The views presented herein are completely our own and do not necessarily reflect those of the Board of Governors of the Federal Reserve System.
Main Results

ARS design is flawed

- Vulnerability to two runs:
  - Investors’ run, partially panic-based
  - Broker-dealers’ run
    - Unexpected first mover withdrawal of liquidity support triggered simultaneous withdrawal by all major broker-dealers
  - Two runs interact and amplify each other

- Problems with uniform price auction
  - Strong evidence of underpricing
  - Auction reset rates only weakly related to fundamentals, positively related to maximum rate
Main Results

ARS design is flawed

- Vulnerability to two runs:
  - Investors’ run, partially panic-based
  - Broker-dealers’ run
    - Unexpected first mover withdrawal of liquidity support triggered simultaneous withdrawal by all major broker-dealers
  - Two runs interact and amplify each other

- Problems with uniform price auction
  - Strong evidence of underpricing
  - Auction reset rates only weakly related to fundamentals, positively related to maximum rate
Auction Rate Securities (1984-2008)

- **Long-term debt** securities with variable interest rates, reset every 7, 28, 35 days etc. through a Uniform-Price Auction Process
- **Purpose**: ARS allows issuer to fund long term liability with short term debt
- **Issuers**: municipalities, close-end funds and student loans authorities
- **Investors**: corporate treasury, high net-wealth individuals
- **Market size**: $330 billion (end of 2007), half in Muni ARS (MARS)

![ARMB Issuance and Interest Rates](image)
Auction Process & Dealer’s Role

**Purpose**
- Price discovery: Setting interest rates
- Source of liquidity: transfer ownership

**Order Types**
- Existing Owner: Sell, Hold, Hold at rate
- Potential Buyer: Buy at rate

**Clearing Rate**
- the lowest rate at which bids are sufficient to cover all sells
- In the example, the clearing rate is 6%

If sells > buys, auction fails. Transfer prorated. Reset rates set at maximum rate.
Dealer can participate after seeing the demand curve to support auctions, but not required to do so.
Auction Process & Dealer’s Role

Purpose

- Price discovery: Setting interest rates
- Source of liquidity: transfer ownership

- **Clearing Rate**: the lowest rate at which bids are sufficient to cover all sells
- In the example, the clearing rate is 6%

Order Types

- Existing Owner: Sell, Hold, Hold at rate
- Potential Buyer: Buy at rate

If sells > buys, auction fails. Transfer prorated. Reset rates set at maximum rate

Dealer can participate after seeing the demand curve to support auctions, but not required to do so.
### Auction Process & Dealer’s Role

#### Purpose
- **Price discovery**: Setting interest rates
- **Source of liquidity**: Transfer ownership

#### Order Types
- **Existing Owner**: Sell, Hold, Hold at rate
- **Potential Buyer**: Buy at rate

#### Clearing Rate
- **Clearing Rate**: The lowest rate at which bids are sufficient to cover all sells
- In the example, the clearing rate is 6%

#### Diagrams
- **Rate vs. Units**
  - **Demand Curve**
  - **Supply Curve**
  - **Clearing rate = 6%**
  - **Maximum rate = 10%**

- **Rate vs. Units**
  - **Demand Curve**
  - **Supply Curve**
  - **Clearing rate = 5%**
  - **Maximum rate = 10%**
  - **Dealer’s bid**

- **If sells > buys, auction fails. Transfer prorated. Reset rates set at maximum rate**
- **Dealer can participate after seeing the demand curve to support auctions, but not required to do so.**
Before Week of Feb 12: Managed Bidding

Dealer’s impact in:

- Pricing: Price talk and Actual bids
- Liquidity: net Buyer in auctions, net Seller in non-auction secondary market

False Sense of Safety

- Many investors are unaware of auction dealer’s role in auctions

Many insiders expect the “implicit support” to be binding

Note. Based on data from three major auction agents
Data in MARS

- Auction results from three main auction agents
  - Auction status, reset rates, benchmark index rate
- Muni transactions data from MSRB
  - Trade size, price, direction of trade
- Bond characteristics from Bloomberg
- Identify maximum rates through “rule matching”

Three sample periods

- Pre-crisis period  7/1/2007-12/31/2007
- Crisis period     2/11/2008-2/19/2008
- Post-crisis period 2/20/2008-3/19/2008
Empirical 1: Investors’ Run

- Unusually large number of sell orders on Feb 12

- Sudden surge in the incidence of failures (Pseudo Fail+Actual Fail)

Note. Based on data from three major auction agents.
Determinants of Auction Failures

- Fundamental variables: bond characteristics, credit risk, macro factors
- Max rate: auction likely to succeed if \( \text{maxrate} \geq \) upper support of fundamental value

![Graph showing failure rates over time with specific dates and labels.](image-url)
Abnormal Failure Rates

- Panic based (Sunspot) v.s. Informational based?

Abnormal Failure Rates in Mid-February

<table>
<thead>
<tr>
<th>Date</th>
<th>Actual $\bar{p}_t$</th>
<th>Predicted $\tilde{\bar{p}}_t$</th>
<th>Abnormal $\bar{p}^*_t$</th>
<th>Std. Dev. of $p^*_t$</th>
<th>$N_t$</th>
<th>t-Stat of $\frac{\bar{p}^*_t}{\tilde{\bar{p}}_t}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/11/2008</td>
<td>0.04</td>
<td>0.42</td>
<td>-0.40</td>
<td>0.44</td>
<td>225</td>
<td>-13.64</td>
</tr>
<tr>
<td>2/12/2008</td>
<td>0.13</td>
<td>0.39</td>
<td>-0.28</td>
<td>0.51</td>
<td>358</td>
<td>-10.45</td>
</tr>
<tr>
<td>2/13/2008</td>
<td>0.60</td>
<td>0.43</td>
<td><strong>0.11</strong></td>
<td>0.48</td>
<td>385</td>
<td>4.49</td>
</tr>
<tr>
<td>2/14/2008</td>
<td>0.57</td>
<td>0.43</td>
<td><strong>0.09</strong></td>
<td>0.37</td>
<td>309</td>
<td>4.04</td>
</tr>
<tr>
<td>2/15/2008</td>
<td>0.57</td>
<td>0.38</td>
<td><strong>0.11</strong></td>
<td>0.32</td>
<td>359</td>
<td>6.79</td>
</tr>
<tr>
<td>2/19/2008</td>
<td>0.53</td>
<td>0.45</td>
<td>0.01</td>
<td>0.32</td>
<td>403</td>
<td>0.83</td>
</tr>
</tbody>
</table>

The runs are partially panic driven.
Dealer’s Inventory Stress

Broker–Dealer Net Buys in and post Auctions

Cumulative Inventory Aggregated over All Broker–Dealers

Song Han and Dan Li
Liquidity Crisis, Runs, and Security Design
Dealers’ Run – Failure to Coordinate

- One bank let their auctions fail, all others followed the next day
Why Simultaneous Withdrawal of Liquidity Support?

One dealer’s decision to Support or Not:
- Cost of support: Inventory cost, balance sheet stress
- Benefit: reputation to both investors and issuers

Multiple Dealers: externality of one dealer’s decision on others by letting auctions fail
- Investors run away from all ARS, other dealers forced to take more inventory, more stress to balance sheet
- Relative cost to reputation diminishes for other dealers if they also withdraw

Two Equilibrium outcomes: All support (unstable), or all withdraw (stable)
Why Simultaneous Withdrawal of Liquidity Support?

One dealer’s decision to Support or Not:
- Cost of support: Inventory cost, balance sheet stress
- Benefit: reputation to both investors and issuers

Multiple Dealers: externality of one dealer’s decision on others by letting auctions fail
- Investors run away from all ARS, other dealers forced to take more inventory, more stress to balance sheet
- Relative cost to reputation diminishes for other dealers if they also withdraw

Two Equilibrium outcomes: All support (unstable), or all withdraw (stable)
Why Simultaneous Withdrawal of Liquidity Support?

One dealer’s decision to Support or Not:

- Cost of support: Inventory cost, balance sheet stress
- Benefit: reputation to both investors and issuers

Multiple Dealers: externality of one dealer’s decision on others by letting auctions fail

- Investors run away from all ARS, other dealers forced to take more inventory, more stress to balance sheet
- Relative cost to reputation diminishes for other dealers if they also withdraw

Two Equilibrium outcomes: All support (unstable), or all withdraw (stable)
Empirical 2: Uniform Price Auction Inefficiencies

- All bidders pay at the clearing rate

**Theoretical Predictions, Back & Zender 93 , 01**

1. Without dealer support—fixed quantity auction
   - Equilibrium may be unrelated to fundamentals
   - Equilibrium with lowest price (highest interest rate) preferred

2. With dealer support — endogenous quantity auction
   - Difference between worse-case equilibrium and fundamental value converge to zero as number of bidder increases
Results from OLS Regressions of Reset Rates

<table>
<thead>
<tr>
<th>Independent var.</th>
<th>7/1/07-12/31/07</th>
<th>2/20/08-3/19/08</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(5)</td>
</tr>
<tr>
<td>Maximum rate</td>
<td>0.012**</td>
<td>0.228**</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Lag. cum. inventory</td>
<td>0.050**</td>
<td>0.224**</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Lag. non-auc. trade</td>
<td>-0.011</td>
<td>0.579**</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Bond, credit, macro</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.66</td>
<td>0.66</td>
</tr>
<tr>
<td>N</td>
<td>34369</td>
<td>34369</td>
</tr>
<tr>
<td></td>
<td>0.21</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>3496</td>
<td>3496</td>
</tr>
</tbody>
</table>

In the pre-crisis equilibrium (endogenous supply model):
- reset rates reflect strongly fundamentals;
- auction variables such as the maximum rate are not relevant;

In the post-crisis equilibrium (fixed supply model):
- reset rates are weakly related to bonds’ fundamentals;
- reset rates are positively related to maximum rate;

Reset rates in the post-crisis equilibrium are increasing in the secondary non-auction market liquidity. (Less competitive bidding)
### Results from OLS Regressions of Reset Rates

<table>
<thead>
<tr>
<th>Independent var.</th>
<th>7/1/07-12/31/07</th>
<th></th>
<th>2/20/08-3/19/08</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(5)</td>
<td>(6)</td>
<td>(10)</td>
</tr>
<tr>
<td>Maximum rate</td>
<td>0.012**</td>
<td>(0.00)</td>
<td>0.228**</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Lag. cum. inventory</td>
<td>0.050**</td>
<td>(0.01)</td>
<td>0.224**</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Lag. non-auc. trade</td>
<td>-0.011</td>
<td>(0.01)</td>
<td>0.579**</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Bond, credit, macro</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R²</td>
<td>0.66</td>
<td>0.66</td>
<td>0.21</td>
<td>0.30</td>
</tr>
<tr>
<td>N</td>
<td>34369</td>
<td>34369</td>
<td>3496</td>
<td>3496</td>
</tr>
</tbody>
</table>

- In the pre-crisis equilibrium (endogenous supply model):
  - reset rates reflect strongly fundamentals;
  - auction variables such as the maximum rate are not relevant;

- In the post-crisis equilibrium (fixed supply model):
  - reset rates are weakly related to bonds’ fundamentals;
  - reset rates are positively related to maximum rate;

- Reset rates in the post-crisis equilibrium are increasing in the secondary non-auction market liquidity. (Less competitive bidding)
Summary of Findings and Lessons

Findings

- ARS is flawed
- ARS crisis caused by two types of runs
- Prices in auctions can deviate from fundamentals, underpricing
- Unexpected impact of secondary market liquidity

Lessons

- Complex products should not trade on simply trust
- Implicit support should be explicit
- Lack of market transparency creates false sense of safety
- Financial crisis is the ultimate test of financial innovation
Summary of Findings and Lessons

Findings

- ARS is flawed
- ARS crisis caused by two types of runs
- Prices in auctions can deviate from fundamentals, underpricing
- Unexpected impact of secondary market liquidity

Lessons

- Complex products should not trade on simply trust
- Implicit support should be explicit
- Lack of market transparency creates false sense of safety
- Financial crisis is the ultimate test of financial innovation