Primary Dealers & The Demand For Government Debt

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January 5, 2021

Introduction

Government bonds

= Almost risk-free assets, traded in large markets

- Avg daily trade volume in 2018: $547.8 bn in US

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- Demand of an individual institution $\rightarrow$ substitutes or complements?
  - E.g. Vayanos and Vila (2021)

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Introduction

What do we know about the supply?

- Governments issue bond in primary auctions
  - In 2020: $>$ \$4.4 T in U.S.

- Objectives

1. Issue debt at lowest cost of financing over time → How?
   - Which auction format?
   - How much supply of which securities?

2. Facilitate well-functioning of the secondary market→ How?
   - Volcker rule: regulate based on the business model

This Paper

- **Proposes a method** to identify demands of primary dealers (PDs) for Treasury securities of different maturities

- **To help policymakers**
  1. Partition PDs into business "types" based on their preferences
  2. Make a more informed decision on how to split the supply of government debt across different securities

Approach

- Focus on the primary market, use an institutional feature: **simultaneous Treasury Bill auctions**

→ This allows us to control for unobserved heterogeneity

  - Same market (auction) rules, participants
  - Same time period, economic situation. . .

Institutional Environment

- 3 types of T-bills in Canada: m= 3, 6, 12 months
- 3 separate auctions, run in parallel
  - G groups of **dealers** (d): market-makers, niche dealers, ...
  - **customers** (c): can only submit bids through a dealer

Institutional Environment

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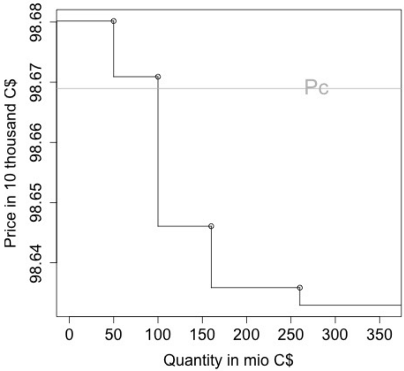
Pay-As-Bid Auction

- A 'bid' in an auction is a bid step function: $\{b_k, q_k\}_{k=1}^{K_i}$



- Given a supply Q_m market clears at p_m^c s.t. total demand $= Q_m$
- Every bidder pays their bid for all allocated units

Data

- All 366 Canadian T-bill auctions of 3,6,12M from 2002 to 2015
- Bidder IDs
  - avg: roughly 11 dealers
  - avg: 95 % of dealers go to all 3 auctions
- Individual bids (including updates)
  - avg: # of steps in bid-function is about 4.5

Summary Stats Bid updating

Goal

- Devise a method for partitioning the dealers into (ex-ante) groups
- Measure whether and how closely securities are substitutable or complementary for each group

Microfoundation

Today: 2 (not 3) different securities

A dealer wants bills

1. **Own balance sheets**
   - have private info about how much value the bill for “personal usage”
2. **Sell in the secondary market, where**
   - clients demand different maturities
   - costly to fail in serving clients (cost has increasing differences)

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  even if securities are substitutes in the secondary market
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Dealer $i \in g$ with private information $(s^g_{1i\tau}, s^g_{2i\tau}, s^g_{3i\tau}) \sim F^g$
is approximately willing to pay

$$v^g_{1i}(q_1, q_2, s^g_{1i\tau}) = f(s^g_{1i\tau}) + \lambda^g_{1i} q_1 + \delta^g_{1i} q_2$$

more at time τ for amount q_1 conditional on winning q_2.

- λ: own-price elasticity of demand
- δ: cross-price elasticity of demand ($\delta < 0$: substitutes)

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Challenges

1. Dealers may have different latent types

$\Rightarrow$ Different beliefs about competition generate asymmetries in auction

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$\Rightarrow$ Incentives to misrepresent their true demands (i.e., shade bids)

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$=$ Bids for security 1 cannot depend on security 2

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$=$ Bids for security 1 cannot depend on security 2

$\Rightarrow$ We observe $b_{1i}^{g}(q_1, s_{1i\tau}^{g})$ not $v_{1i}^{g}(q_1, q_2, s_{1i\tau}^{g})$ w/o knowing $s_{1i\tau}^{g}$

Estimation

Stage 0) Guess ex-ante types ($G = 2$)

1. **Market makers**: different securities are complementary
2. **Others**: mixed, time-varying preferences

Estimation

Stage 1) Estimate dealers' true WTP

- **By inversion** (Guerre, Perrigne and Vuong (2000))
  - Assume all play the group-symmetric BNE
  - Back out which WTPs rationalize the bids we observe

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- **By inversion** (Guerre, Perrigne and Vuong (2000))
  - Assume all play the group-symmetric BNE
  - Back out which WTPs rationalize the bids we observe
- **Key identifying assumption** (Hortacsu (2002), Kastl (2011))
  - Private information of dealer i at time τ is iid across bidders conditional on observed auctions/date characteristics

details

Estimation

Stage 2) Estimate $\lambda^g_{mi}, \vec{\delta}^g_{mi}$

- When bidding for amount $q_{mi\tau k}$ in auction m,
  dealer i guesses how much he wins, $\vec{Q}^c_{-m}$, in other auctions $-m$

$$\hat{\mathbb{E}}[v^g_{mi}(q_{mi\tau k}, \vec{Q}^c_{-m}, s^g_{mi\tau})|\text{win } q_{mi\tau k}]$$

$$= f(s^g_{mi\tau}) + \lambda^g_{mi} * q_{mi\tau k} + \vec{\delta}^g_{mi} \cdot \hat{\mathbb{E}}[\vec{Q}^c_{-m}|\text{win } q_{mi\tau k}] + \epsilon_{mi\tau k}$$

Estimation

Stage 2) Estimate $\lambda^g_{mi}, \vec{\delta}^g_{mi}$

- OLS regressions with bid functions that have > 1 step (88%)

$$\underbrace{\hat{\mathbb{E}}[v^g_{mi}(q_{mi\tau k}, \vec{Q}^c_{-m}, s^g_{mi\tau})|\text{win } q_{mi\tau k}]}_{\textit{estimated}}$$

$$= \underbrace{f(s^g_{mi\tau})}_{\textit{fixed effect}} + \lambda^g_{mi} * \underbrace{q_{mi\tau k}}_{\textit{observed}} + \vec{\delta}^g_{mi} \cdot \underbrace{\hat{\mathbb{E}}[\vec{Q}^c_{-m}|\text{win } q_{mi\tau k}]}_{\textit{estimated}} + \epsilon_{mi\tau k}$$

Estimation

Stage 3)

- Classify dealers into groups based on the estimated $\vec{\delta}_{mi}$
- If classification coincides with the initial guess from Stage 0), terminate, otherwise go to Step 1) using the updated partition

Results: Dealer groups

- 14 dealers

= 8 classify as market maker

+ 6 classify as niche

- Similar to what the trading desk of the Bank of Canada guessed

Results: Overview

- **The WTP is fairly flat in Canada** (w.r.t. all maturities)

$\Rightarrow$ Issue 1% more of the 3M bills, market clearing yield $\uparrow$ by $\leq$ 1 bsp

- **3,6,12M bills are often complements, not substitutes**

$\Rightarrow$ Individual cross-price elasticities in the primary market seem to differ from aggregate elasticities in the secondary markets

- **The rule how to split supply should be time-varying**

Results: Example

Table: Market makers in 12M T-Bill auctions

	Pre 09/2007		Post 01/2010	
λ_{1Y}	-11.21^{***}	(0.14)	-15.70^{***}	(0.20)
$\delta_{1Y,3M}$	-0.37	(0.38)	$+2.55^{***}$	(0.71)
$\delta_{1Y,6M}$	$+1.32^{***}$	(0.32)	$+1.54^{***}$	(0.58)
N	4,354		3,080	

Standard errors in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

- **Elasticities and complementarities increased**

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- **Elasticities and complementarities increased**
  - Substitutability in secondary market ↓
  - Costs to turn down clients ↑
  - Likelihood that clients have demand for different securities ↑

Conclusions

We estimate the demand of primary dealers

- Leveraging an institutional feature of Treasury auctions

We find

- T-bills of different maturities may be complements in the primary market
- Substantial heterogeneity across dealers

Our results can

- Improve the decision of how to allocate supply across securities with different maturities given some target revenue
- Help in implementing the Volcker rule as bidding behavior can be informative about a dealer's downstream model (hold or resale)

Thank you!

Summary Stats

	Mean			SD			Min			Max		
	3M	6M	12M	3M	6M	12M	3M	6M	12M	3M	6M	12M
Issued amount	5.76	2.12	2.12	1.68	0.52	0.52	3.05	1.22	1.22	10.40	3.80	3.80
Dealers	11.88	11.79	11.03	0.90	0.93	0.83	9	9	9	13	13	12
Global part. (%)	93.67	93.84	98.84	24.34	24.04	10.67	0	0	0	100	100	100
Customers	6.26	5.68	5.35	2.69	2.94	2.54	1	0	0	14	13	15
Global part. (%)	35.66	40.13	39.46	47.90	49.02	48.88	0	0	0	100	100	100
Comp demand as % of announced sup.	16.29	16.91	17.02	7.96	7.61	7.31	0.002	0.019	0.005	25	25	25
Submitted steps	4.83	4.23	4.35	1.86	1.78	1.75	1	1	1	7	7	7
Updates by dealer	2.89	2.18	2.48	3.58	2.87	3.18	0	0	0	31	31	42
Updates by customer	0.12	0.13	0.19	0.40	0.40	0.58	0	0	0	4	3	9
Non-comp dem. as % of announced sup.	0.05	0.15	0.15	0.03	0.10	0.10	$5/10^5$	$4/10^5$	$2/10^3$	0.24	0.58	0.58

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Details on Stage 1

Which valuations rationalize the bids we observe if all play the type-symmetric BNE?

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Which valuations rationalize the bids we observe if all play the type-symmetric BNE?

- Bidder i of group g draws private type $s^g_{i,\tau}$
- He forms beliefs about market clearing price conditional on all info available at τ: $\theta_{i,\tau}$ (this might involve knowledge of customer bids etc.), and submit a bid that solves:

One pay-as-bid auction

$$v(q_k, s^g_{i,\tau}) = b_k + \frac{\Pr\left(b_{k+1} \geq P^c | \theta_{i,\tau}\right)}{\Pr\left(b_k > P^c > b_{k+1} | \theta_{i,\tau}\right)} \left(b_k - b_{k+1}\right)$$

Details on Stage 1

Which valuations rationalize the bids we observe if all play the type-symmetric BNE?

- given bidder i of group g draws <u>vector</u> of types $s^g_{i,\tau} = \left(s^g_{3M}, s^g_{6M}, s^g_{12M}\right)_{i,\tau}$
- forms beliefs about market clearing price conditional on all info available at τ: $\theta_{i,\tau}$ (this might involve knowledge of customer bids etc.), and submit a bid that solves:

Simultaneous pay-as-bid auctions

$$\tilde{v}_m(q_{m,k}, s^g_{m,i,\tau}) = b_{m,k} + \frac{\Pr\left(b_{m,k+1} \geq P^c_m | \theta_{i,\tau}\right)}{\Pr\left(b_{m,k} > P^c_m > b_{m,k+1} | \theta_{i,\tau}\right)} \left(b_{m,k} - b_{m,k+1}\right)$$

- Note that $\tilde{v}_m(q_{m,k}, s^g_{m,i,\tau})$ is a transformed MWTP due to interdependency:
  - MWTP for maturity m will depend on expectations of how much of securities of other maturities a bidder expects to win!
  - This expectation is conditional on how much i wins in m!

Resampling

By resampling we can consistently estimate the joint distribution of

- the market clearing prices $\vec{P}^c_{|\theta_{i,\tau}} = (P^c_{3M|\theta_{i,\tau}}, P^c_{6M|\theta_{i,\tau}}, P^c_{12M|\theta_{i,\tau}})$
- how much bidder i wins $\vec{Q}^c_{|\theta_{i,\tau}} = (Q^c_{3M|\theta_{i,\tau}}, Q^c_{6M|\theta_{i,\tau}}, Q^c_{12M|\theta_{i,\tau}})$

- This allows us to construct the needed (conditional) expectations of how much of other maturities a bidder expected to win given his bid for maturity m

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Simplified Resampling Procedure

Assume

- Bidder is from group g
- N_{-g} potential bidders from each $-g$ and $N_g - 1$ from g are ex-ante type-sym and play the type-sym BNE
- Private information is independent across bidders, no updates (just for illustration)
- All $T \times M$ auctions have identical covariates

Simplified Resampling Procedure

Procedure

1. Fix bidder i and the bidding schedules he submitted in all auctions he participated in. If he did not bid in an auction, replace his bid by 0.

2. Draw a random subsample of $N_g - 1$ bid vector triplets with replacement from the sample of $N_g(T \times M)$ bids in the data set and N_{-g} from $N_{-g}(T \times M)$.

3. Construct one realization of bidder i's residual supply $\forall m$ were others to submit these bids to determine
   - realized clearing prices $\vec{p} = \{p_{3M}, p_{6M}, p_{12M}\}$
   - if i would have won $\vec{q}_i = \{q_{i,3M}, q_{i,6M}, q_{i,12M}\}$ for all $(\vec{q}, \vec{p})$.

$\rightarrow$ Repeat many times $\Rightarrow$ Consistent estimate of the joint distr. of $\vec{P}$ and $\vec{Q}_i$

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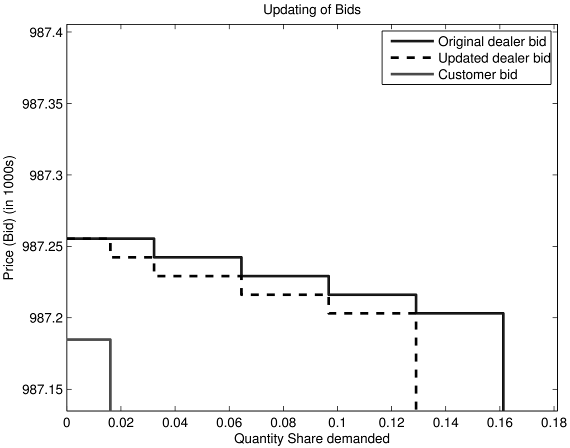
Preliminary Evidence: Bid Updating



Observing a customer bid in one maturity ⇒ Update in other maturities?

$$update_{i,m} = \alpha_i + \sum_m I_m \left(\beta_m customer_m + \delta_{m,-m} customer_{-m}\right) + \varepsilon_{i,m}.$$

Preliminary Evidence of Interdependency

Table: Probability of Dealer Updating Bids

		Dependent variable:	
		update	
Coefficient	Verbal description	(1)	(2)
$\hat{\beta}_{3M}$	update in $3M$ after order for $3M$	0.534***	0.713***
		(0.056)	(0.053)
$\hat{\delta}_{3M,6M}$	update in $3M$ after order for $6M$	0.409***	0.534***
		(0.064)	(0.061)
$\hat{\delta}_{3M,12M}$	update in $3M$ after order for $12M$	0.305***	0.448***
		(0.057)	(0.054)
$\hat{\delta}_{6M,3M}$	update in $6M$ after order for $3M$	0.088	0.250***
		(0.063)	(0.059)
$\hat{\beta}_{6M}$	update in $6M$ after order in $6M$	0.846***	0.929***
		(0.076)	(0.070)
$\hat{\delta}_{6M,12M}$	update in $6M$ after order in $12M$	0.732***	0.765***
		(0.080)	(0.074)
$\hat{\delta}_{12M,3M}$	update in $12M$ after order for $3M$	0.552***	0.662***
		(0.070)	(0.065)
$\hat{\delta}_{12M,6M}$	update in $12M$ after order for $6M$	0.123**	0.247***
		(0.059)	(0.056)
$\hat{\beta}_{12M}$	update in $12M$ after order for $12M$	0.830***	0.936***
		(0.061)	(0.059)
Constant		0.473***	0.444***
		(0.007)	(0.007)
Observations		39,122	39,122
Log Likelihood		−23,537.510	−23,293.960

*p<0.1; **p<0.05; ***p<0.01

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