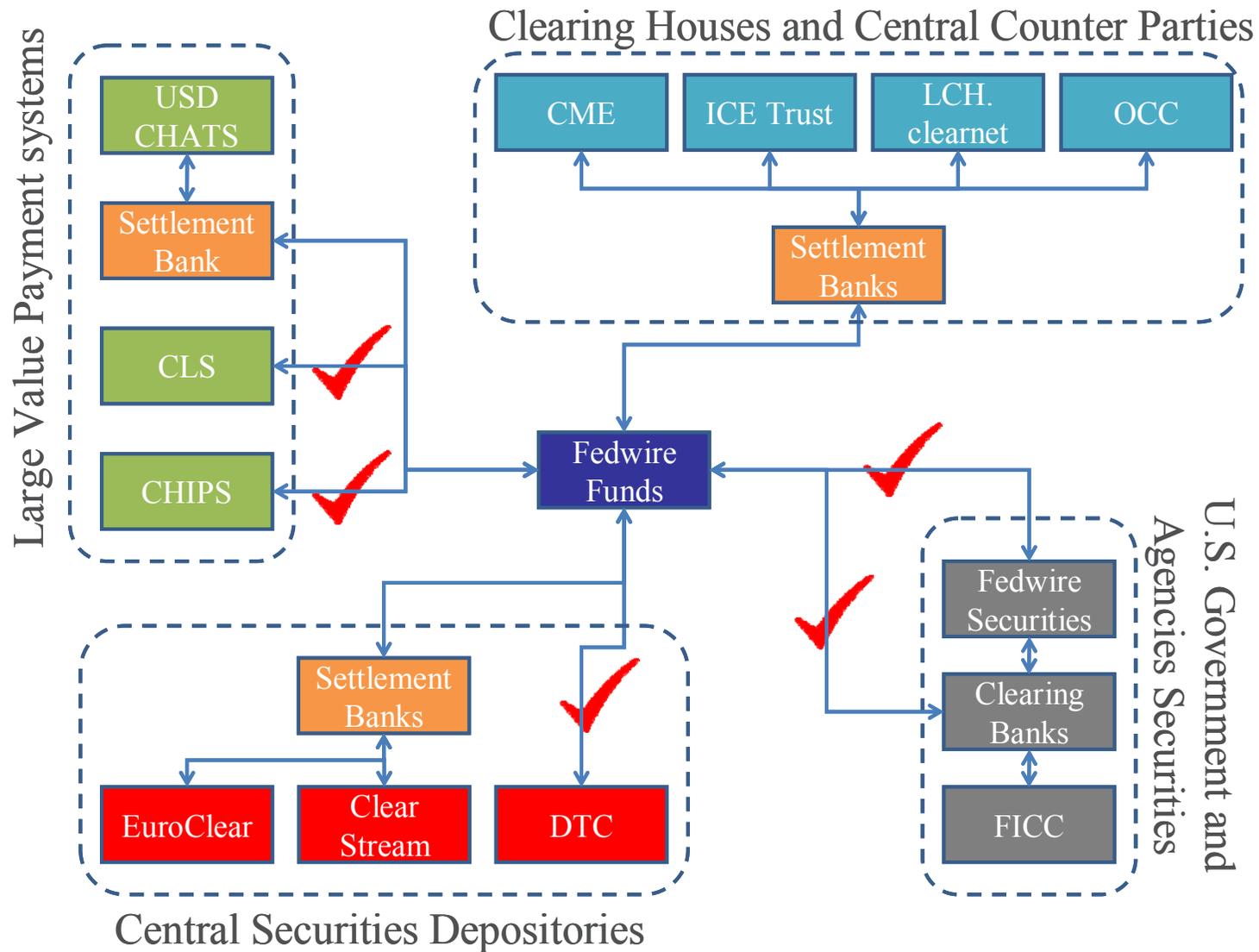
Indirect Funding Links
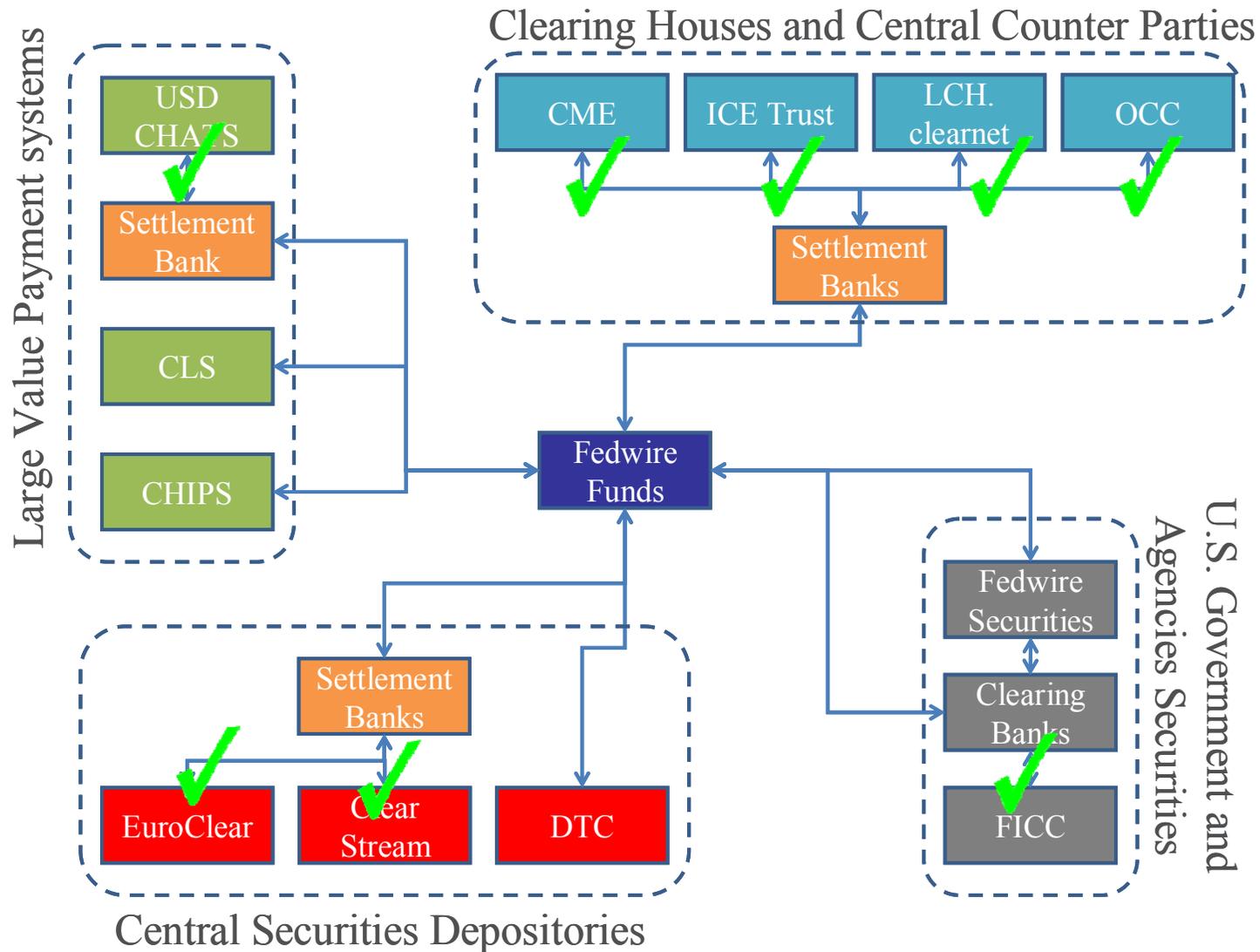
How to measure settlement liquidity?

- **Liquidity is hard to measure**
  - Proxies often used
    - Market: bid-ask spreads, trading volumes
    - Funding: Libor – OIS spread

- **In the context of central banks**
  - The amount of reserves
    - e.g. Cecchetti and Disyatat 2010

- **Sources of funds in wholesale payment systems**
  - Balances, intraday credit, Incoming payments and credit extensions bwt. participants (e.g. interbank loans)
   - Fed: Peak DOD $150B pre crisis

How to measure settlement liquidity?

- Degree of delay
  - Absolute approach
    - Count the seconds from a obligations was ready to be settled to when its actually was
      - Even a system operator will only know the latter
  - Relative approach
    - Assume the arrival process is "constant"
    - Rely on changes in settlement times to identifying changes in settlement liquidity

Case Study of our definition of liquidity: Settlement times following Lehman
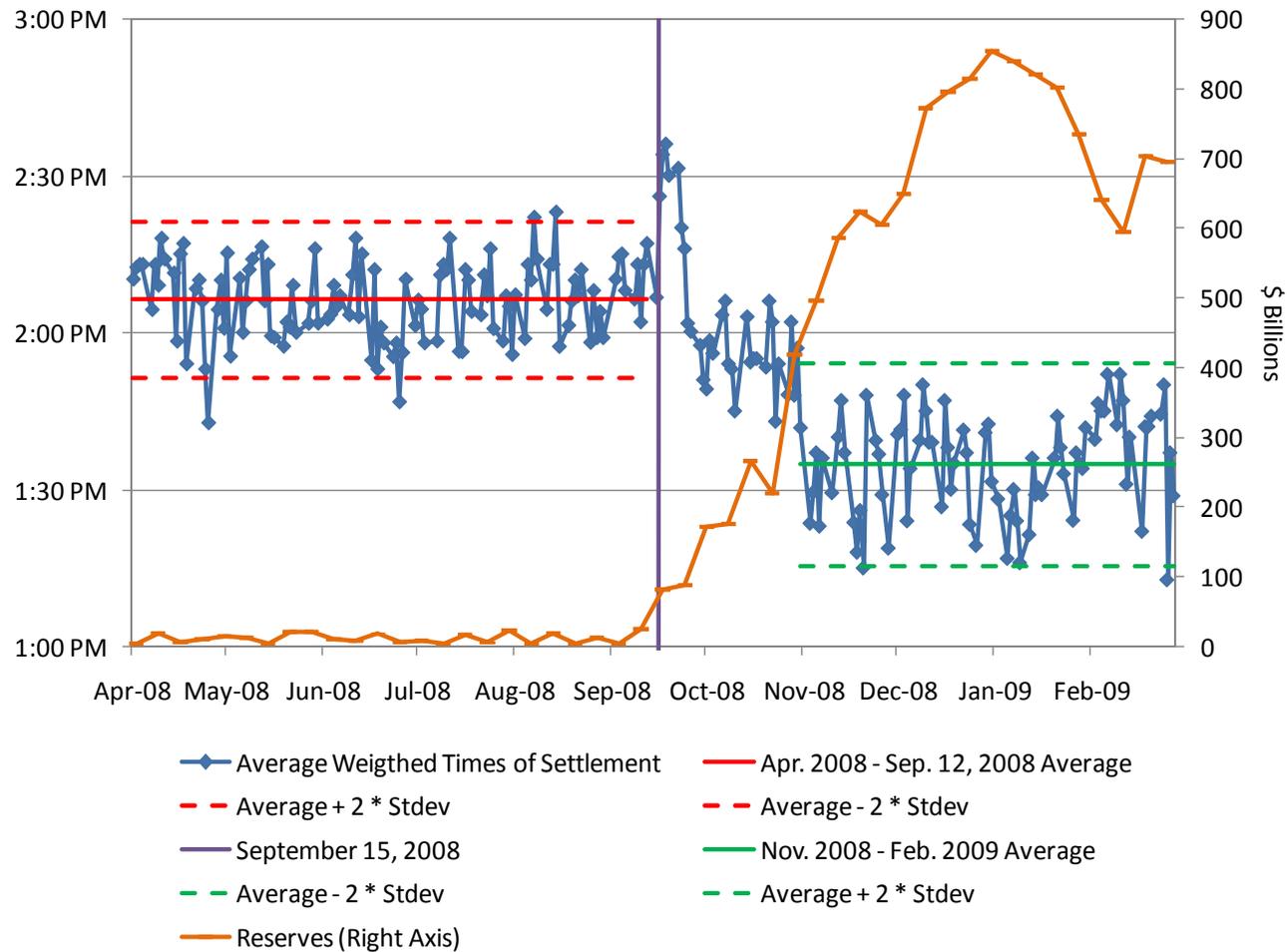
Higher reserves provision alone does not signify higher liquidity.

Why might balances quicken payment submission?

Bech and Garratt (2003): costly daylight credit leads to trade-off between cost of delay and cost of daylight credit

McAndrews and Potter (2002), Kahn, McAndrews, and Roberds (2003), Mills and Nesmith (2008): presence of settlement risk (and costly overnight borrowing) leads to delay

Provision of large amounts of zero opportunity cost balances (payment of interest on reserves at policy rate) would, in these models, reduce cost of daylight credit and reduce dependence on the receipt of others' payments, and so, quicken payments.

# Fedwire Funds, timing and endogenous liquidity

Nodes = 16 important Participants; scaled by value

Links = 1 payment between participants

Coloring Scheme:
Time at which 70% of value has settled along each links

Gray: that is less than or equal to 95th percentile of reference period = No Delay

Red: Greater than 95th percentile of reference period = Delay
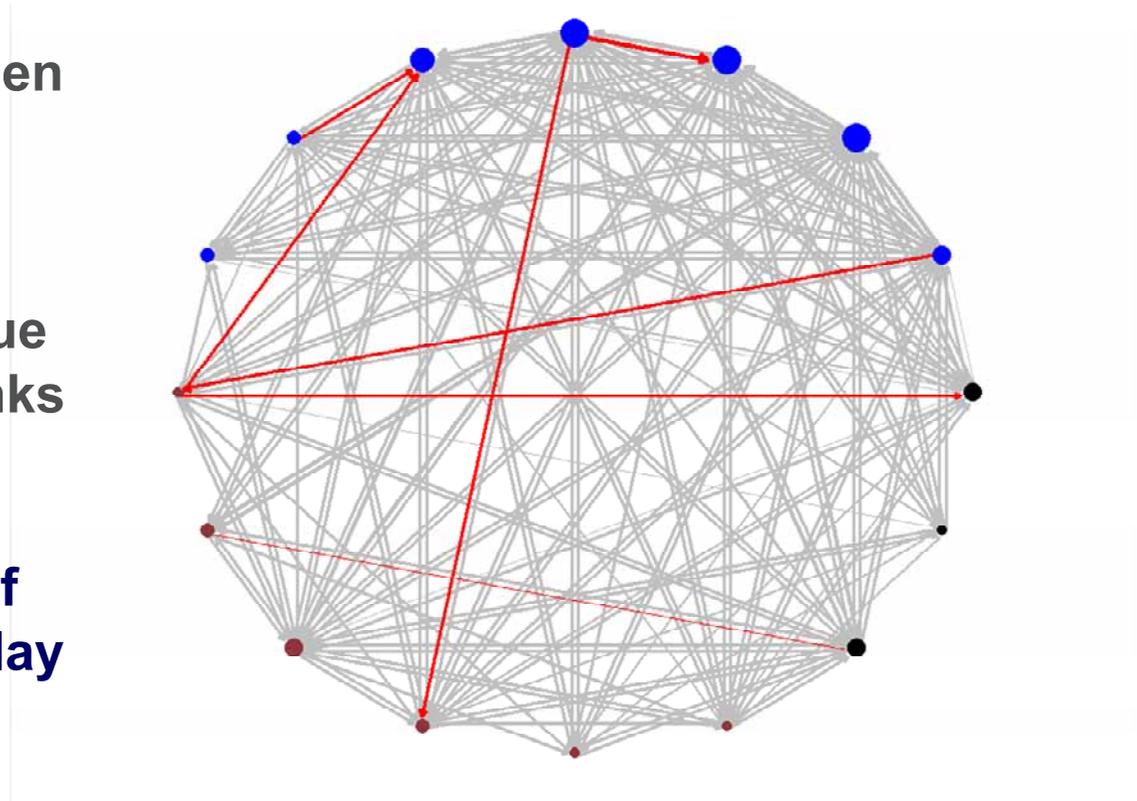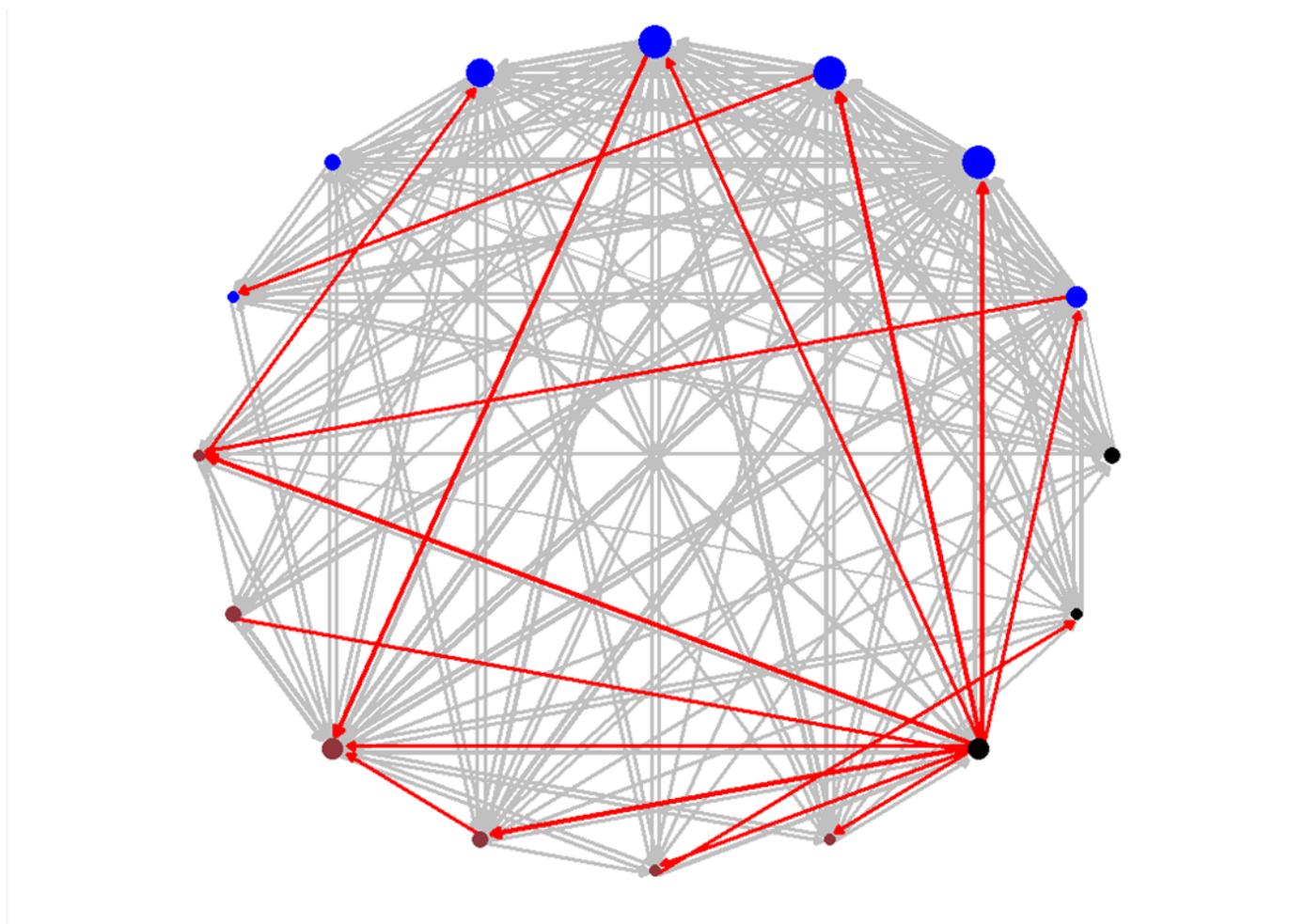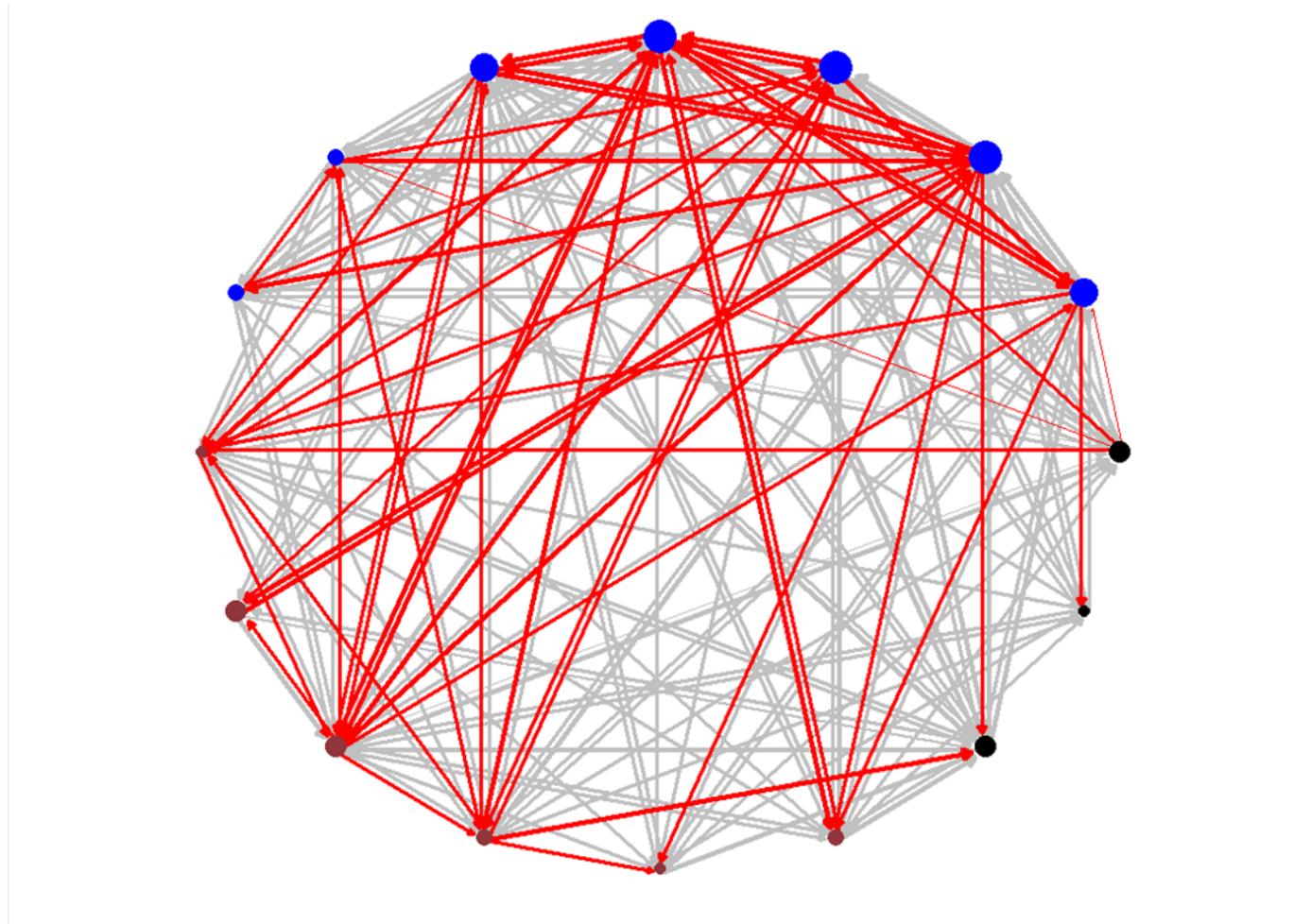
The delay is an endogenous, best-reply, response to others' behavior.

Fedwire Settlement Delay - September 2008

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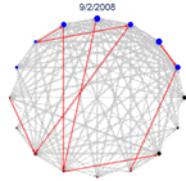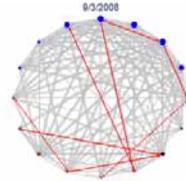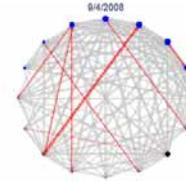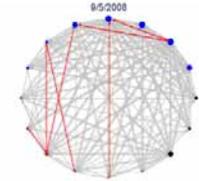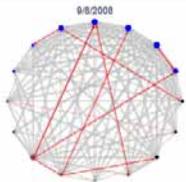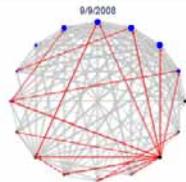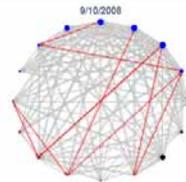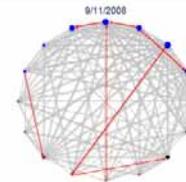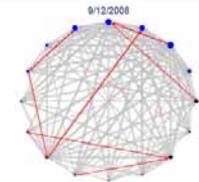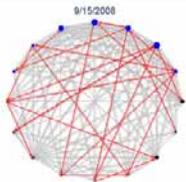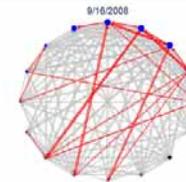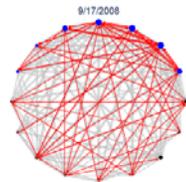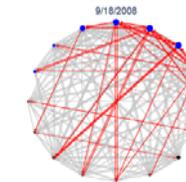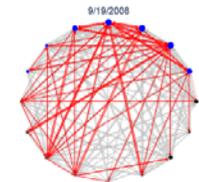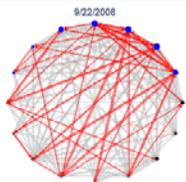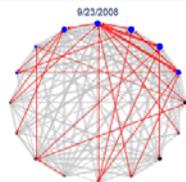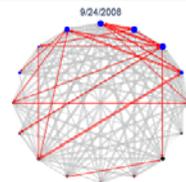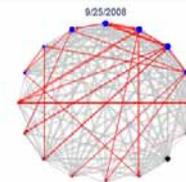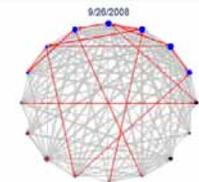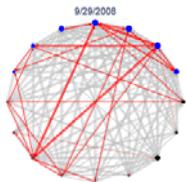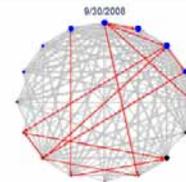
Time series plot of Opening Balances

Mean Monthly Opening Balances

Sources: Federal Reserve Bank of New York Author's calculations.
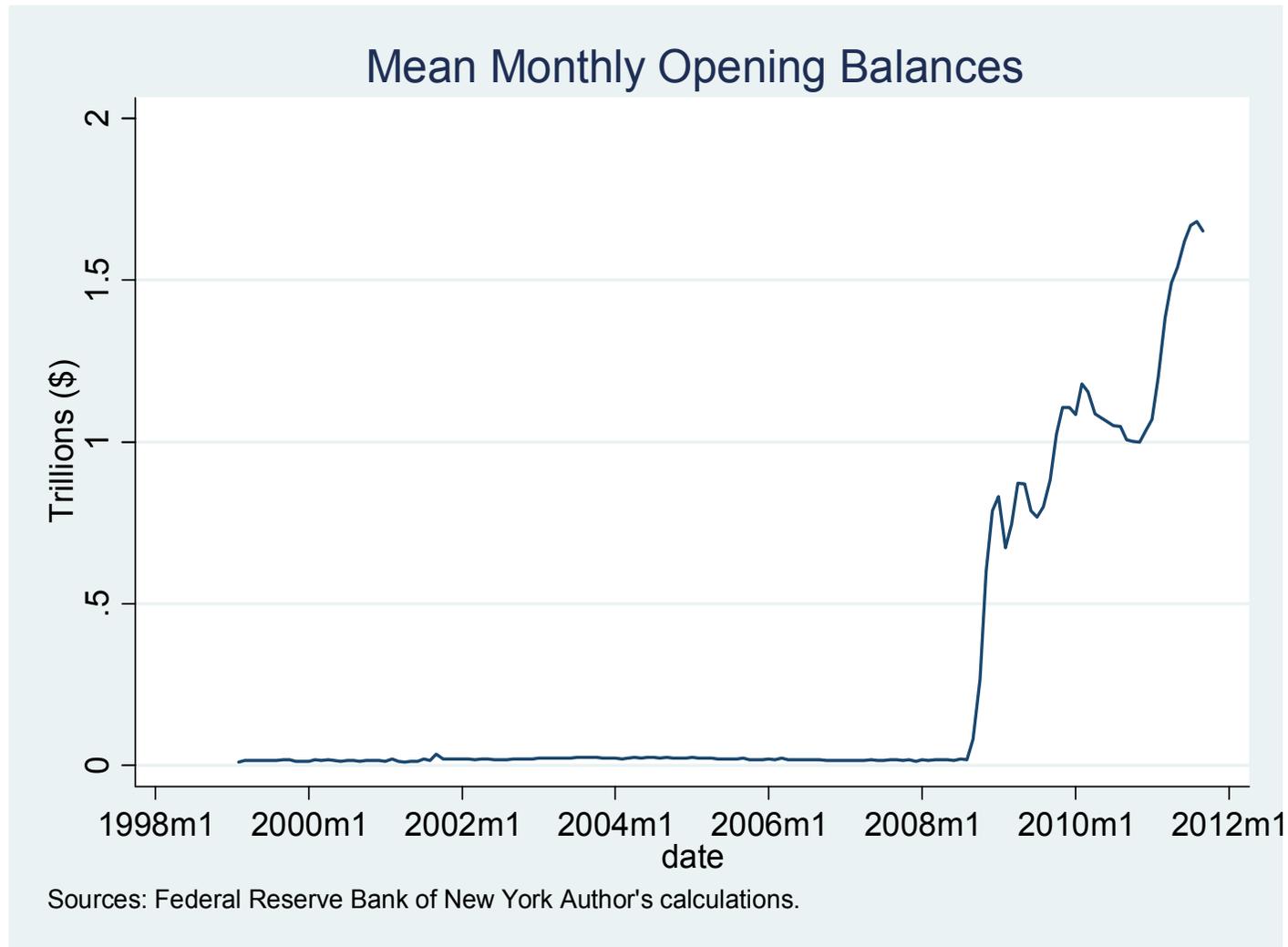
Levels of reserves, borrowing, and asset purchases

Legend:
- Total Assets
- All Liquidity Facilities and Lending in Support of Specific Institutions
- Securities Held Outright
- Reserve Balances

Y-axis: Billions of dollars (0, 500, 1,000, 1,500, 2,000, 2,500, 3,000)
X-axis: 2007, 2008, 2009, 2010, 2011
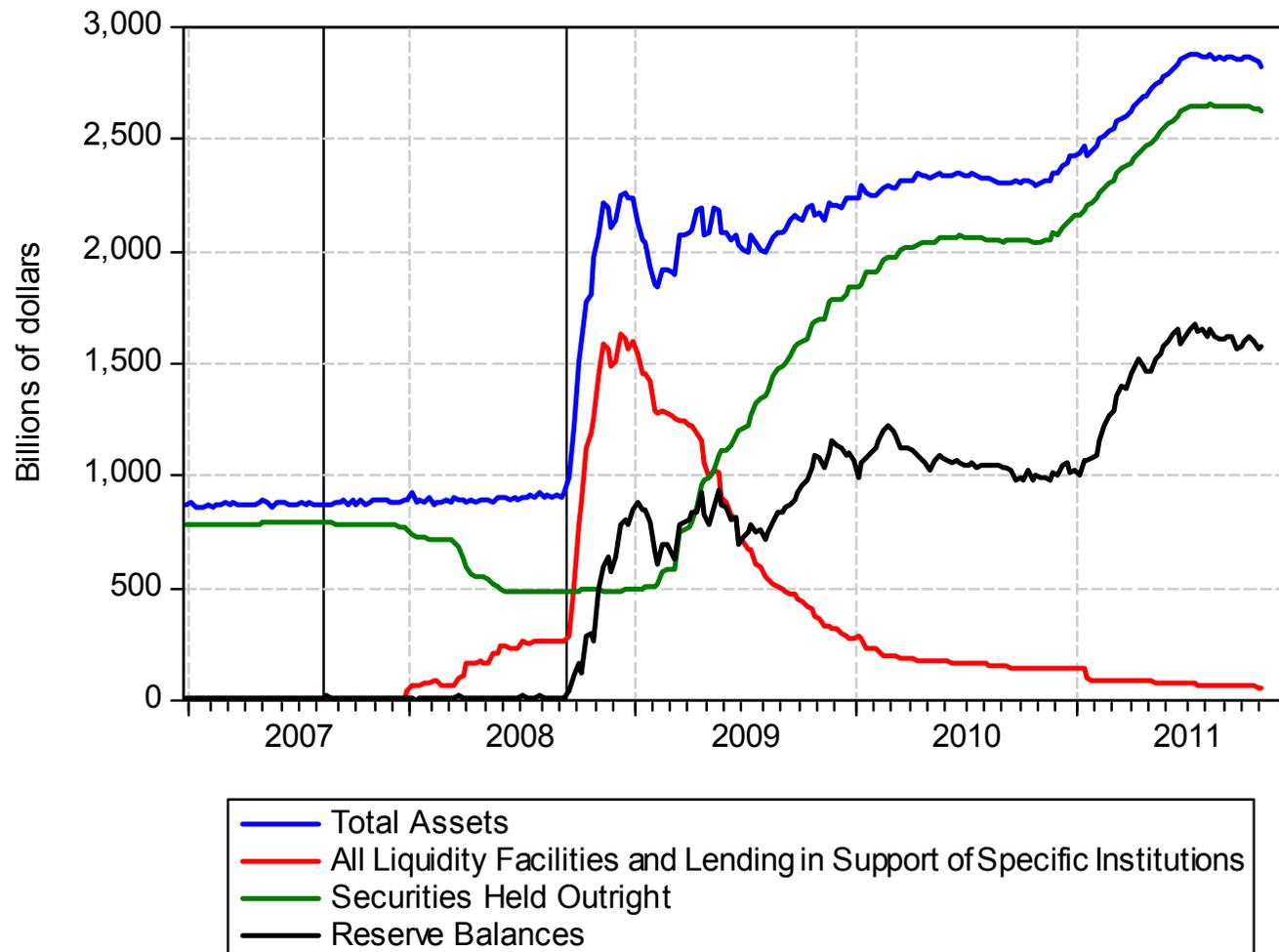
Deciles of Fedwire Value Settled Throughout the Day

Deciles of Fedwire Value Time Distribution
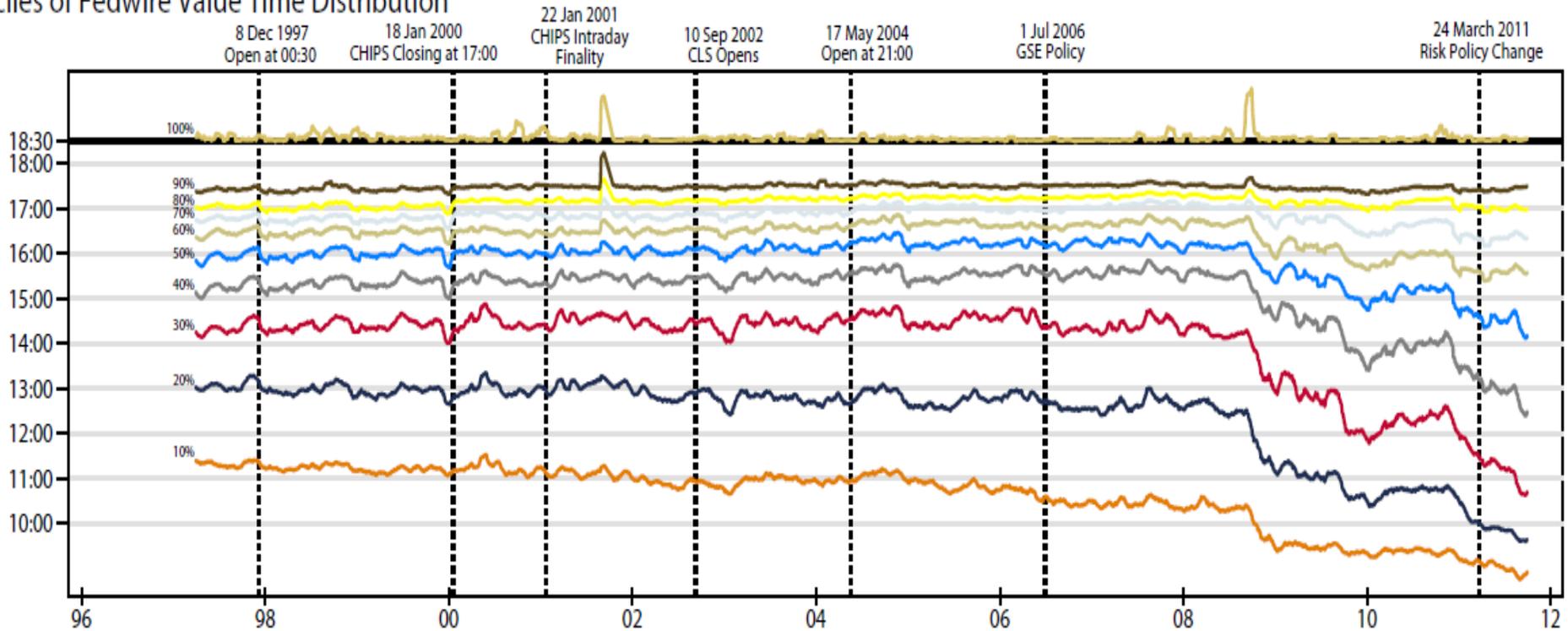
Notes: A twenty–one day centered moving average is used. Values exclude payments related to CHIPS, CLS, DTC, and P&I payment funding.
Sources: Federal Reserve Bank of New York. Authors' calculations.

Time series plot of HHI of Opening Balances

Mean Monthly HHI of
Opening Balances for Top 100 Banks

Sources: Federal Reserve Bank of New York Author's calculations.
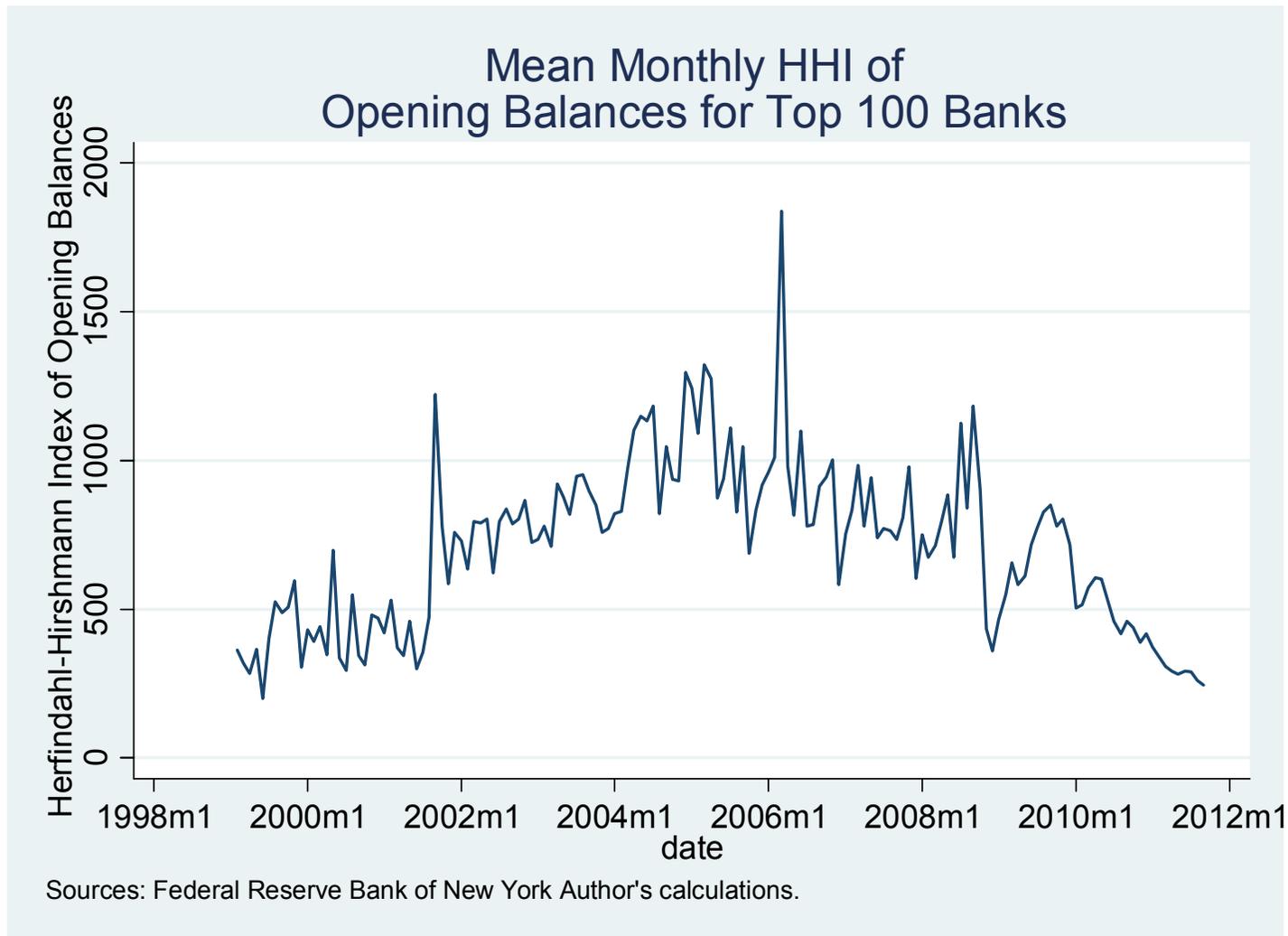
Time series plot of Tri-Party Repo Proxy

Mean Monthly Tri-Party Repo Proxy Value

Sources: Federal Reserve Bank of New York Author's calculations.
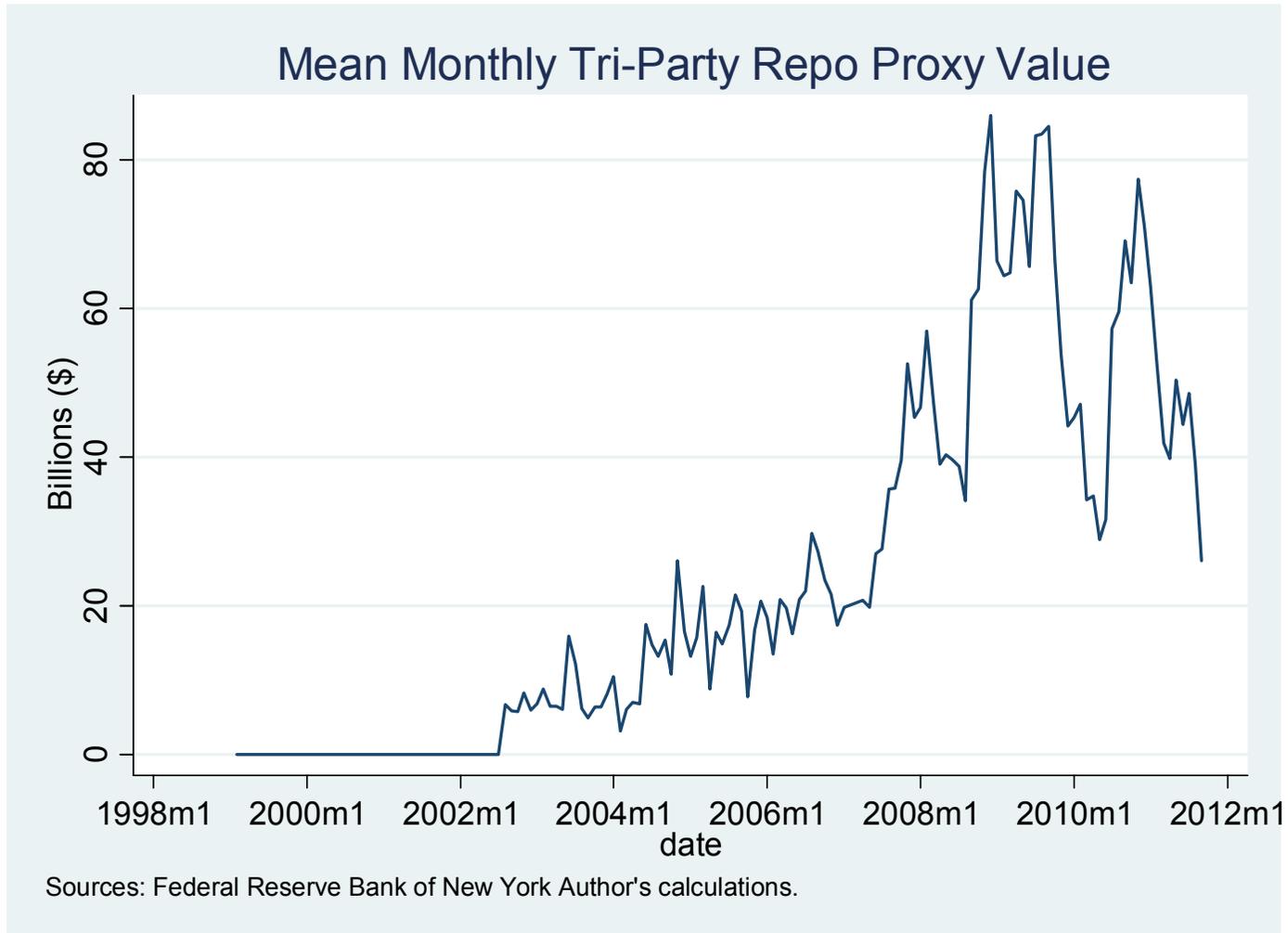
Model

The model is based on a previous paper, Armantier, Arnold, and McAndrews (2008) that examined the timing of each percentile of the distribution of settlement times on the Fedwire Funds transfer system.

$$\Delta p_t^{10} = \beta_0^{10} + \beta_1^{10} \times \Delta OpenBal_t + \beta_2^{10} \times \Delta 3PRepo_t + \Delta x_t^{AAM\,'} \times \boldsymbol{\beta}_{AMM}^{10} + \varepsilon_t^{10}$$

$$\Delta p_t^{20} = \beta_0^{20} + \beta_1^{20} \times \Delta OpenBal_t + \beta_2^{20} \times \Delta 3PRepo_t + \Delta x_t^{AAM\,'} \times \boldsymbol{\beta}_{AMM}^{20} + \varepsilon_t^{20}$$

$$\vdots$$

$$\Delta p_t^{90} = \beta_0^{90} + \beta_1^{90} \times \Delta OpenBal_t + \beta_2^{90} \times \Delta 3PRepo_t + \Delta x_t^{AMM\,'} \times \boldsymbol{\beta}_{AMM}^{90} + \varepsilon_t^{90}$$

Explanatory and control variables

We employ many variables, including

- Calendar effects of two types
    - Recurring dates (such as reserve maintenance period days)
    - One time policy changes, significant events, etc.
- Settlement times of auxiliary system, such as DTC and CHIPS
- The fed funds interest rate
- Numerous variables related to fed funds activity, eurodollar market activity, and in this paper we proxy for *triparty repo settlement payments*
- *The HHI of balances*
- *The level of balances*

Regression Table

| Explanatory Variables	30%, Pre-Lehman	30%, Post-Lehman	60%, Pre-Lehman	60%, Post-Lehman	90%, Pre-Lehman	90%, Post-Lehman
Change in sum of opening balances	0.136	-0.131**	0.0700	-0.0613*	0.0526	-0.0273*
	[0.0950]	[0.0377]	[0.0564]	[0.0254]	[0.0488]	[0.0113]
Change in tri-part repo activity	-0.00401	0.426**	-0.0115	0.227**	-0.0675*	0.0298
	[0.0738]	[0.119]	[0.0389]	[0.0738]	[0.0306]	[0.0322]
Change in customer transfers value	-0.0474**	-0.0229	0.00757	0.0402	0.00975**	0.0338*
	[0.0119]	[0.0236]	[0.00755]	[0.0293]	[0.00378]	[0.0162]
Change in value of federal funds deliveries	0.103*	-0.0972	0.0264	0.0189	-0.00168	0.000221
	[0.0456]	[0.0753]	[0.0231]	[0.0499]	[0.0334]	[0.0272]
Change in value of federal funds returns	0.0666	-0.169*	0.0274	-0.146**	-0.0279	-0.0240
	[0.0341]	[0.0781]	[0.0222]	[0.0419]	[0.0225]	[0.0225]
Change in target federal funds rate	537.9	98.77	325.7	653.8*	-147.2	-107.9
	[543.0]	[286.1]	[305.3]	[292.1]	[318.7]	[183.4]
Change in deviation from fed funds target rate	-3.240	-3.302	-8.300*	-5.861	-3.620	0.878
	[4.859]	[4.610]	[3.391]	[3.665]	[2.338]	[1.624]
Change in HHI of value sent	0.158**	0.158**	0.0578	0.110**	0.0165*	0.0430*
	[0.0420]	[0.0353]	[0.0329]	[0.0371]	[0.00799]	[0.0197]
Change in final pay-outs, total value of payments	0.0626	-0.103	0.0671**	-0.0156	0.00851	-0.00987
	[0.0422]	[0.0706]	[0.0217]	[0.0322]	[0.0129]	[0.0160]
Change in DTC final pay-out value	0.00639	-0.469	0.0389	0.328	0.00276	-0.0958
	[0.0465]	[0.535]	[0.0214]	[0.417]	[0.0229]	[0.186]
Change in length of an extension to Fedwire operating hours	0.0760*	0.0382	0.0460**	0.0260	0.172*	0.0384**
	[0.0350]	[0.0552]	[0.0174]	[0.0259]	[0.0737]	[0.0122]
Change in total volume of Fedwire (non-settlement)	0.0414**	0.0147	0.0115	-0.0242	0.00199	-0.0153
	[0.0159]	[0.0200]	[0.00673]	[0.0172]	[0.00584]	[0.00995]
Change in Eurodollar borrowing value	0.0500	0.0211	0.0214	0.103	-0.0174	0.0589*
	[0.0374]	[0.0576]	[0.0201]	[0.0531]	[0.0159]	[0.0261]
Change in Eurodollar lending value	0.138**	0.0395	0.0850*	0.0862	0.0366	0.0462
	[0.0522]	[0.0536]	[0.0337]	[0.0598]	[0.0216]	[0.0268]
Change in HHI of opening balances for top 100	0.000381	0.0337*	0.000632	0.0162*	-0.000791	0.00550
	[0.000657]	[0.0140]	[0.000329]	[0.00714]	[0.000461]	[0.00399]
Change in Sept 11-18, 2001	-24.33	--	36.62*	--	79.83**	--
	[15.23]	--	[15.71]	--	[27.69]	--
Constant	-0.0395	0.0681	-0.0273	0.144	-0.0233	0.0940
	[0.135]	[0.280]	[0.0696]	[0.186]	[0.0674]	[0.0927]
Observations	1,810	760	1,810	760	1,810	760
R-squared	0.449	0.535	0.595	0.535	0.480	0.501

Standard errors in brackets
** p<0.01, * p<0.05

# Residuals, pre- and post-Lehman periods
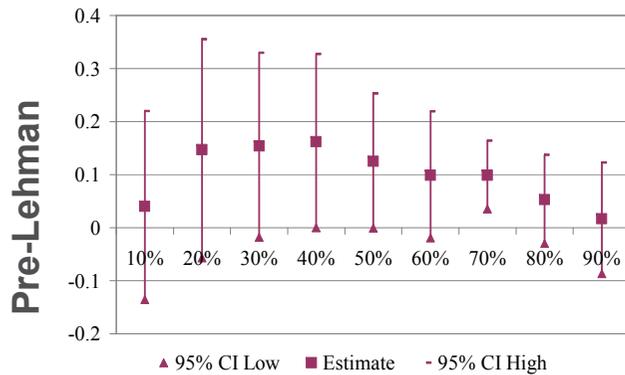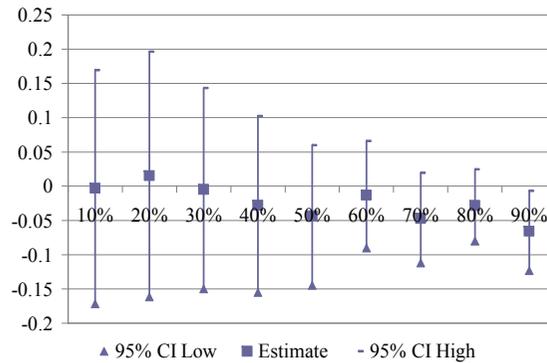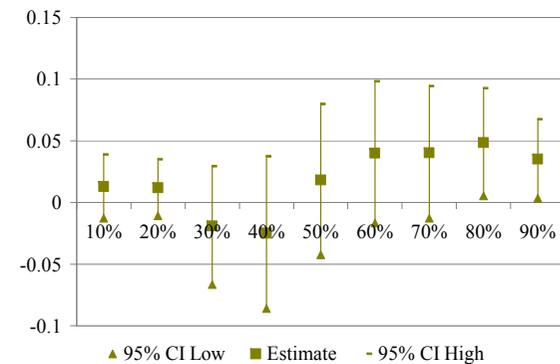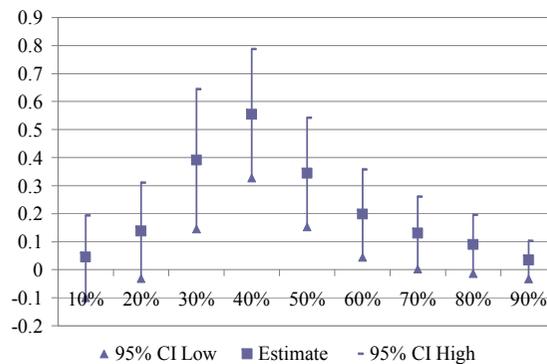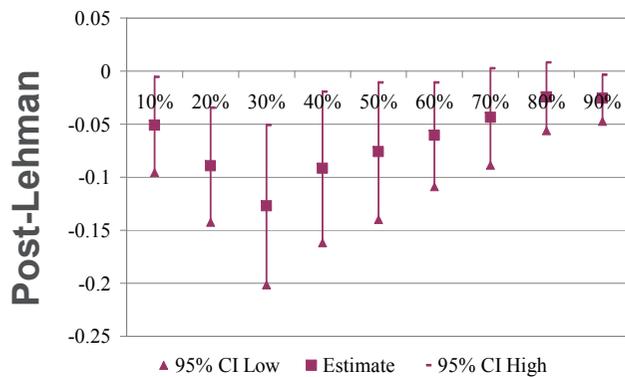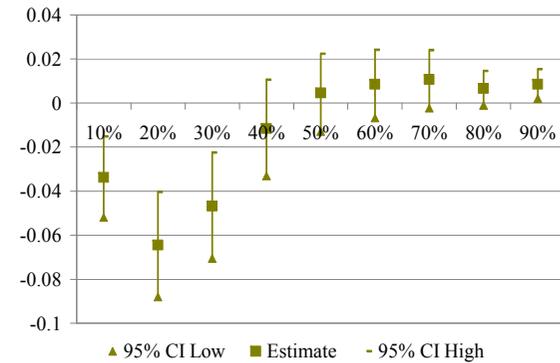
Explanatory Variables		Percentile								
		10%	20%	30%	40%	50%	60%	70%	80%	90%
Change in customer transfers value	Coefficient (minutes/Billion ($))	0.0141	0.0067	-0.0229	-0.0213	0.0204	0.0402	0.0389	0.0467*	0.0338*
	Estimated Effect on Timing (hours)	-0:07	-0:03	0:11	0:10	-0:10	-0:19	-0:19	-0:23	-0:16
Change in DTC final pay-out value	Coefficient (minutes/Billion ($))	0.6192	0.4665	-0.4688	0.5587	-0.2970	0.3278	-0.3297	-0.2230	-0.0958
	Estimated Effect on Timing (hours)	-0:01	0:00	0:00	-0:01	0:00	0:00	0:00	0:00	0:00
Change in Eurodollar borrowing value	Coefficient (minutes/Billion ($))	0.0625**	0.0489	0.0211	0.0735	0.1178**	0.1030	0.0920	0.0848*	0.0589*
	Estimated Effect on Timing (hours)	-0:07	-0:05	-0:02	-0:08	-0:13	-0:12	-0:10	-0:11	-0:06
Change in Eurodollar lending value	Coefficient (minutes/Billion ($))	0.0325	0.0390	0.0395	0.0806	0.0962	0.0862	0.0953	0.0794	0.0462
	Estimated Effect on Timing (hours)	-0:04	-0:05	-0:06	-0:12	-0:14	-0:12	-0:14	-0:11	-0:06
Change in length of an extension to Fedwire operating hours	Coefficient (minutes/Billion ($))	-0.0171	0.0453	0.0382	0.0688	0.0442	0.0260	0.0472*	0.042**	0.0384**
	Estimated Effect on Timing (hours)	0:04	-0:12	-0:10	-0:18	-0:11	-0:06	-0:12	-0:11	-0:10
Change in value of federal funds deliveries	Coefficient (minutes/Billion ($))	0.0041	-0.0914	-0.0972	-0.1549*	-0.0678	0.0189	0.0262	0.0108	0.0002
	Estimated Effect on Timing (hours)	0:00	0:10	0:11	0:18	0:08	-0:02	-0:03	-0:01	0:00
Change in deviation from fed funds target rate	Coefficient (minutes/Billion ($))	-1.7189	-9.6522*	-3.3020	-10.0093	-2.5737	-5.8609	0.9172	3.6761	0.8779
	Estimated Effect on Timing (hours)	0:01	0:05	0:01	0:05	0:01	0:03	0:00	-0:02	0:00
Change in value of federal funds returns	Coefficient (minutes/Billion ($))	-0.0594	-0.1259*	-0.1686*	-0.2491**	-0.2326**	-0.1463**	-0.1166**	-0.0504	-0.0240
	Estimated Effect on Timing (hours)	0:04	0:09	0:12	0:18	0:17	0:10	0:08	0:03	0:01
Change in final pay-outs, total value of payments	Coefficient (minutes/Billion ($))	-0.0344	-0.1068*	-0.1030	-0.0184	-0.0383	-0.0156	-0.0171	-0.0312	-0.0099
	Estimated Effect on Timing (hours)	-0:02	-0:06	-0:06	-0:01	-0:02	0:00	-0:01	-0:01	0:00
Change in HHI of opening balances for top 100	Coefficient (minutes/Billion ($))	0.0181**	0.0176*	0.0337*	0.024*	0.0088	0.0162*	0.0071	0.0032	0.0055
	Estimated Effect on Timing (hours)	-0:23	-0:22	-0:43	-0:30	-0:11	-0:20	-0:09	-0:04	-0:07
Change in HHI of value sent	Coefficient (minutes/Billion ($))	0.0445*	0.0977**	0.1585**	0.1478**	0.1172**	0.1103**	0.1128**	0.0705**	0.043*
	Estimated Effect on Timing (hours)	-0:02	-0:05	-0:08	-0:08	-0:06	-0:06	-0:06	-0:03	-0:02
Change in sum of opening balances	Coefficient (minutes/Billion ($))	-0.0503*	-0.0917**	-0.1313**	-0.0956**	-0.0772*	-0.0613*	-0.0458	-0.0259	-0.0273*
	Estimated Effect on Timing (hours)	-1:10	-2:08	-3:03	-2:13	-1:47	-1:25	-1:04	-0:36	-0:38
Change in target federal funds rate	Coefficient (minutes/Billion ($))	83.5125	1085.895**	98.7725	63.6994	1,145.6930	653.774**	287.0886	-14.1479	-107.8923
	Estimated Effect on Timing (hours)	-0:02	-0:36	-0:03	-0:02	-0:38	-0:21	-0:09	0:00	0:03
Change in tri-part repo activity	Coefficient (minutes/Billion ($))	0.0634	0.1508	0.4257**	0.5536**	0.3406**	0.2273**	0.1544*	0.0810	0.0298
	Estimated Effect on Timing (hours)	-0:02	-0:06	-0:19	-0:25	-0:15	-0:10	-0:07	-0:03	-0:01
Change in total volume of Fedwire (non-settlement)	Coefficient (minutes/Billion ($))	-0.0112	0.0078	0.0147	0.0178	-0.0080	-0.0242	-0.0153	-0.0222	-0.0153
	Estimated Effect on Timing (hours)	-0:04	0:02	0:05	0:06	-0:02	-0:08	-0:05	-0:08	-0:05
Actual Time Change	Actual Change in Timing (hours)	-1:47	-3:01	-3:37	-3:02	-2:10	-1:39	-0:57	-0:36	-0:24

Daylight Overdrafts, absolute and as percentage of Fedwire Value
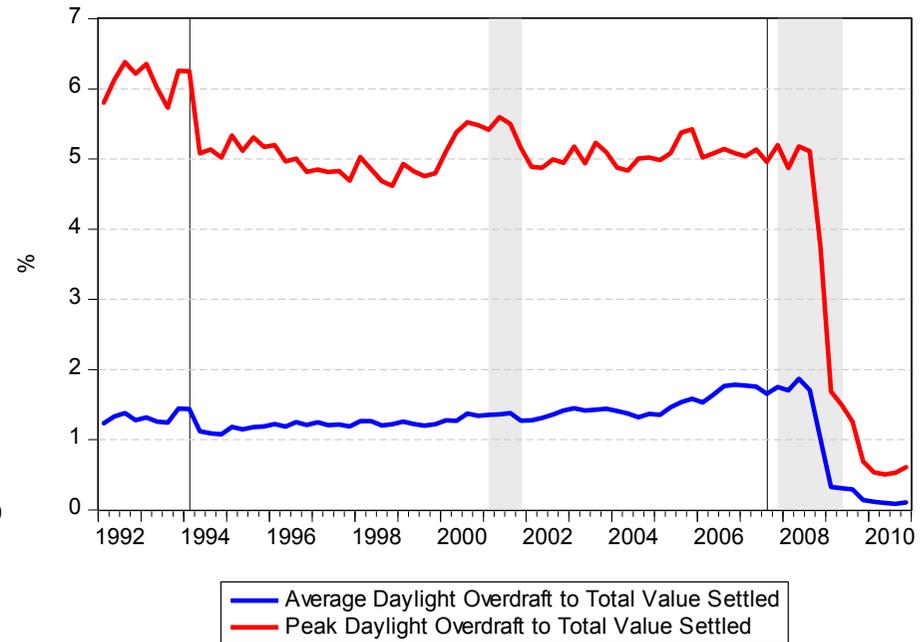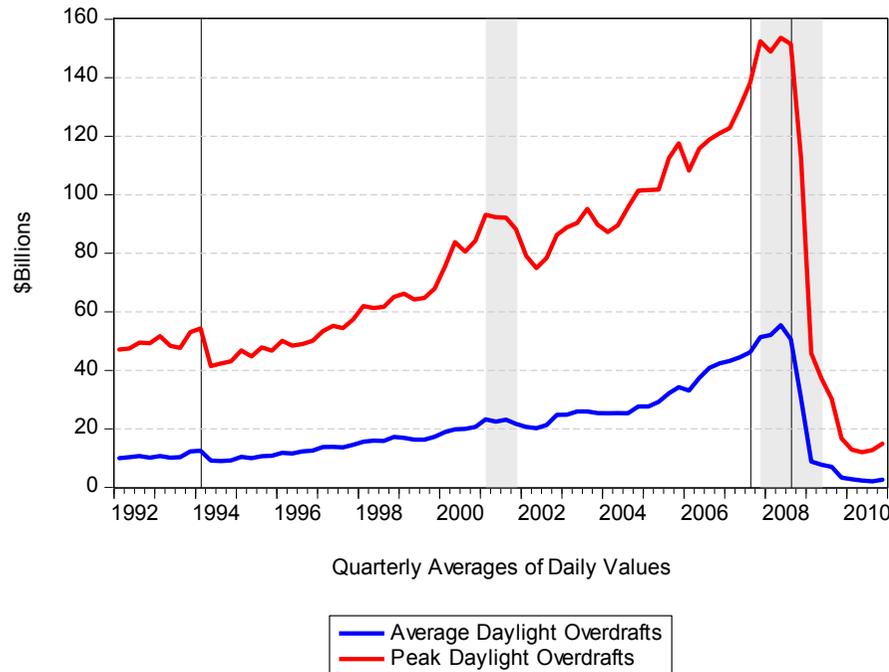
Note: Vertical lines denote Jan 1, 1994, Aug. 8, 2007 and Sept. 15, 2008. Shading reflects NBER recessions.
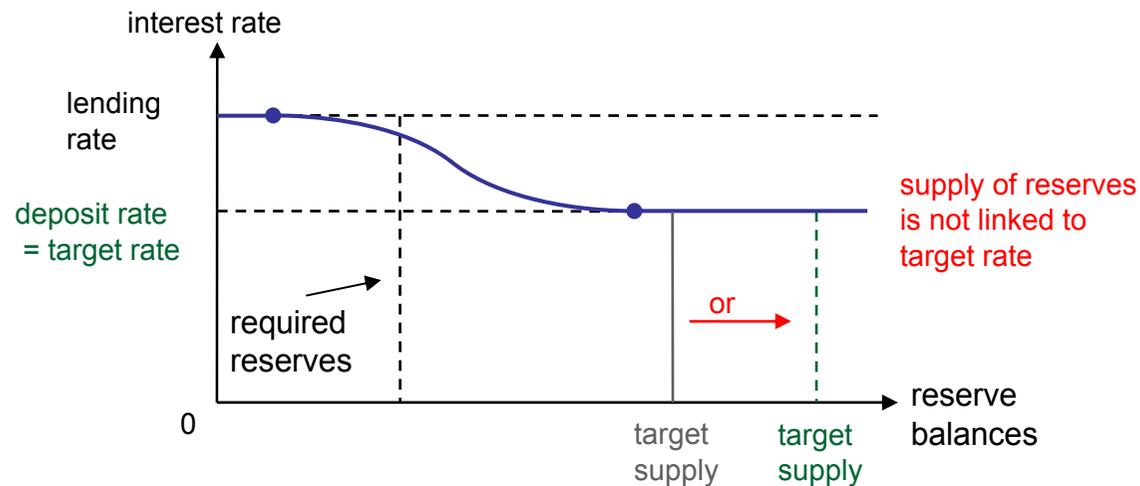
From the perspective of payment system efficiency, monetary authorities should:

1.Reduce the opportunity cost of the marginal level of reserve balances, and

2.Appropriately balance the benefits from higher reserves for payment system efficiency against the increased interest risk of higher asset holdings.

Summary findings

- The massive increase in Federal Reserve supplied bank reserves, caused both by lending to banks and the LSAP programs, appears to be very highly correlated with a remarkable quickening of payments settled on the Fedwire Funds Transfer Service.

- This quickening represents a much higher level of settlement liquidity in the U.S. payment system.

- The quickening occurred concurrently with a huge decline in the provision of daylight credit by the Federal Reserve.

- The provision of high levels of reserves can significantly improve the functioning of payment systems.