Systemic Dynamics in the Federal Funds Market

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Preliminary results from work in progress

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Disclaimer: The opinions presented are those of the authors and not of the Federal Reserve Bank of New or the Federal Reserve System.

Perspective

- Like any over-the-counter market, the Federal Funds market is subject to allocation frictions.
- Trading is normally conducted through isolated bilateral negotiation.
- Precautionary intra-day control of balances by a given bank is dynamically stabilizing for that bank's balances, when taking the remainder of the market as given.
- We raise, but do not yet resolve, whether precautionary behavior can be systemically destabilizing in some extreme settings.

Connections with Search-Based Market Theory

- So far, the available theories of trading dynamics in over-the-counter markets are based on search.
- Any trader contacts any other trader randomly over time, with an intensity that may depend on incentives to trade.
- At contact, counterparties negotiate bilaterally, each having the option to search for another counterparty.
- The negotiated price reflects the difficulty with which alternative suitable counterparties can be contacted.
- As search intensities get large, one obtains the effect of efficient-allocation centralized market.

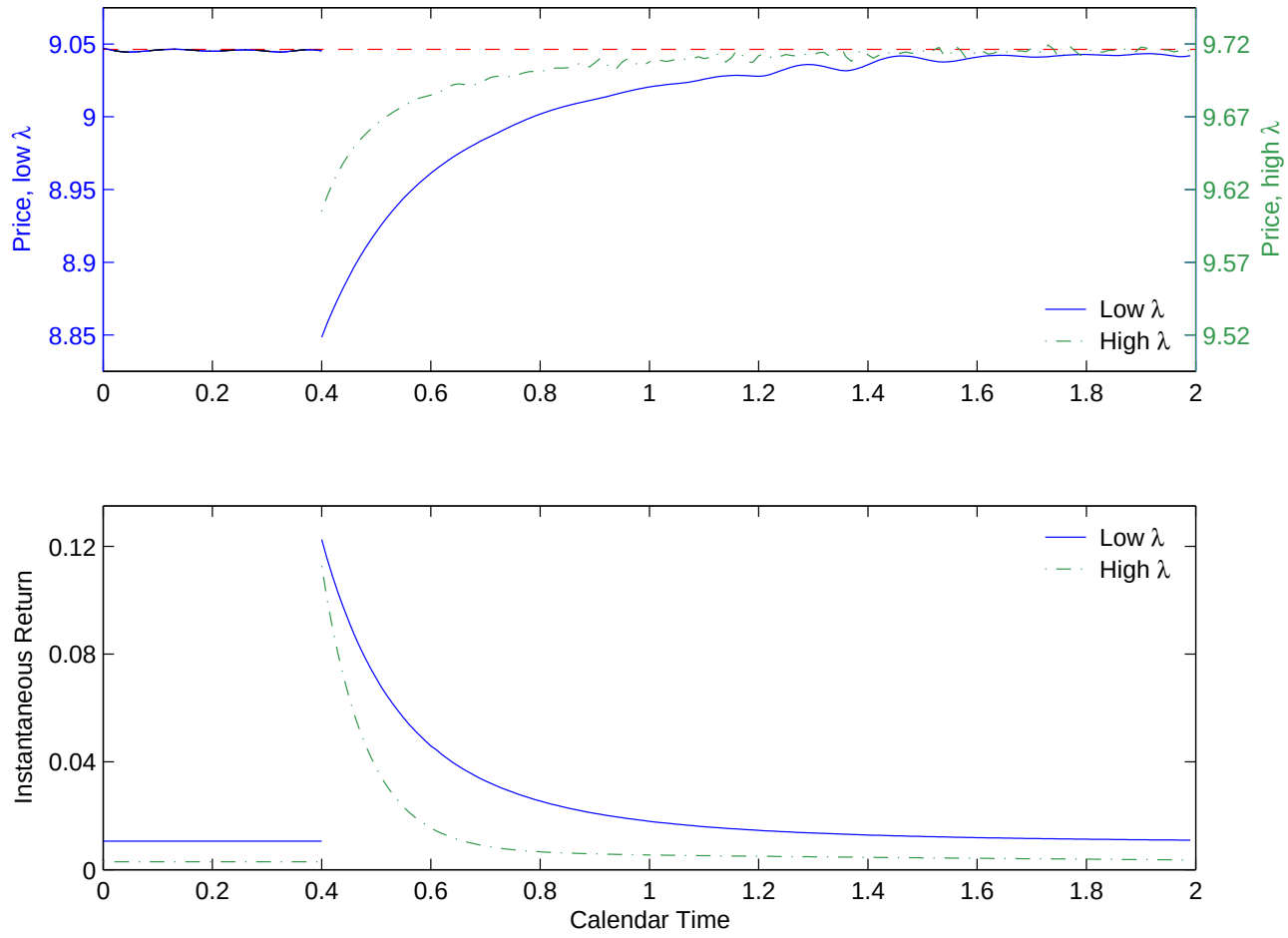


Figure 1: Liquidity shock at time 0.4. Low search intensity $\lambda = 125$; high search intensity $\lambda = 625$. Source: Duffie, Gârleanu, and Pedersen (2005).

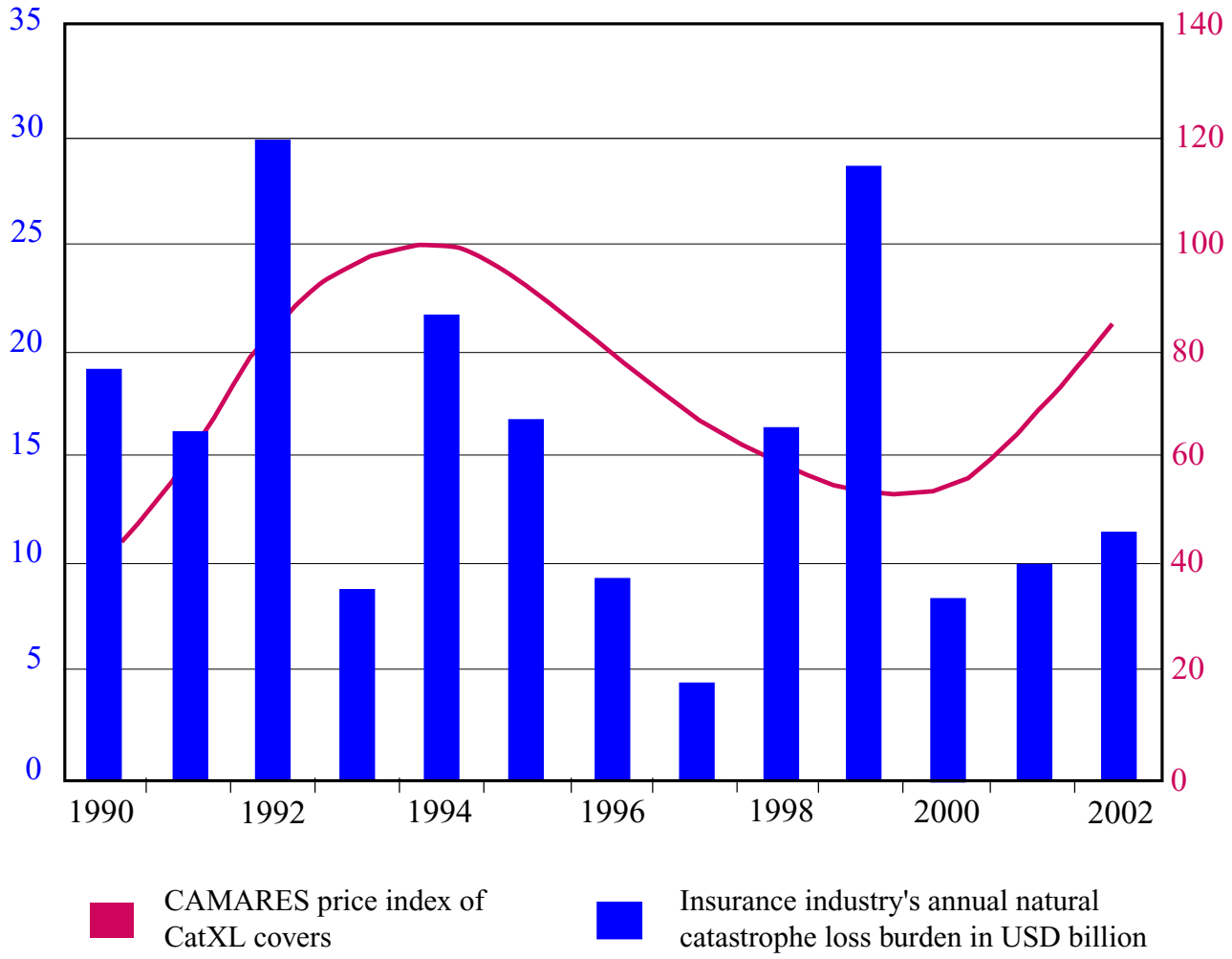


Figure 2: Catastrophe risk: premiums and global volume of claims. Source: Swiss Re

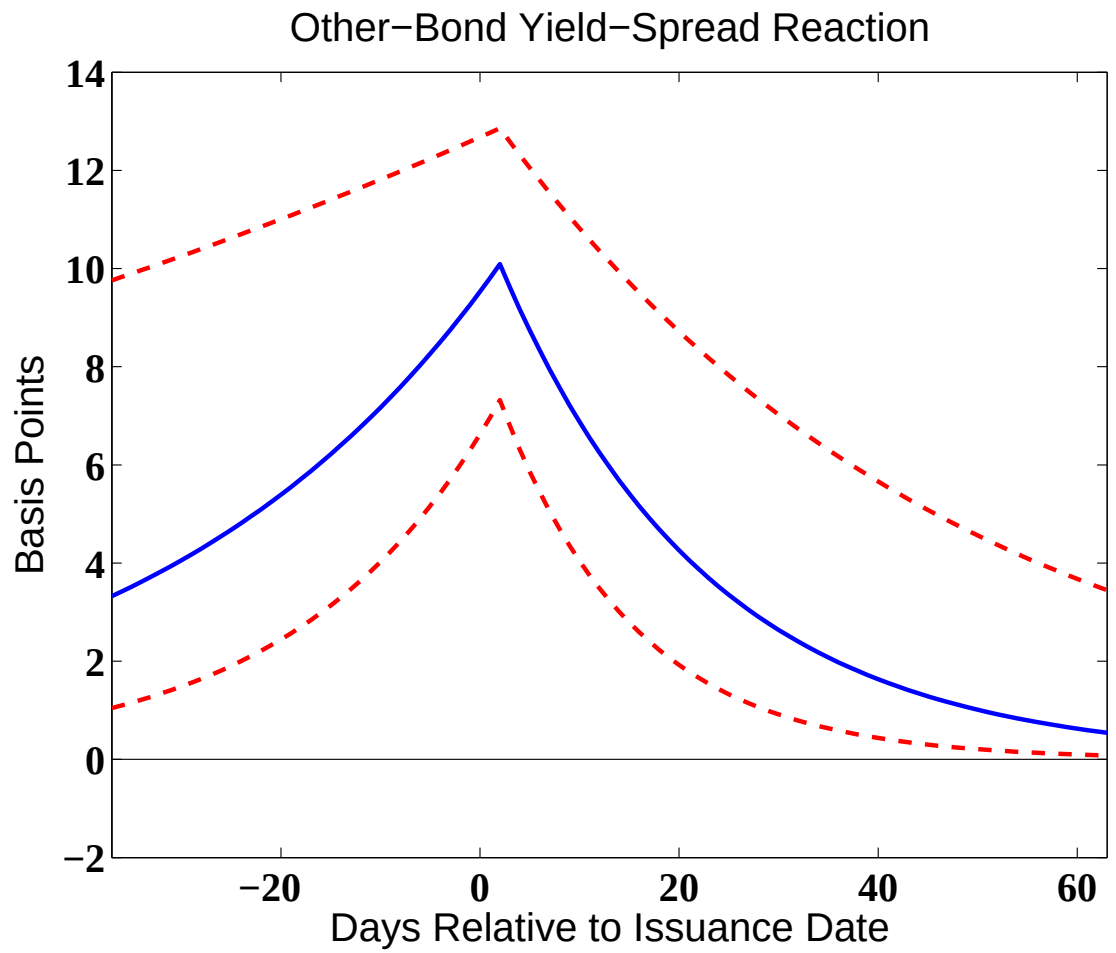


Figure 3: Capital immobility in the Telecom debt market Source: Newman-Rierson (2003).

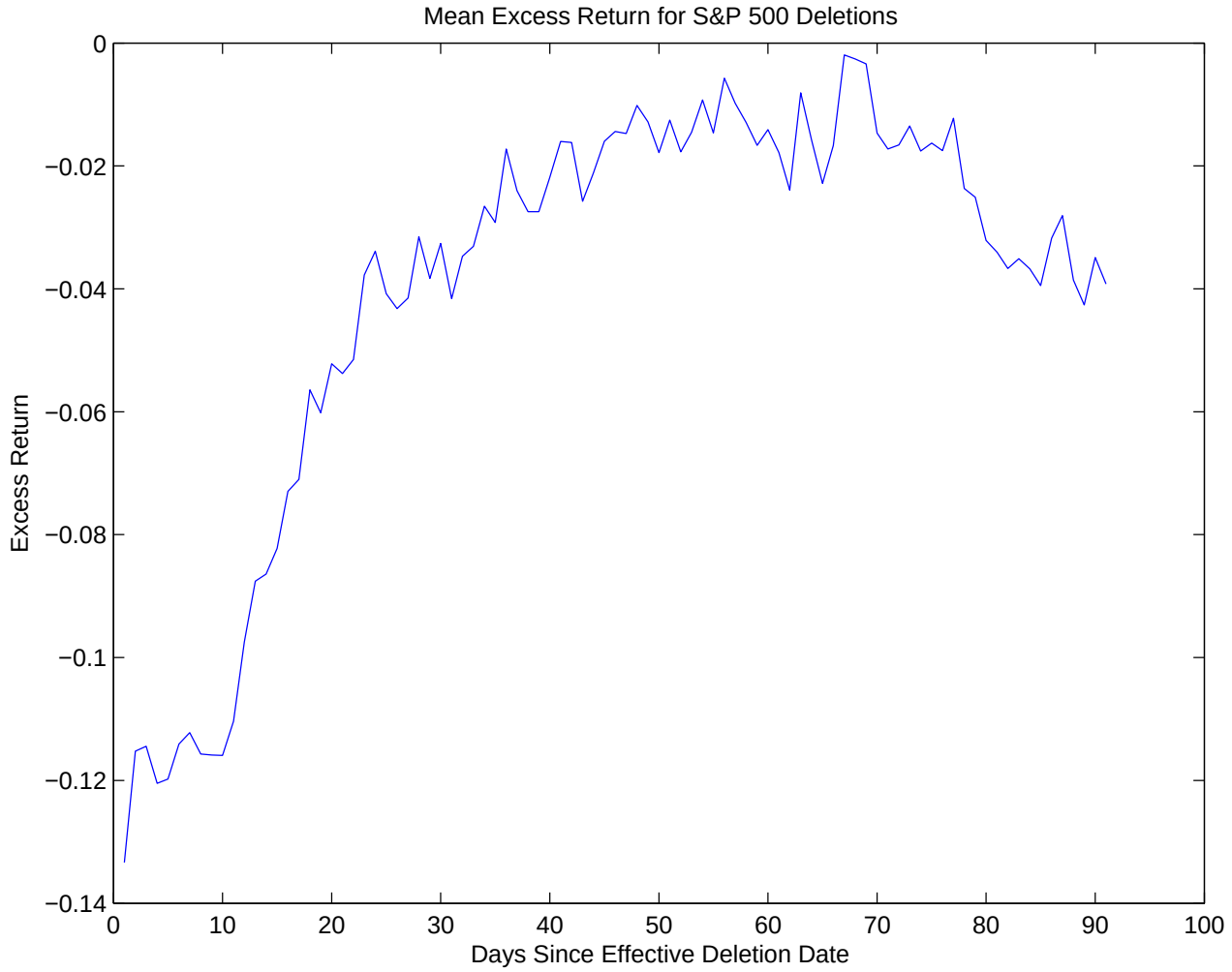


Figure 4: Cumulative returns for dropped S&P500 stocks.

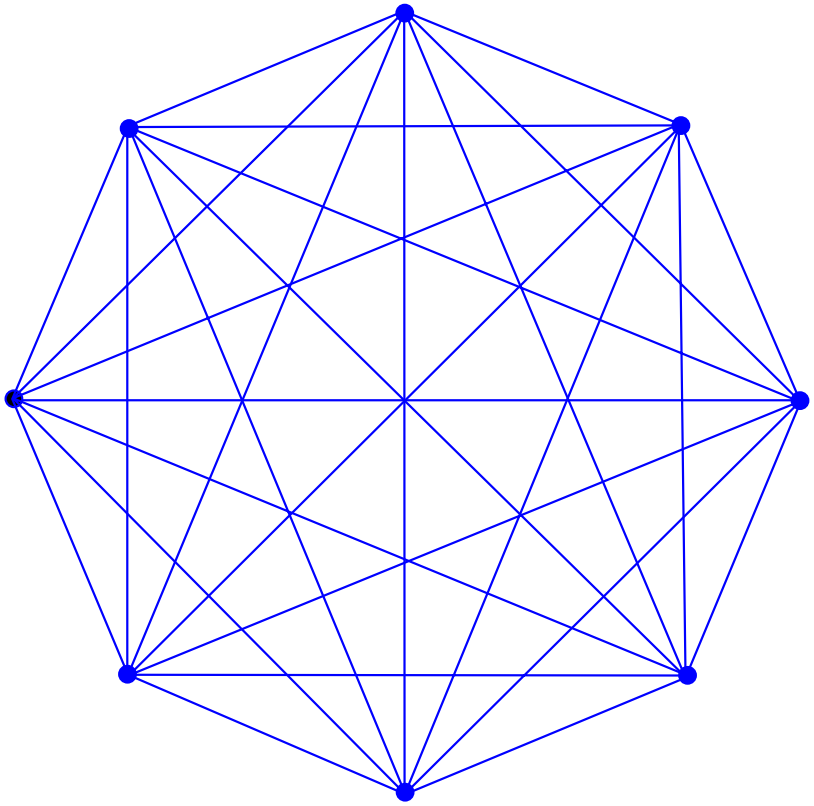


Figure 5: An over-the-counter market is completely connected, but not transparent. Search and negotiation are crucial.

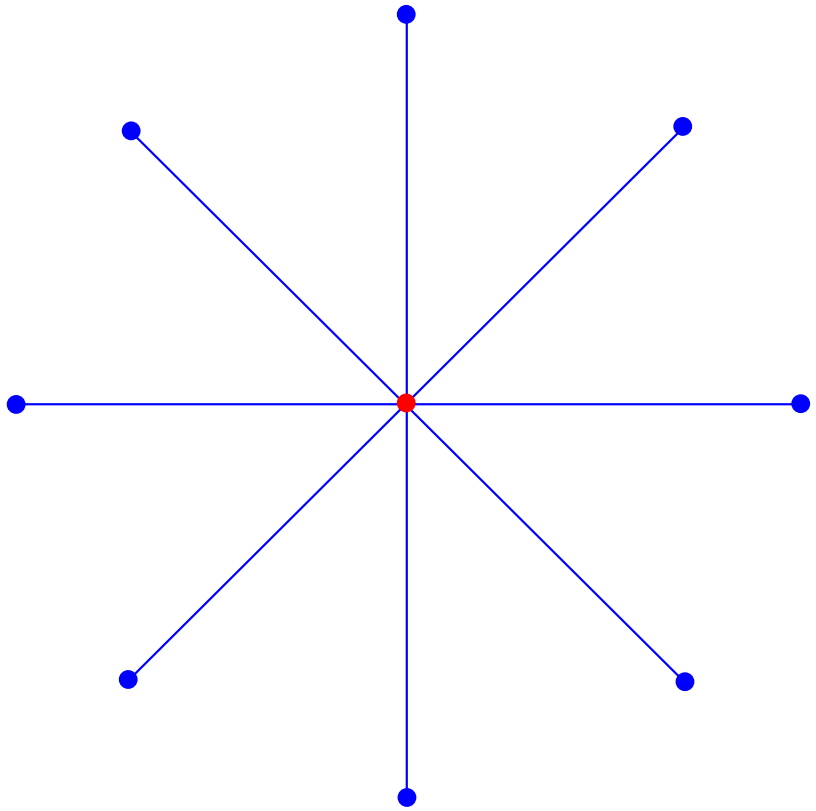


Figure 6: If search costs are the only market friction, the most efficient market structure is hub-and-spoke, for example an electronic limit-order book, or a single broker.

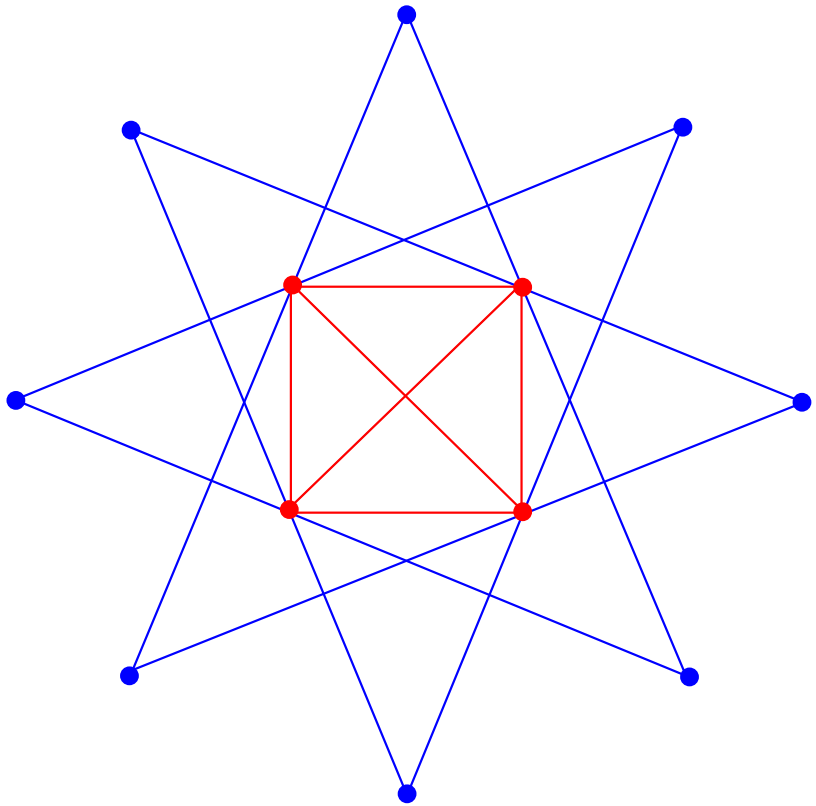


Figure 7: Because of size differences, the "effective" market structure of over-the-counter markets is a hybrid. See Soromäki, Bech, Arnold, Glass, and Beyeler (2006).

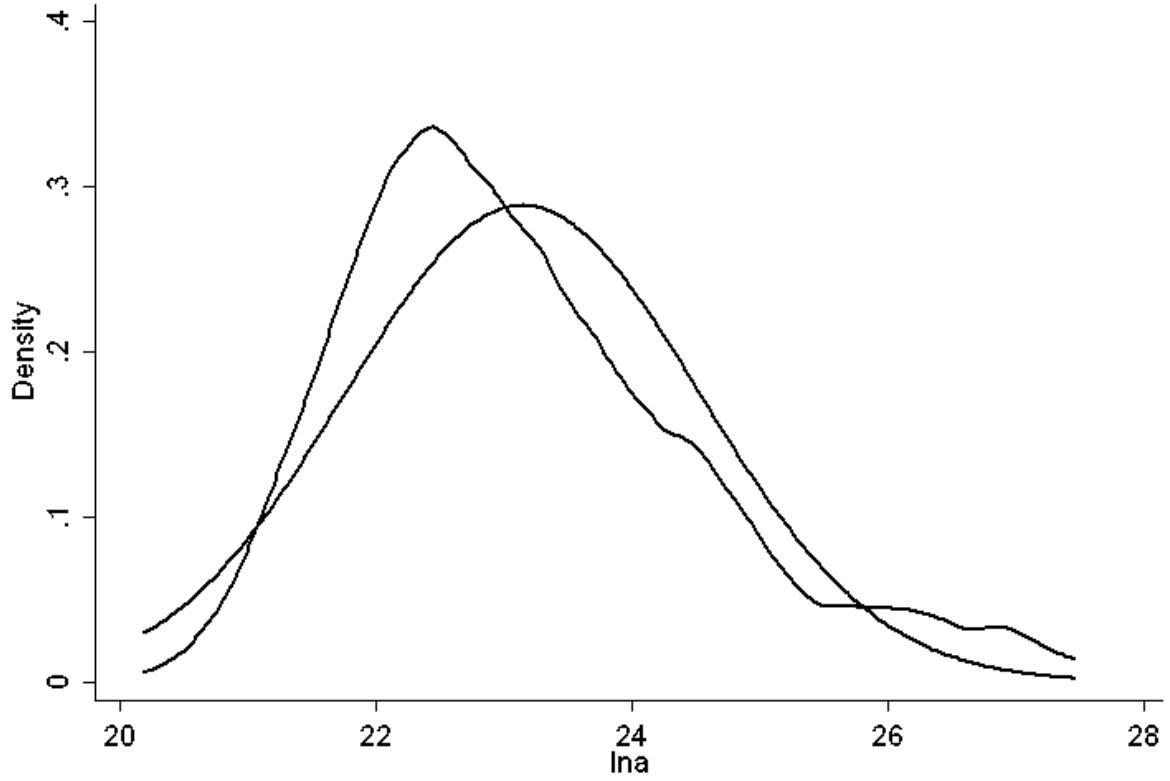


Figure 8: The cross-sectional distribution of fed-funds senders by total volume in December 2005 is more skewed than log-normal.

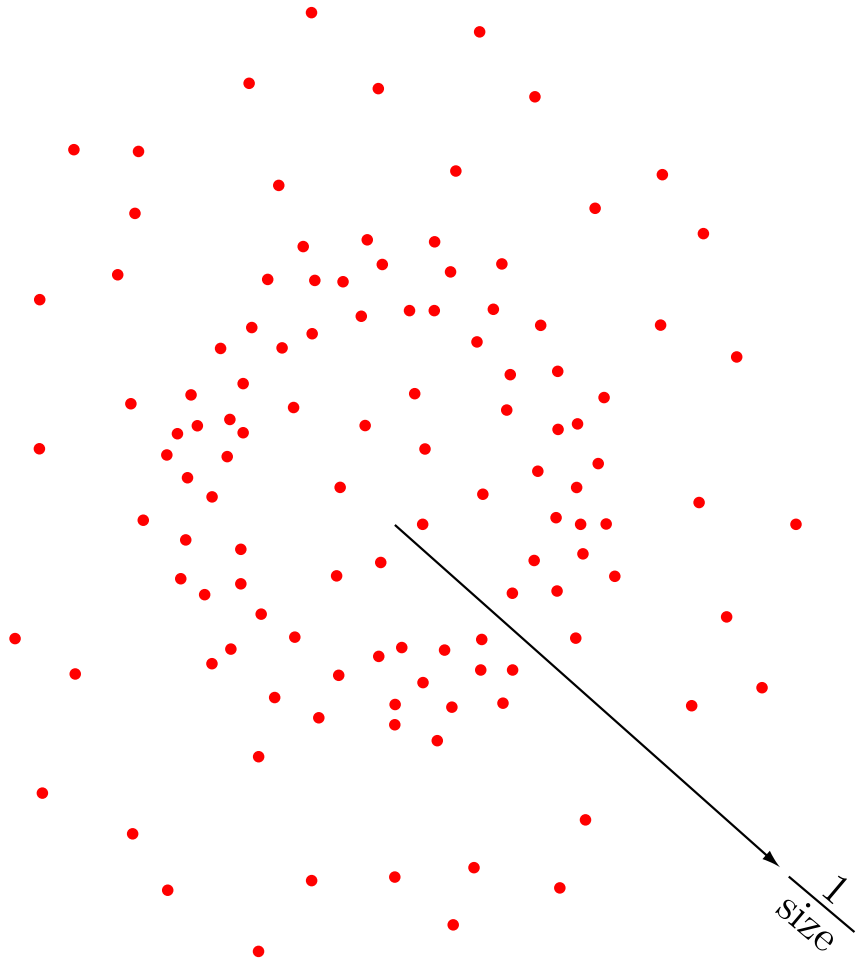


Figure 9: Stylized "fuzzy" hub-and-spoke market structure.

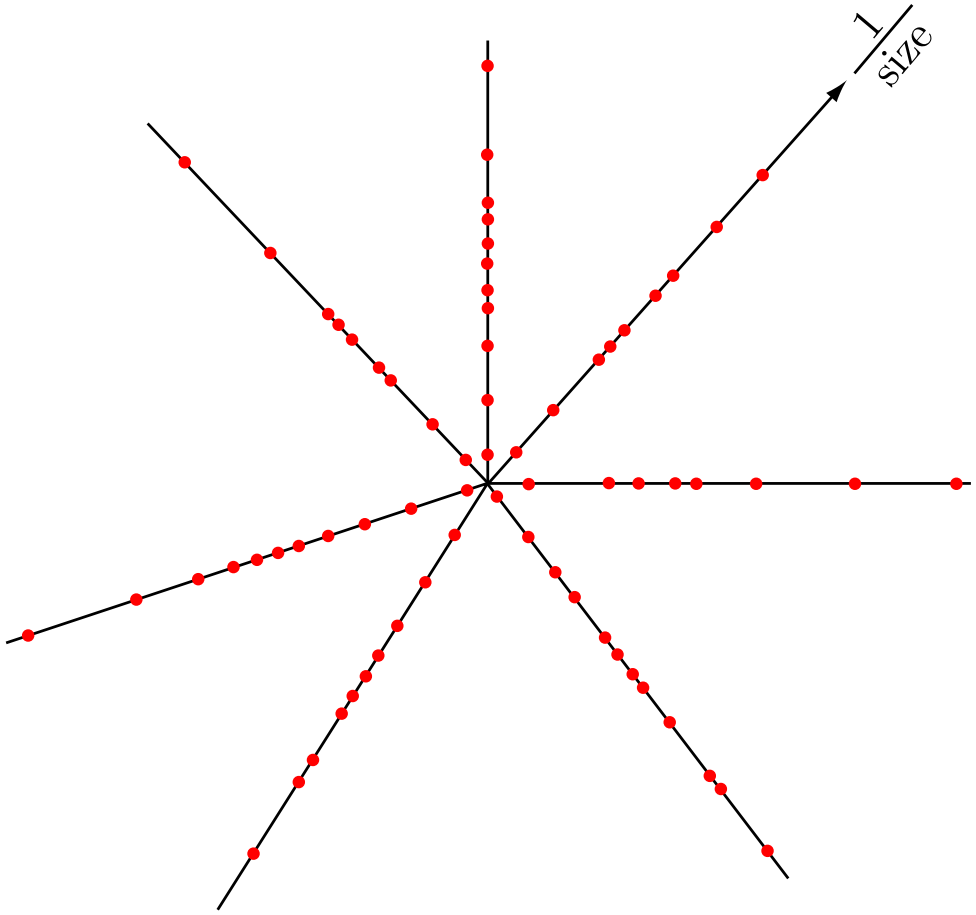


Figure 10: Sectioning along "size rays."

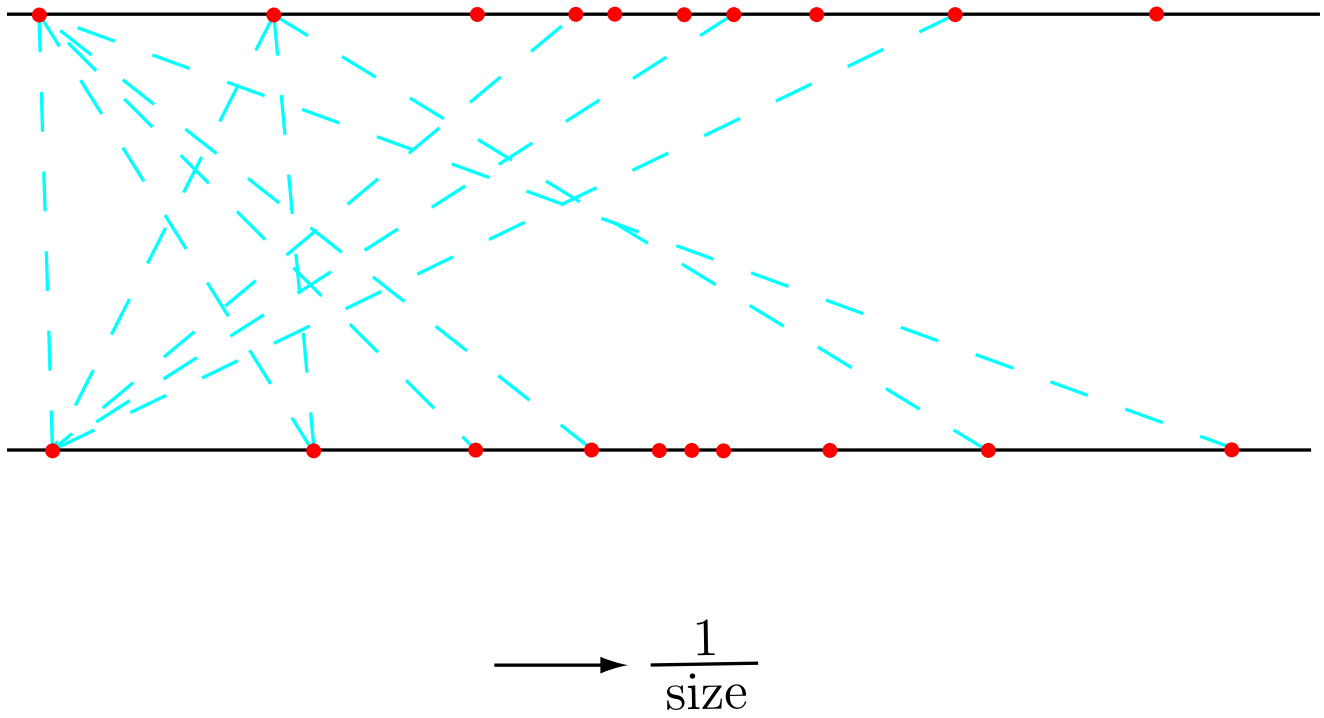
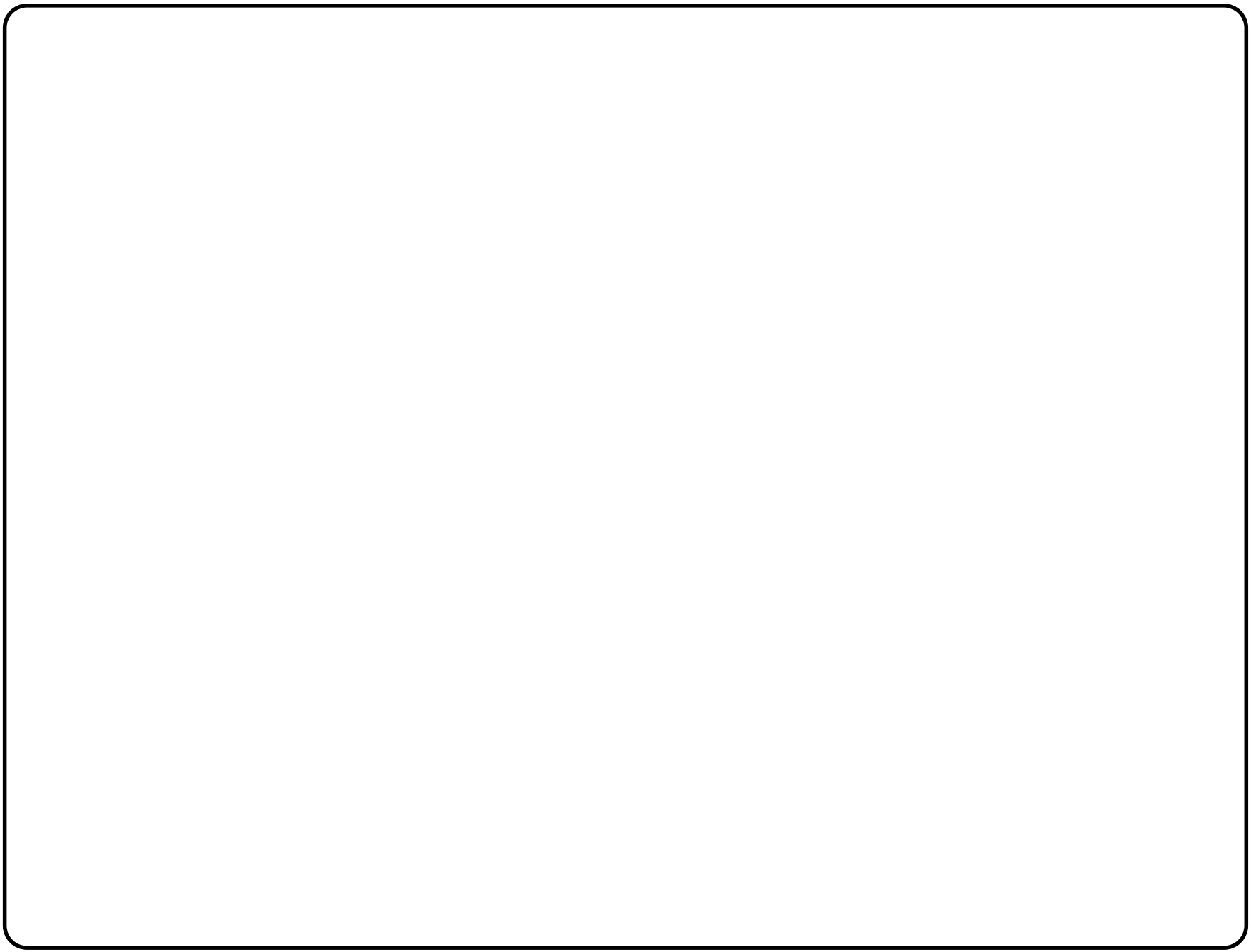


Figure 11: Trading concentration across two size rays.

Table 1: Average Behavior of Sends in the Fed Funds Market during December 2005. "Big" means top-ten by volume.

Sender	Receiver	Median number of receivers	Median monthly volume ($ millions)
Small	Big	3.1	14.4
Small	Small	1.4	2.4
Big	Small	2006.4	645,796
Big	Big	7.0	1,487,043



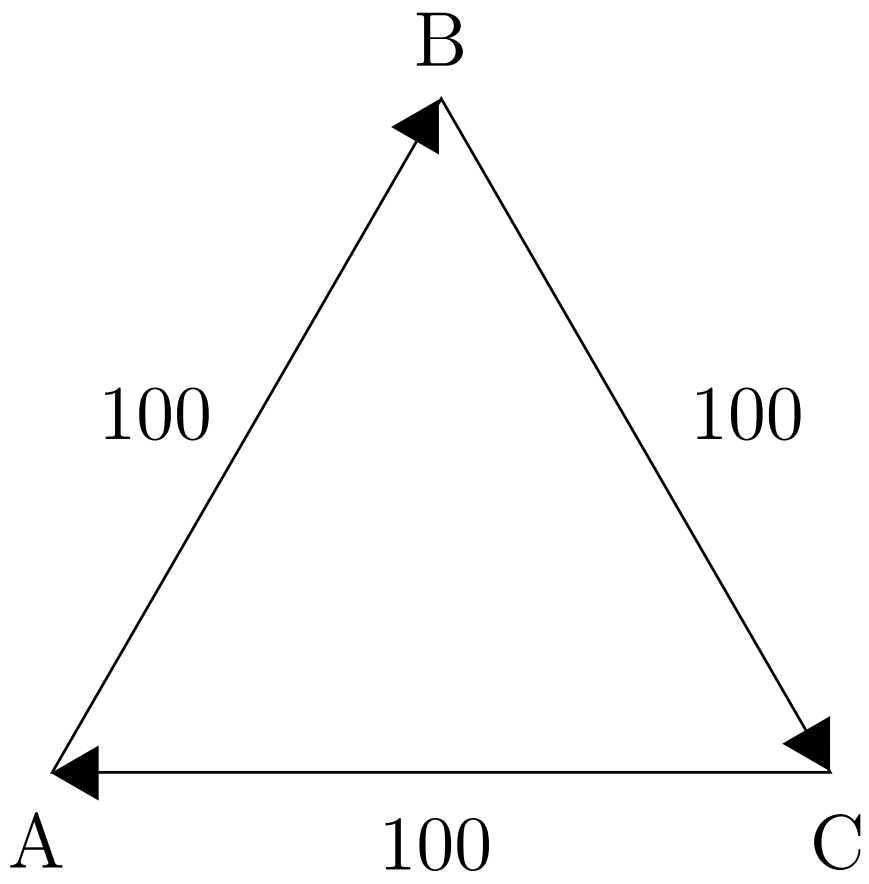


Figure 13: How can A, B, and C all send 100 with no initial inventory? One cannot ignore the dynamics.

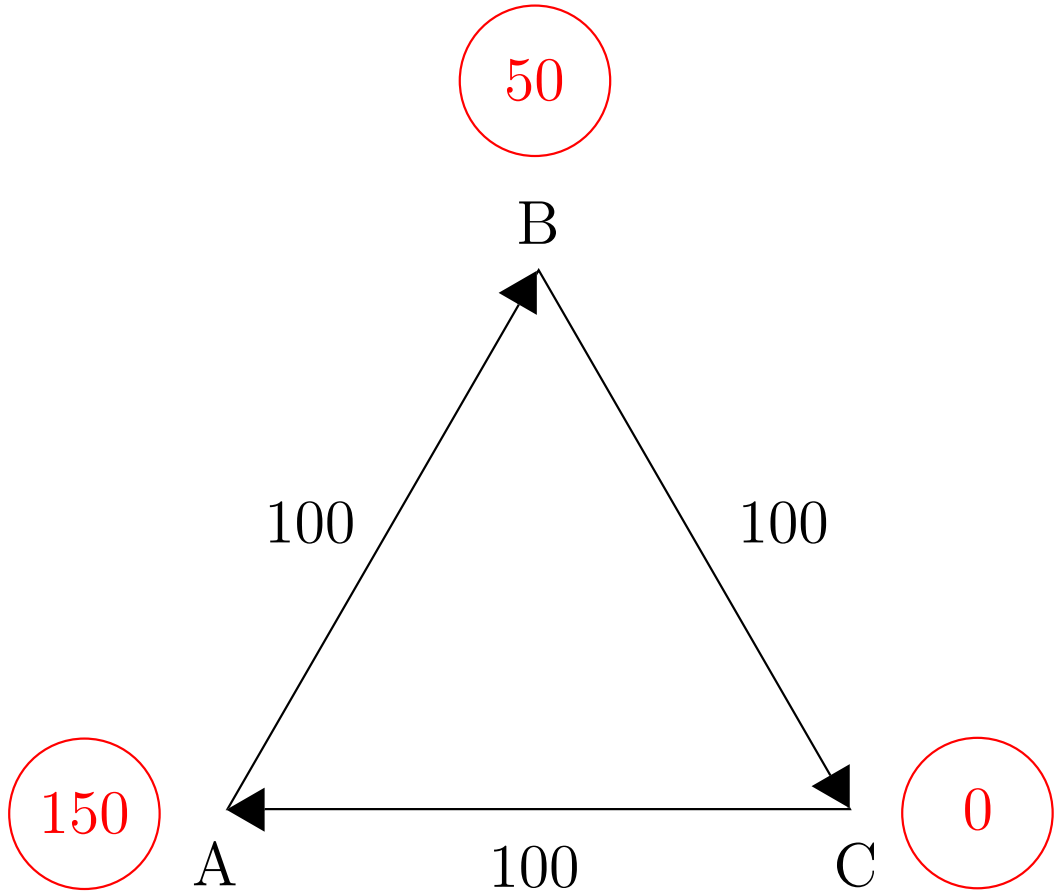


Figure 14: These trades can be implemented in one round, starting with the circled inventories.

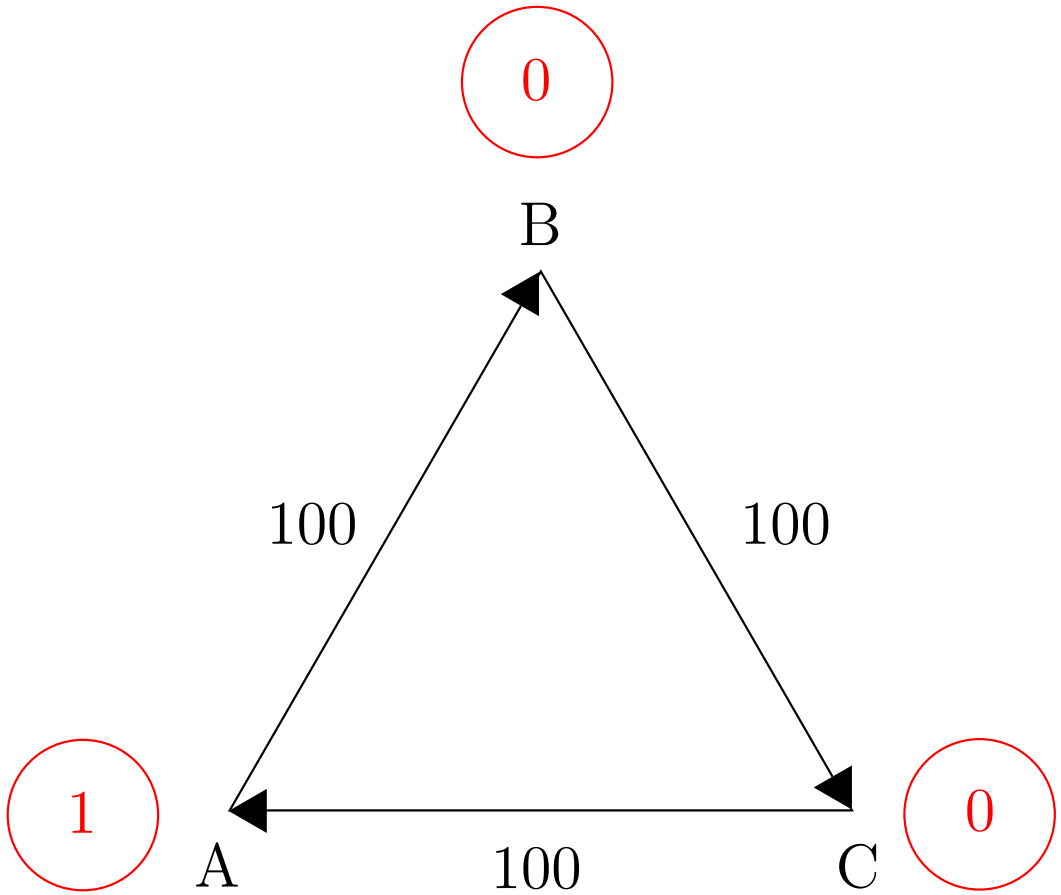


Figure 15: The same trades can also be implemented in many trades from much smaller inventories.

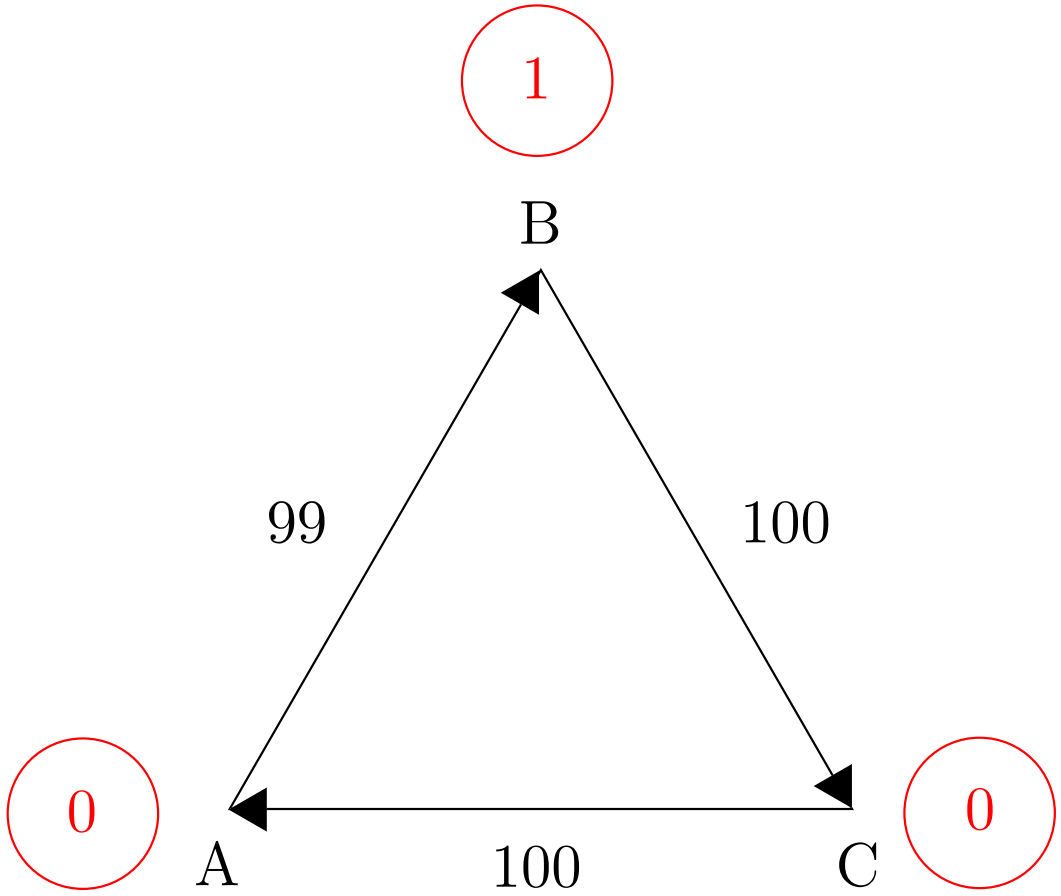


Figure 16: After the first of many trades.

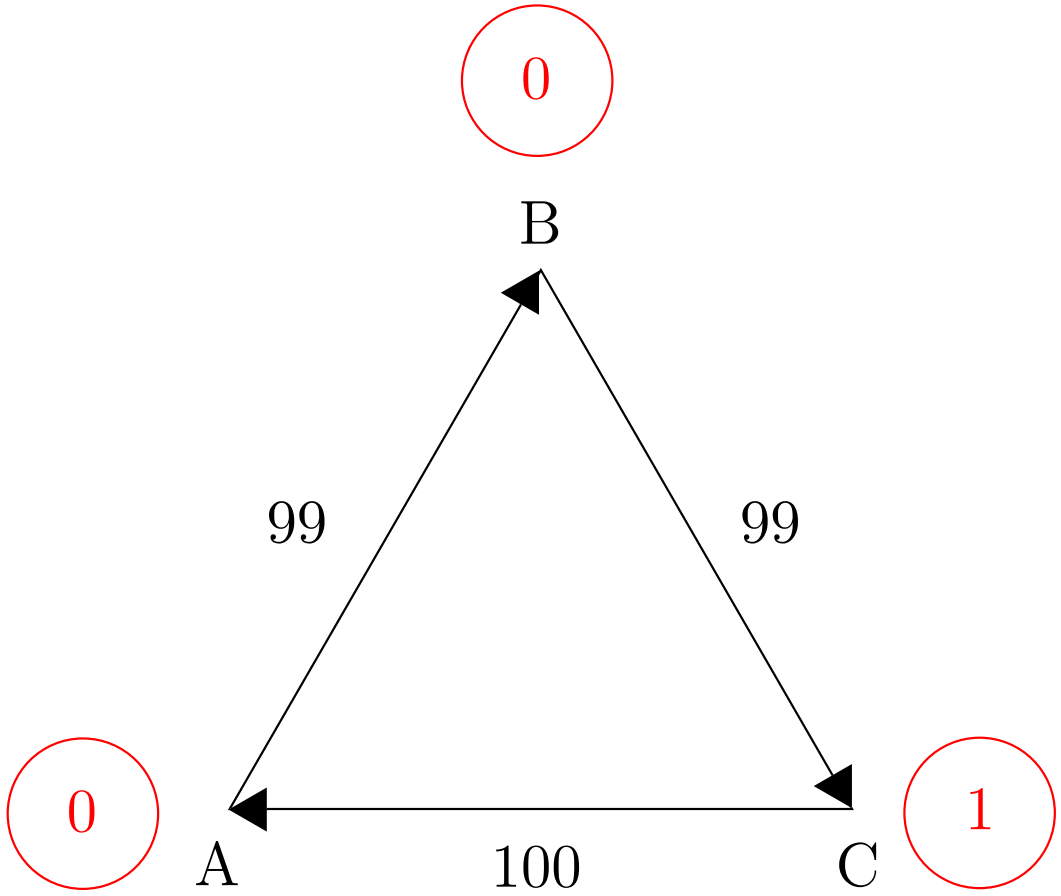


Figure 17: After the second of many trades.

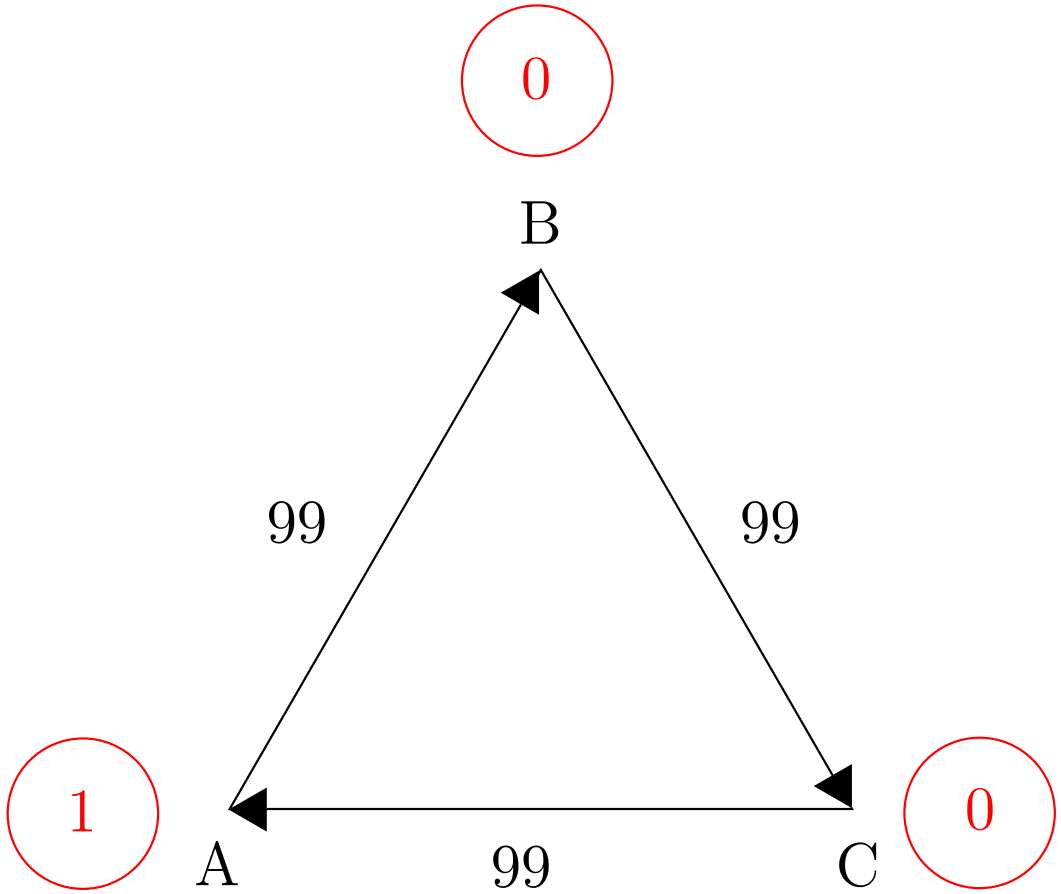


Figure 18: After the third of 300 trades.

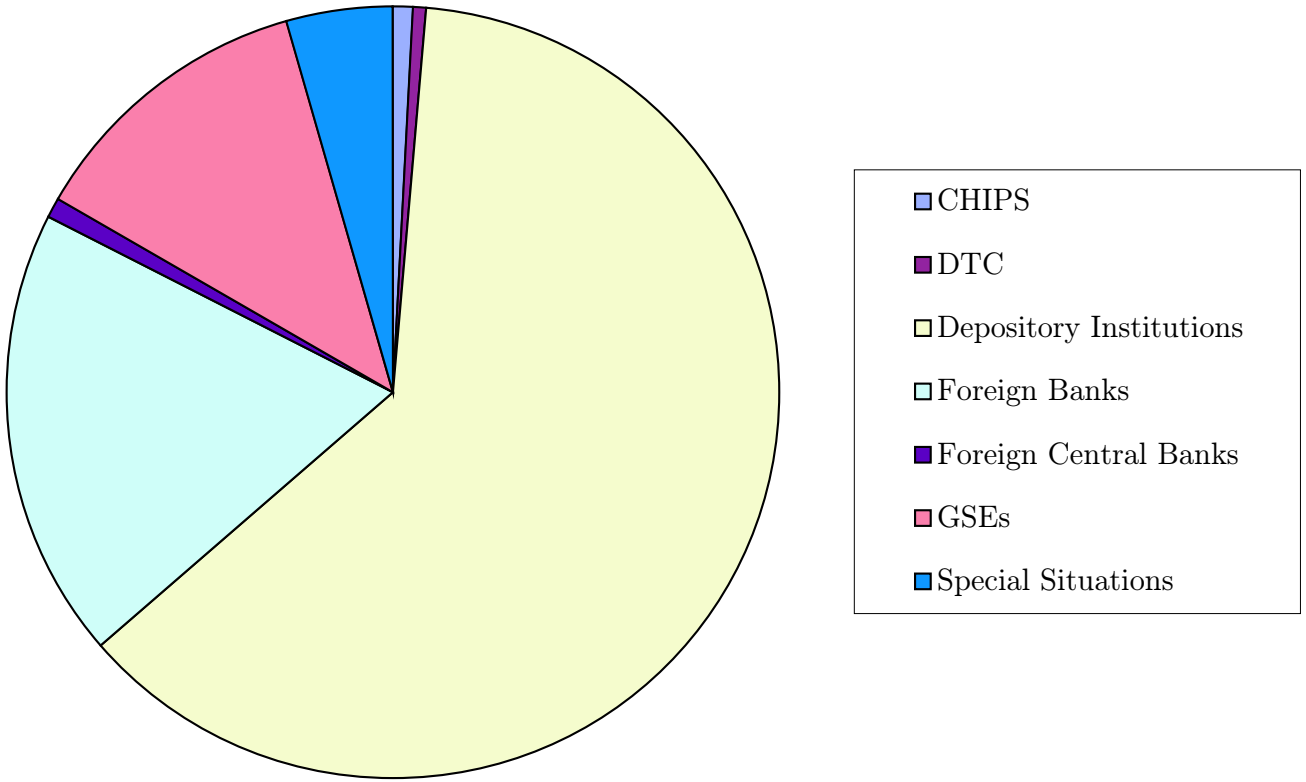


Figure 19: Breakdown of largest-by-volume 100 master account types, by number of accounts.

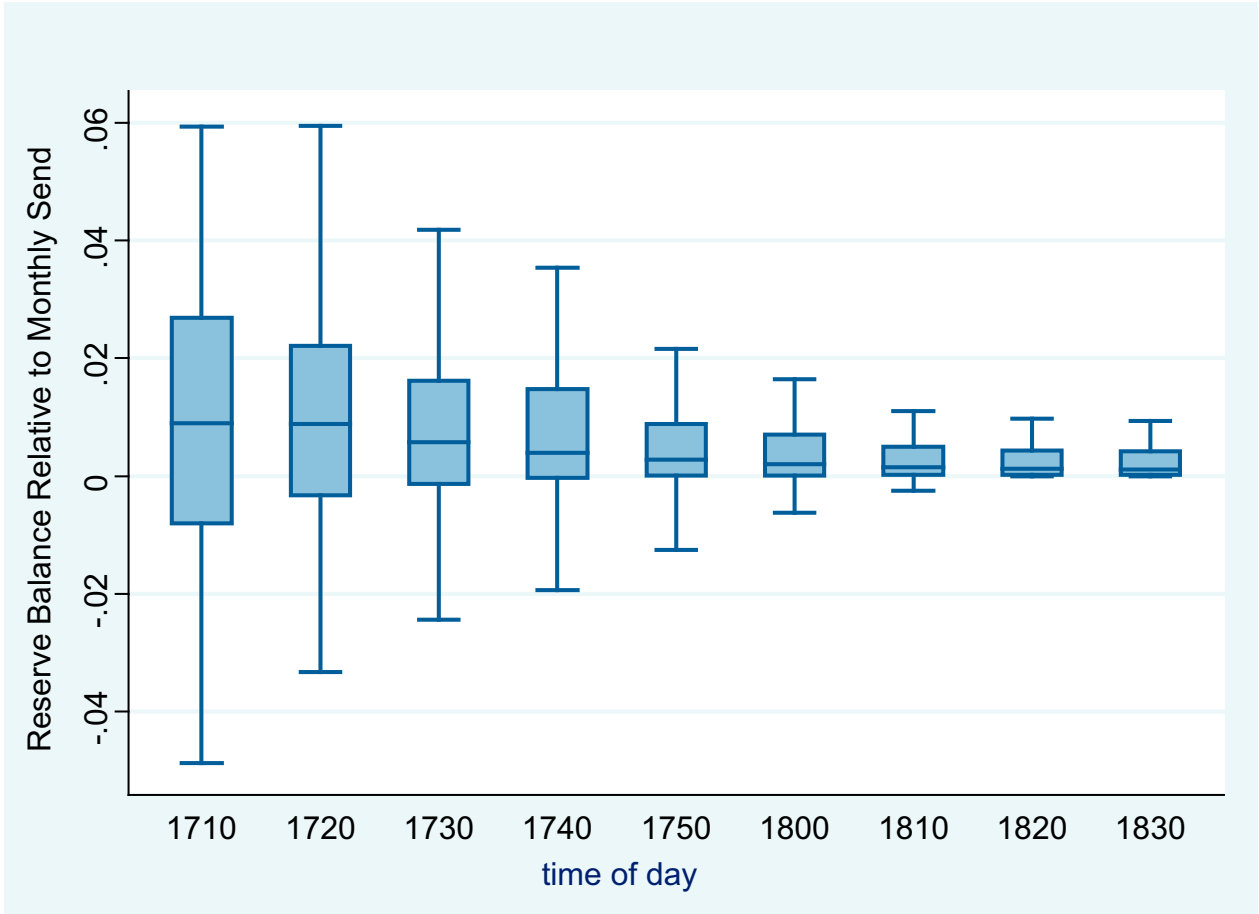


Figure 20: Targeting balances during the crucial 30 minute period: 17:30 to 18:00.


Sent by Top 100 accounts (billions $)
0
20
40
60
80
1700
1710
1720
1730
1740
1750
1800
1810
1820
time of day


Number of Sends by Top 100 accounts
0
100
200
300
400
1700
1710
1720
1730
1740
1750
1800
1810
1820
time of day

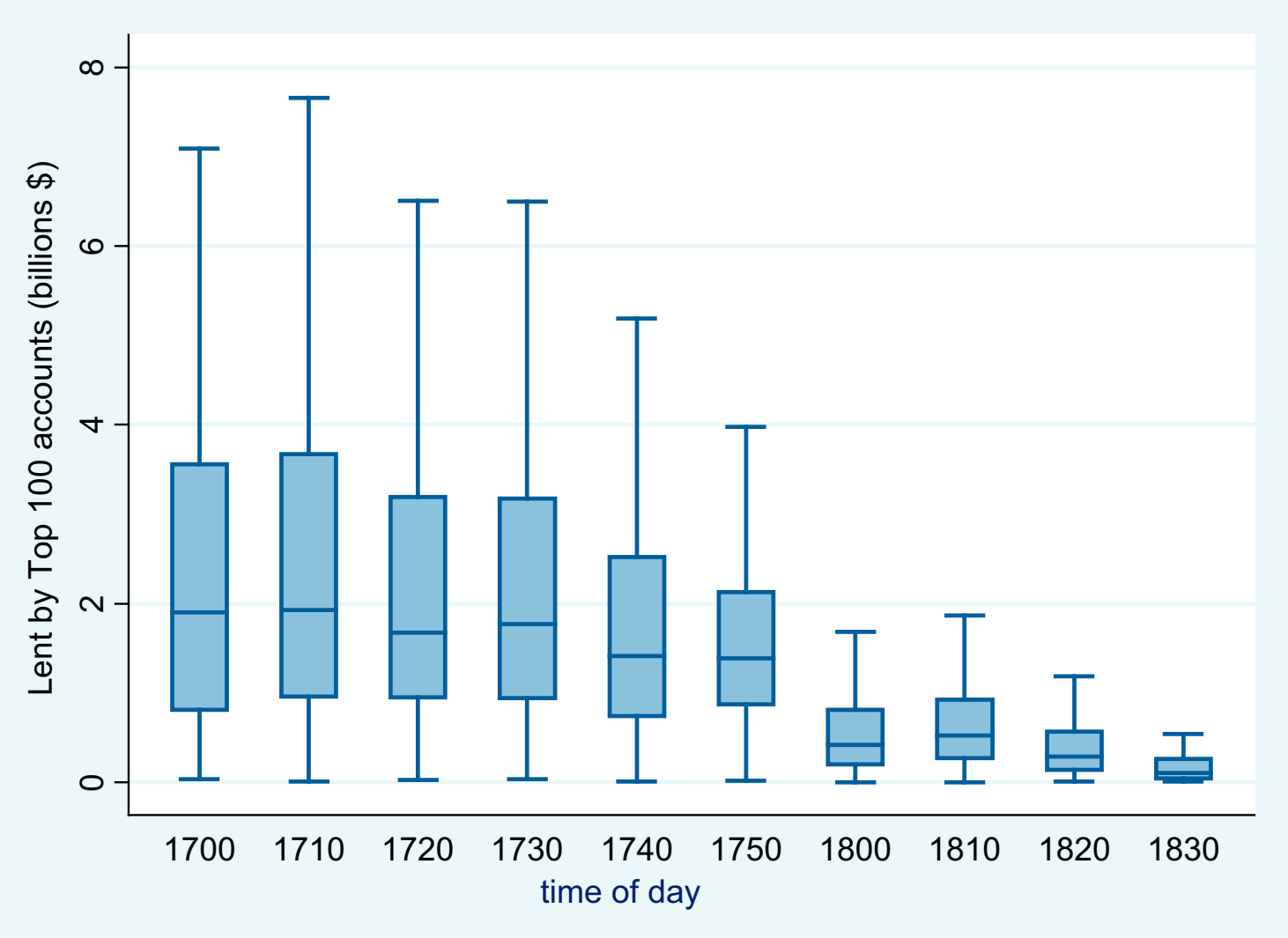


Figure 21: Distribution across lenders of volume of loans, within top 100 accounts.

Probabilistic model of transactions

- Over 225 million observations in 2005, top 100 master accounts.
- Logit estimator of the probability that i sends (or lends) to j in minute t:

$$p_{ij}(t) = L\left(V_i, V_j, \frac{B_i(t)}{V_i}, \frac{B_j(t)}{V_j}, \sigma(t), 1_{\{t \in [\,17{:}30\,,\,18{:}30\,]\}}\right),$$

  where
  - V_i is log of monthly volume of bank i during 17:00 to 18:30.
  - $B_i(t)$ is the balance of bank i at the beginning of minute t minus median-over-days balance of i at t.
  - $\sigma(t)$ is the trailing 30-minute historical volatility of the fed funds rate (dollar-weighted across all included transactions).

Preliminary Results

- Transactions show precautionary targeting of balances.
- Loans are far more sensitive to balances than are other transactions.
- Balance targeting is more active when rate volatility is higher.
- Doubling the size of bank i increases the likelihood of a send to bank j by over 50%.
- The 17:30 to 18:00 period is critical.

Special Effects

- September 2001: lower sensitivity to balances after 9-11.
- On 9-11, drop in dependence on largest banks (BONY?).
- Quarter end: increased sensitivity to balances.
- Notorious 15th-day-of-month effect (due to corporate taxes and GSE interest payments) is not obvious in the data.
- Maintenance effects not apparent. End-of-day balance targeting behavior does not vary markedly within the two-week settlement cycle. From interviews: This may reflect the impact of "sweeps."

Gridlock?

- Precautionary gridlock: With a low balance, bank i waits for a send from j before processing a send to k. Supply shocks could mean that j is meanwhile waiting for a send from m, who is waiting for a send from n, who is ...
- According to interviews: A systemic gridlock was a significant risk on 9/11, when BONY was incapacitated. A concerted effort to provide liquidity by the Federal Reserve and top banks averted an even greater protential problem. See Lacker (2003), McAndrews and Potter (2002).

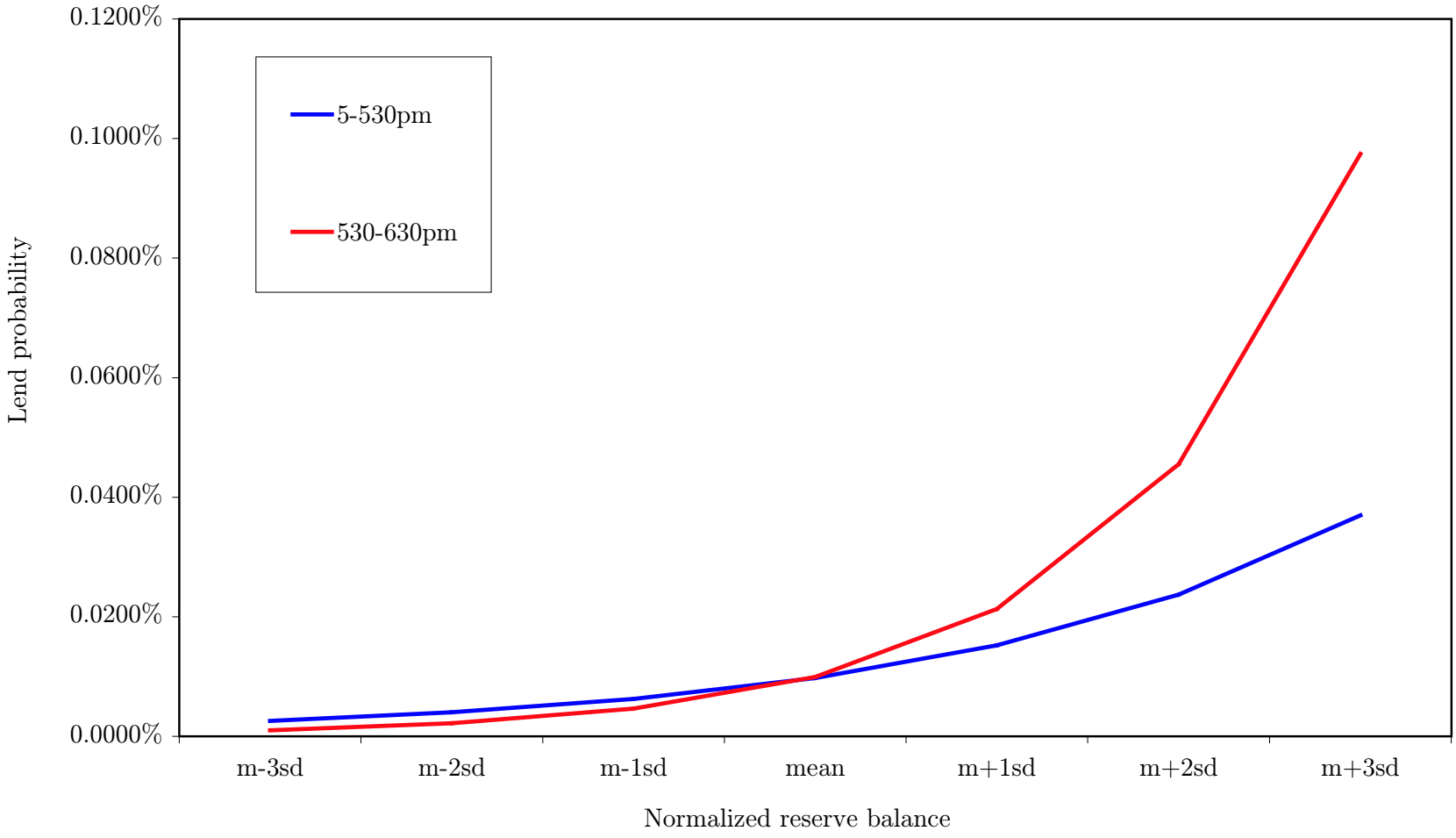


Figure 22: Probability of lend is more sensitive to balances in the last hour.

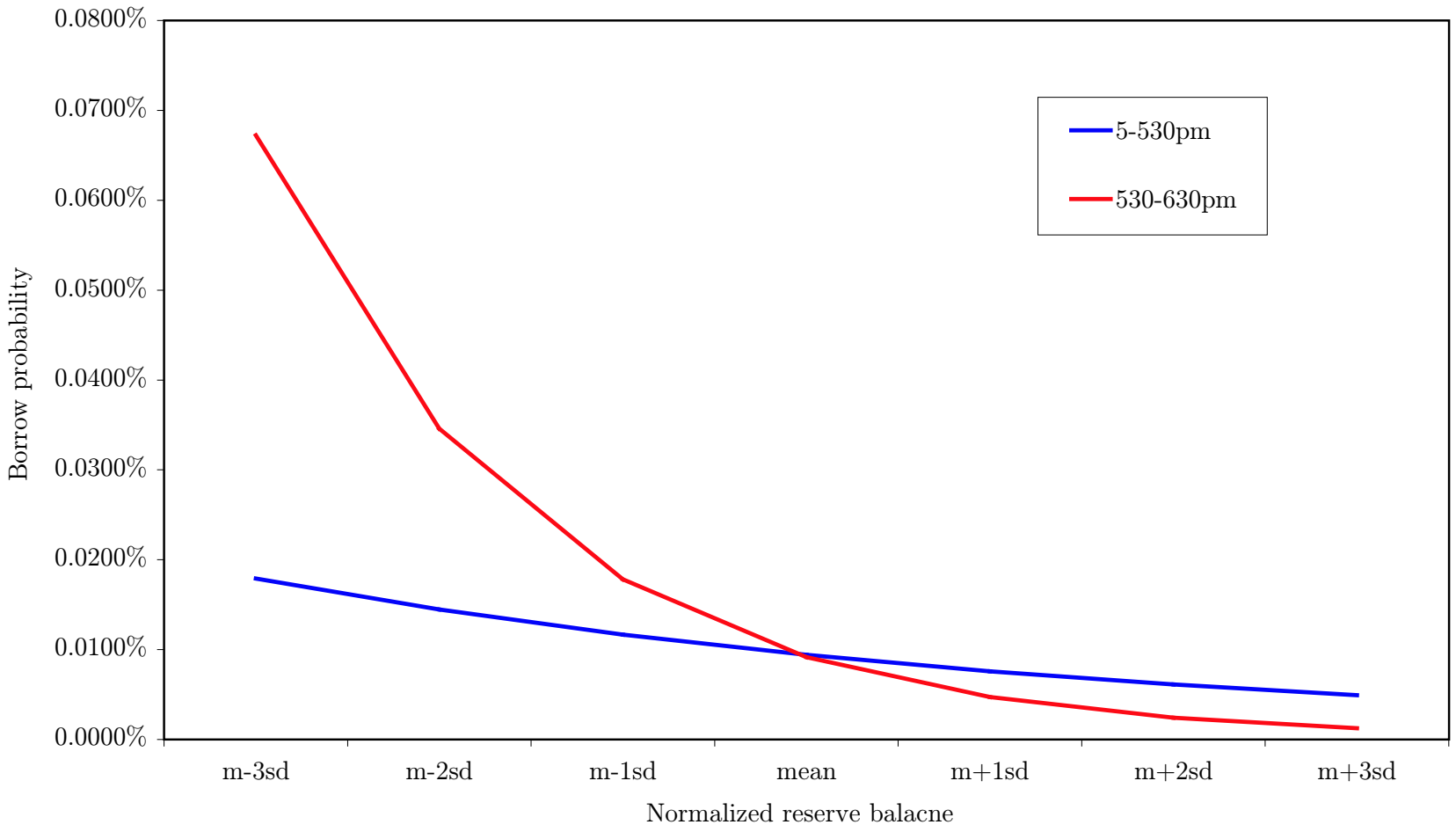


Figure 23: Probability of borrow is more sensitive to balances in the last hour.

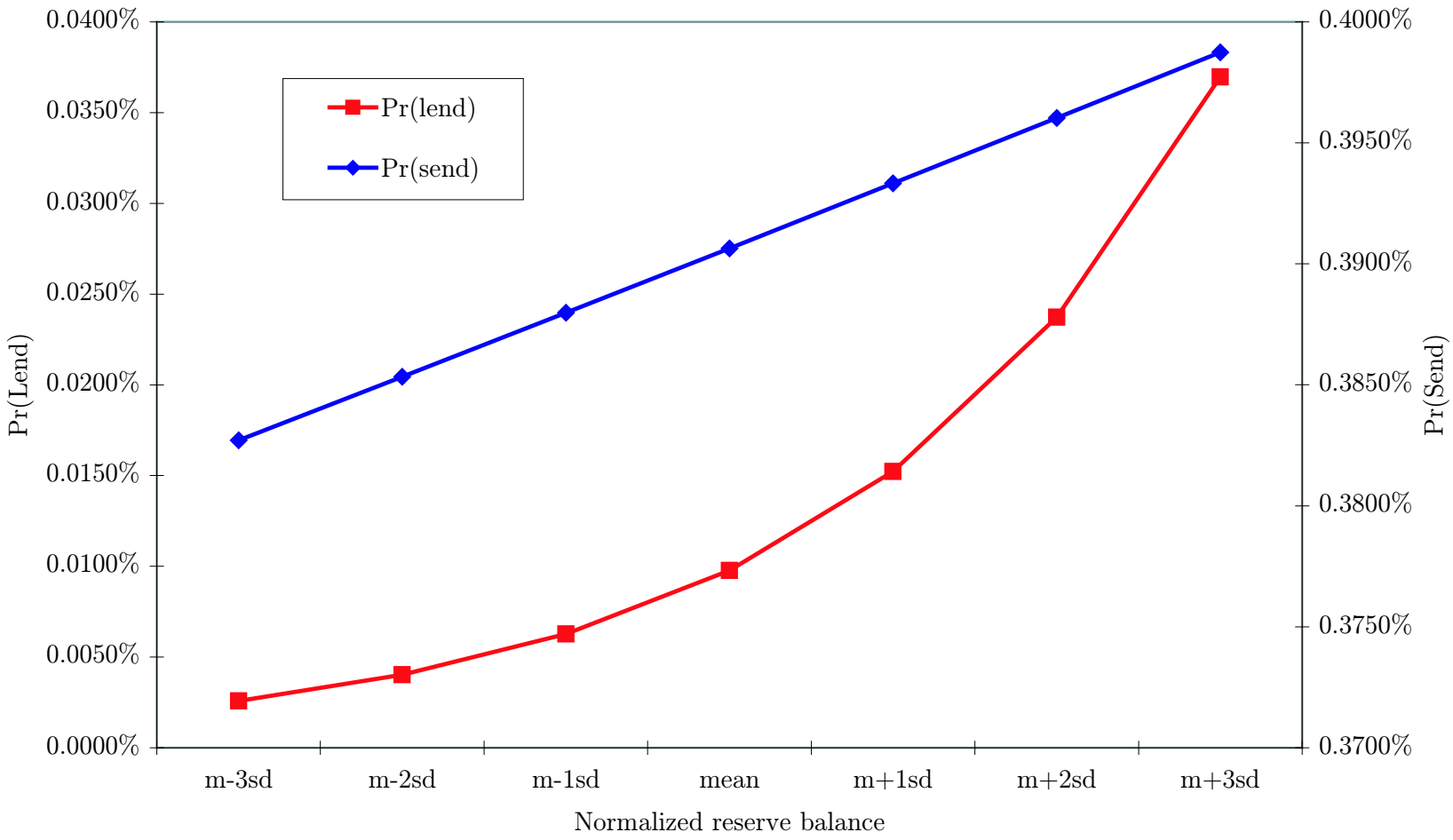


Figure 24: Loans are 81 times more sensitive to balances than are non-loan sends.

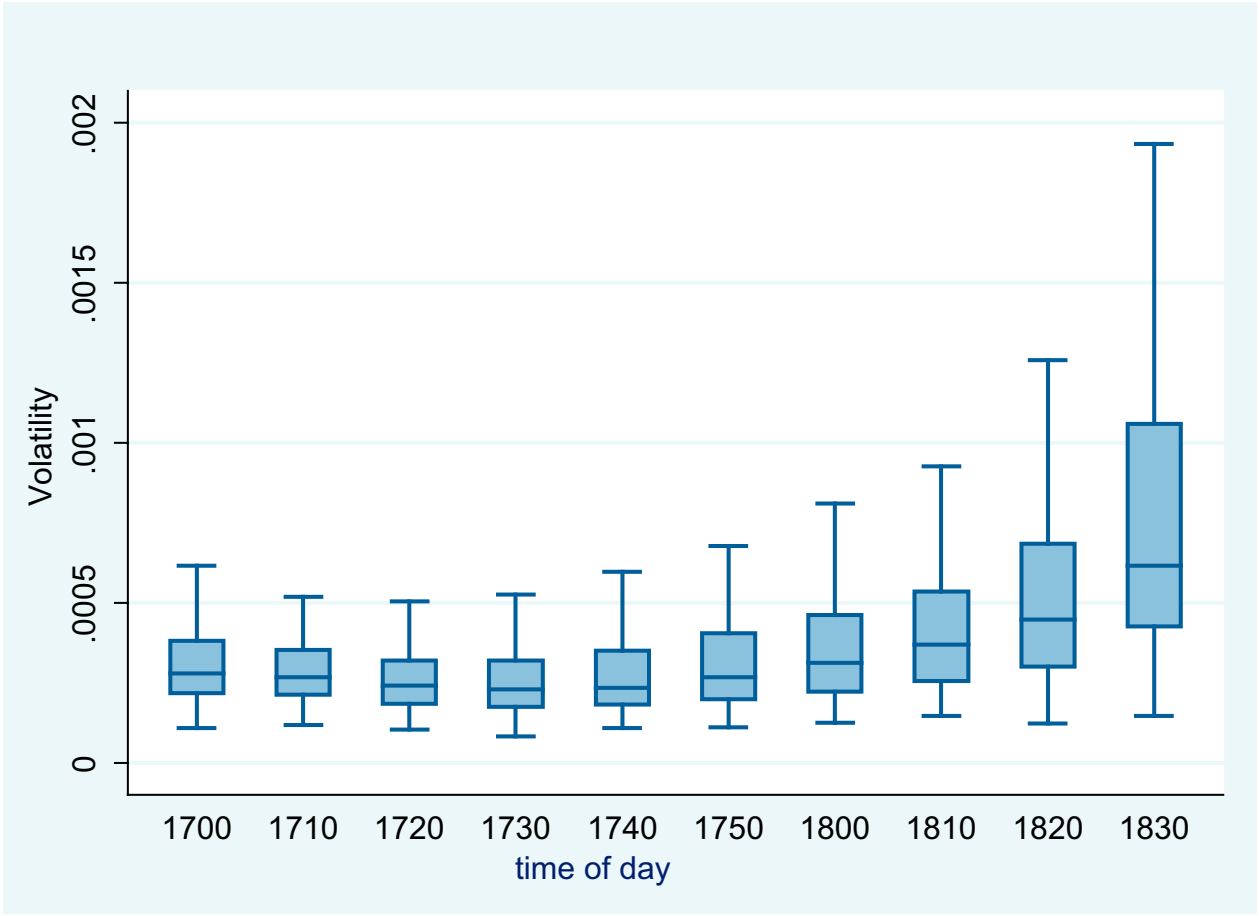


Figure 25: Trailing 30-minute fed funds rate volatility, across 251 business days.

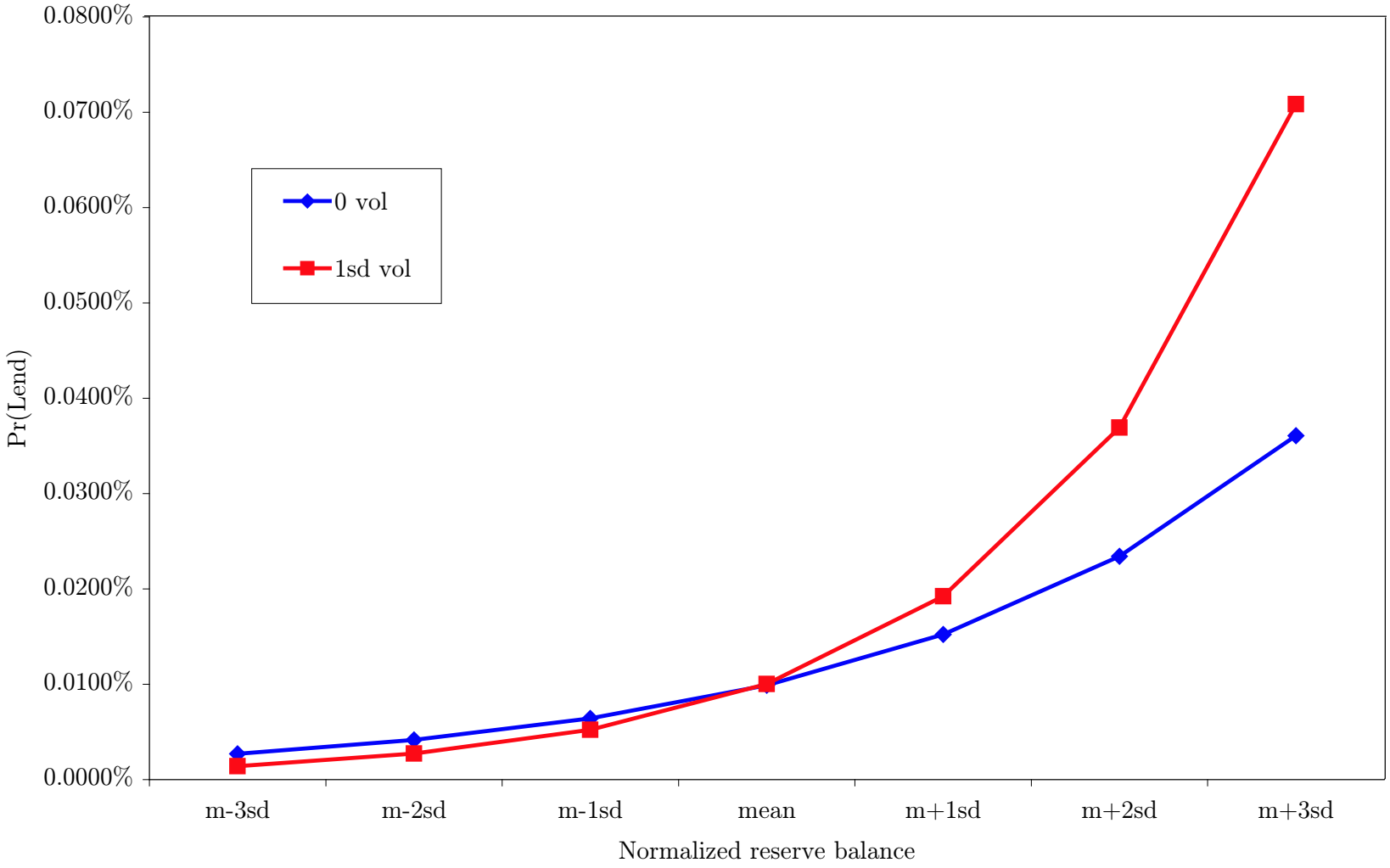


Figure 26: Lend sensitivity to balances increases with volatility.

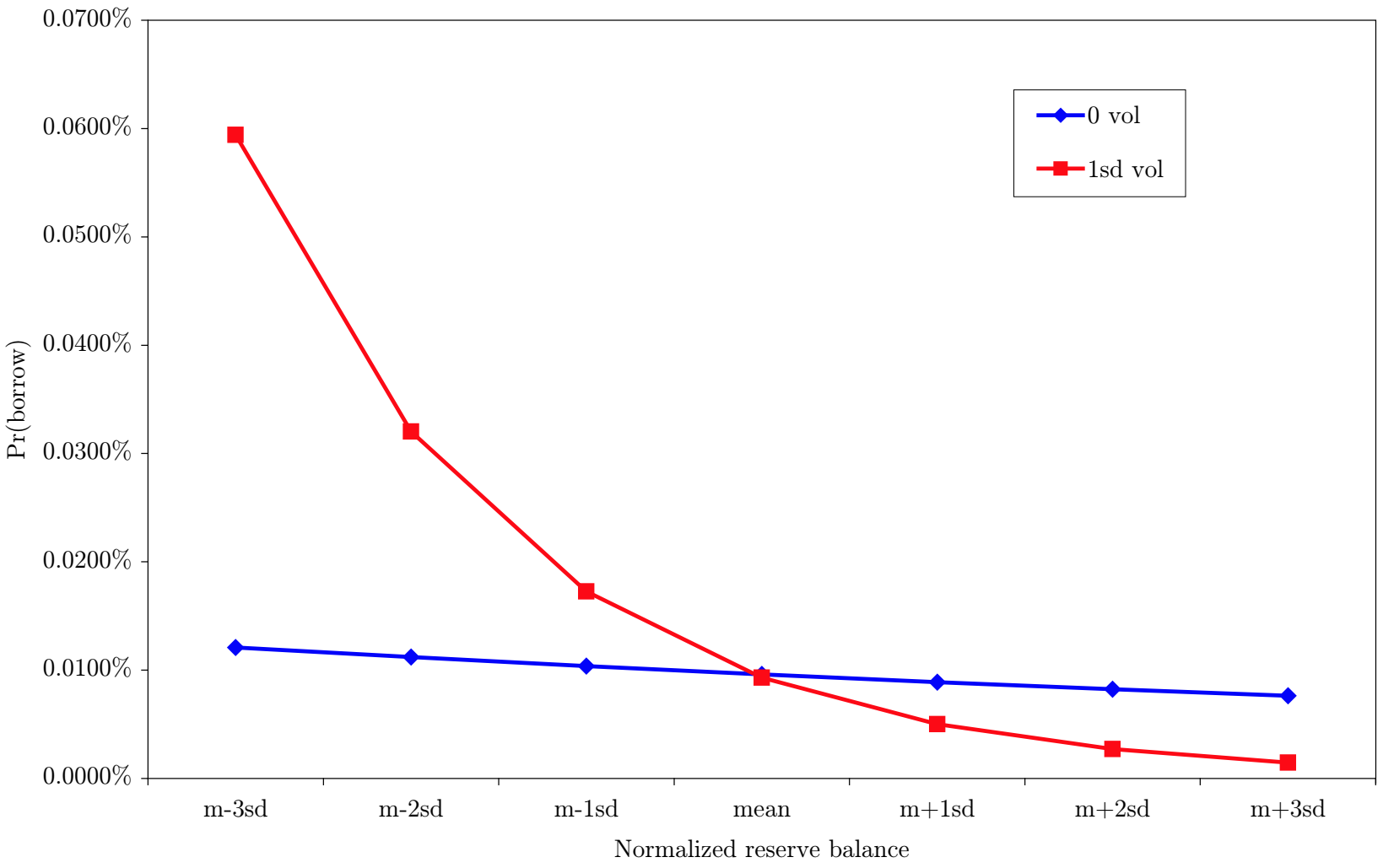


Figure 27: Borrow sensitivity to balances increases with volatility.

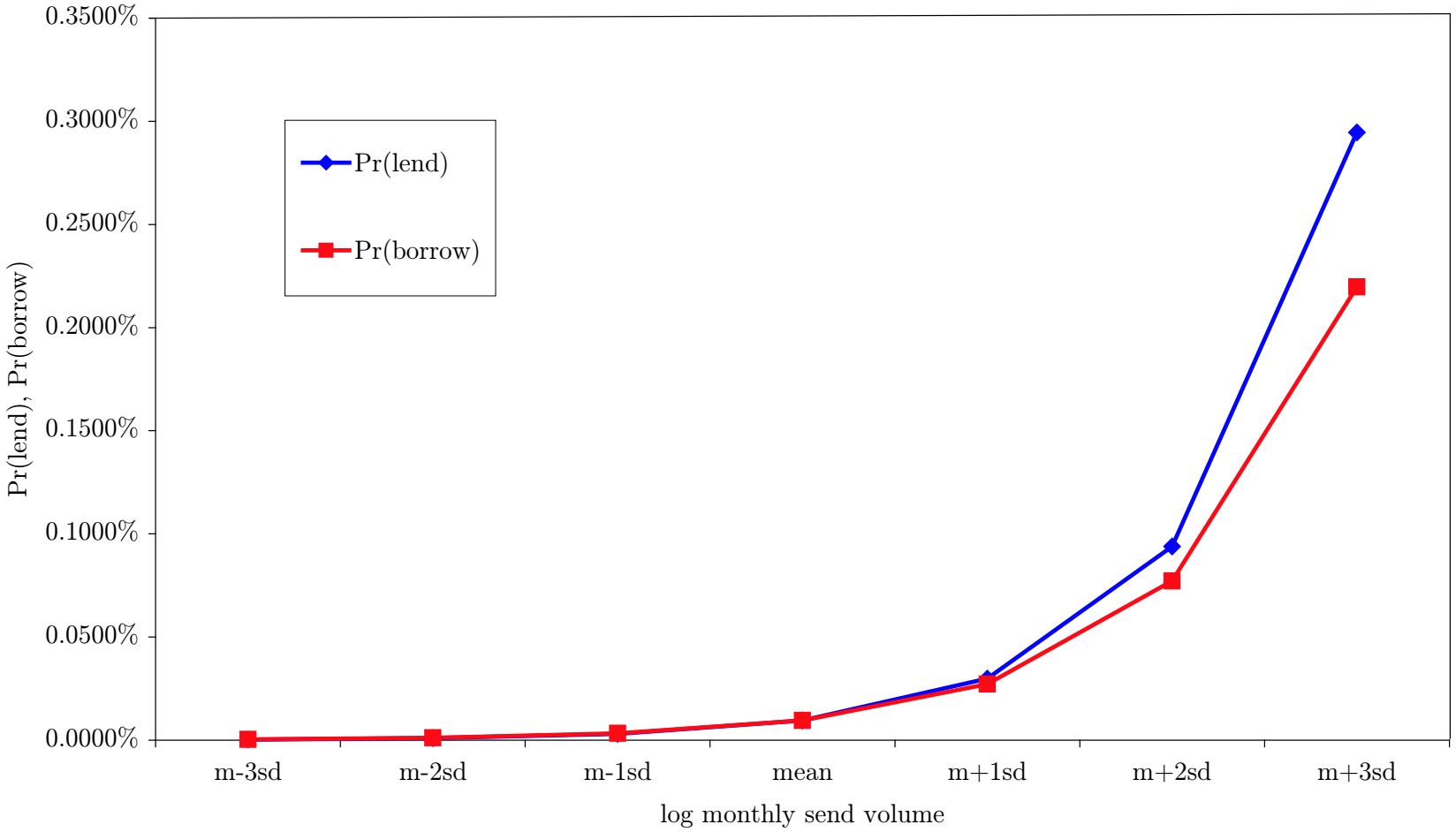


Figure 28: Bank size effect, holding counterparty at mean size.

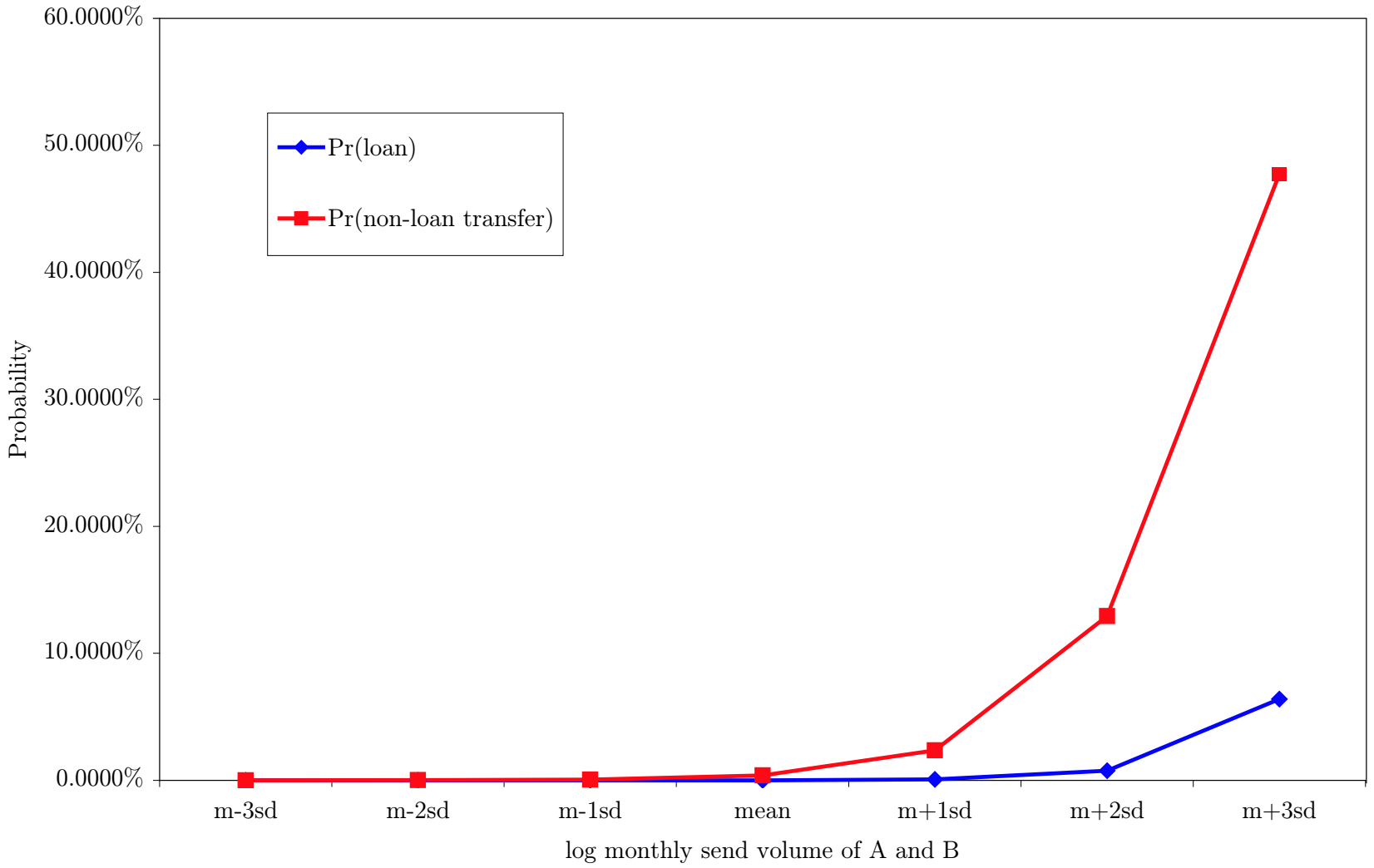


Figure 29: Bank size effect, increasing both counterparties at the same scale.

Next?

- What does it take to cause a gridlock?
- An analysis of the equilibrium transmission of rate shocks through the market.