Intermediaries as Information Aggregators: An Application to U.S. Treasury Auctions

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Motivation

- Why do investors operate through intermediaries?
- In standard theories, intermediaries ameliorate financial frictions:
  - lower information asymmetries (monitoring and screening borrowers)
  - offer diversification/leverage/maturity transformation
- Rationales do not apply to Treasury auctions
  - Intermediaries observe client order flows and advise them
  - This paper ⇒ intermediaries are information aggregators
- Study effect of intermediation on auction revenues
- Start with a simple framework: A menu auction of financial assets, with heterogeneous information about asset value
- New twist: Intermediaries (primary dealers) observe order flow, share average info with clients, and bid on their own account
- Calibrate model to Treasury auction results
Effect of intermediation

- Gate-keeping intermediaries (e.g. a “full commitment” IPO):
  - Reduce expected auction revenue
  - Reduce revenue variance

- Information intermediaries have the opposite effect:
  - Increase expected auction revenue
  - Increase revenue variance
Institutional detail

- Competitive (price-contingent) and non-competitive bids (retail and FIMA)
- Clearing rate set by first accepting non-comp bids, then comp bids in ascending rate order up to offered amount
- PDs account for large shares of allotted amounts
  - Explicit/implicit minimum bidding requirements
- Other institutional investors can bid directly or indirectly
  - Most investors’ bids are placed indirectly
Allotted shares by bidders
Number of primary dealers
Basic model

- N investors are evenly assigned to 1 of D dealers
- All have exponential utility $- \exp(\rho_j W_j)$
  $\rho_j$ is $\rho_D$ for dealers $\rho$ for investors and
  \[
  W_j = W_0 - q_j p + q_j f
  \]
- Future value of security $f \sim N(\mu, \tau_f^{-1})$
Each investor has a signal

\[ s_i = f + \varepsilon_i \; ; \; \varepsilon_i \sim N(0, \tau_{\varepsilon}^{-1}) \]

“fundamental” “noise”

Dealers disseminate average \( \bar{s}_j \) to their clients

\[ \bar{s}_j = f + \bar{\varepsilon}_j; \; \bar{\varepsilon}_j \sim N \left( 0, D/N \tau_{\varepsilon}^{-1} \right) \]

Dealers aggregate information (reduce uncertainty)
### Model structure

<table>
<thead>
<tr>
<th>Type</th>
<th>Information</th>
<th>Decisions</th>
<th>Strategic</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market orders</td>
<td>$s_i, \bar{s}, p$</td>
<td>Bidding</td>
<td>Non-competitive</td>
<td>$x \sim N \left(0, \tau_x^{-1}\right)$</td>
</tr>
<tr>
<td>Investors ($N$)</td>
<td>$s_i, \bar{s}, p$</td>
<td>Bidding</td>
<td>Price-takers</td>
<td>$q_i(p</td>
</tr>
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<td>Dealers ($D$)</td>
<td>$\bar{s}, p$</td>
<td>Bidding</td>
<td>Strategic</td>
<td>$q_d(p</td>
</tr>
<tr>
<td>Large invest. (1)</td>
<td>$s_L, \bar{s}, p$</td>
<td>Bidding; intermediation</td>
<td>Strategic</td>
<td>$q_L(p</td>
</tr>
</tbody>
</table>

- Large, strategic investor chooses between bidding directly or through a dealer

**Trade-off:** gain access to $\bar{s}$ but disclose $s_L$ to dealer
Model intuitions

- Optimal bids $q(p)$ condition on information in realized price $p$
- Equilibrium price:

$$p = A + B (f + \bar{\varepsilon}) + Cx$$ (1)

- Investors use $p$ to learn about $f$ but
  - Not perfectly revealing of $\bar{s}$ because of market orders $x$
  - More dealers $\Rightarrow$ less precise $\bar{s}$ $\Rightarrow$ price less informative about $f$
Basic model solution

- Investors bid

\[ q_i(p) = \frac{\mathbb{E}[f|s_i, \bar{s}, p] - p}{\rho \mathbb{V}[f|s_i, \bar{s}, p]} \]
Basic model solution

- Dealers bid

\[ q_d(p) = \frac{\mathbb{E}[f|\bar{s},p] - p}{\rho_D \mathbb{V}[f|\bar{s},p] + dp/dq_d} \]

- Having a dealer lowers payoff uncertainty:

\[ \mathbb{V}[f|s_i,\bar{s},p] < \mathbb{V}[f|s_i,p] \]

- Increasing the number of dealers
  - Makes dealers less strategic: lowers \( dp/dq_d \)
    \[ \Rightarrow \text{Dealers less sensitive to information.} \]
  - Inhibits information aggregation: precision of \( \bar{s}_j \) falls, \( \mathbb{V}[f|s_i,\bar{s},p] \) rises
Calibration

- Assume investors hedge interest rate risk by shorting a replicating portfolio of off-the-runs (from a 1pm estimated yield curve)
- Net revenue measure is the price of the on-the-run minus off-the-run portfolio
- Match target parameters:
  - Coefficient of the estimated equilibrium pricing equation:
    \[ p = -17^{[4.7]} + .97^{[.03]}f + 124^{[34]}x \]
  - Other parameters: mean allotted shares by direct, indirect, dealer and non-competes (including “imputed” FIMA), mean and standard deviation of auction/issue price
Effect of one vs. no dealer

- Less uncertainty with information aggregation
  ⇒ Higher revenues
  ⇒ More sensitivity to information ⇒ more volatility

- Effect of information intermediaries is opposite to IPO underwriters
Changing the number of dealers

- Adding dealers: increases competition, total demand but disaggregates information
  - Higher revenues because of first two effects
  - More uncertainty lowers information sensitivity ⇒ lower volatility
- Work-in-progress on separating effects (only varying information aggregation ⇒ both revenue/volatility decrease)
Intermediation choice

- Large investors bid indirectly for intermediate number of dealers
  - Few dealers: dealer demand very sensitive to information, so optimal for large investor not to disclose signal
  - Many dealers: dealers have less precise information
Minimum bidding requirements

- Primary dealers have minimum bidding requirements:
  - Post 2010 Operating Policies: pro-rata share of offered amount with “reasonable” bids to market
  - A dynamic constraint: high bids in some auctions relax constraint in future auctions
    ⇒ Introduce low bidding penalty $\chi$

- Without penalty:
  \[
  q_d(p) = \frac{\mathbb{E}[f|\tilde{s},p] - p}{\rho_D \nabla [f|\tilde{s},p] + dp/dq_d}
  \]
Minimum bidding requirements

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- With penalty

\[
q_d(p) = \frac{\mathbb{E}[f|\bar{s},p] - (1 - \chi) p}{\rho_D \nabla[f|\bar{s},p] + (1 - \chi) \frac{dp}{dq_d}}
\]

- Higher $\chi$ lowers strategic component of demand but also price elasticity

⇒ Higher auction revenue but higher volatility
Conclusions

- Present a theoretical framework to capture key institutional features of Treasury auctions
- Intermediaries aggregate information:
  - Intermediation results in higher revenues but also higher variance
  - Increasing the number of intermediaries raises competition but disaggregates information