When-Issued Markets and Treasury Auctions

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Introduction

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  - 6% of trading activity in the *inter dealer Treasury* market (Fabozzi and Fleming, 2005; Barclay et al, 2006).

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  - 6% of trading activity in the *inter dealer Treasury* market (Fabozzi and Fleming, 2005; Barclay et al, 2006).
- ***Underpricing*** - Yields on Treasury securities are higher in the auction than in the when-issued market.
  - In the order of $\frac{1}{2}$ to 1 basis point within minutes to the auction (Goldreich (2007), Bikhchandani et al (2000)).
  - Higher underpricing if prices from previous days are considered (Lou, Yan and Zhang (2011)).

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- ***If the price in the auction is lower, why dealers acquire securities in the when-issued market?***
  - Structure of the market:
  - Single-price auctions do not allocate securities efficiently.
  - Dealers can use WI market to improve allocation.
  - Underpricing arises in equilibrium.

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  - Structure of the market:
  - Single-price auctions do not allocate securities efficiently.
  - Dealers can use WI market to improve allocation.
  - Underpricing arises in equilibrium.
- **When-issued market increases efficiency (allocation).**
- **Prices in the when-issued market are a biased proxy for the true market value of securities.**

Related Literature

1. When-issued markets and Treasury auctions
   - Nyborg and Strabulaev (2004); Chatterjea and Jarrow (1998).
2. Divisible good auction.
   - Wilson (1979); Kyle (1989); Back and Zender (1993); Wang and Zender (2002); Ausubel et al (2011); Coutinho (2012)
3. Forward Market and Market Power.
   - Allaz and Vila (1993); Powell (1993), Green (1999).
4. Empirical Treasury Auctions:
   - Nyborg and Sundaransen (1996); Malvey and Archibald (1998); Bikhchandani et al (2000); Keloharju et al (2005); Goldreich (2007);

Example: Two Investors, Two securities

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- Auction:
  - Bids $\beta_i = \left(\beta_i^1, \beta_i^2\right) \in \mathbb{R}_+^2$ $i = A, B$.
  - Units are allocated to the two highest bids.
  - Single-price auction - dealers pay the same price $p^{so} \geq 0$ for acquired units.
  - $p^{so} \equiv$ highest rejected bid.

Example: Auction

- **Claim:** *There is an equilibrium of the auction where dealers submit:*

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- Why?

Dea. A	Dea. B	Aggregate
5	3	5
0	0	3
		0
		0

- Payoff:

$$U_A^0 = (5-0)\times 1 = 5.$$
$$U_B^0 = (3-0)\times 1 = 3.$$

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- Payoff with deviation:

$$\begin{aligned} \hat{U}_A &= 5 \times 2 - 3 \times 2 \\ &= 4 \end{aligned}$$

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- Payoffs:

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- ***Underpricing:*** $p^{wi} > p^{so}$.

Main Model

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  - $V_i(q, m) = v_i(q) + m$;
  - $v_i'(q) = \upsilon_i - \rho q$.

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Dealers trade
When-issued securities

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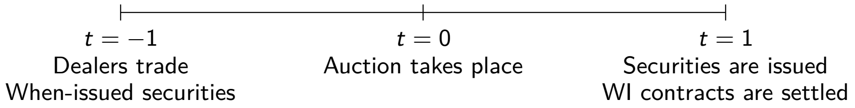
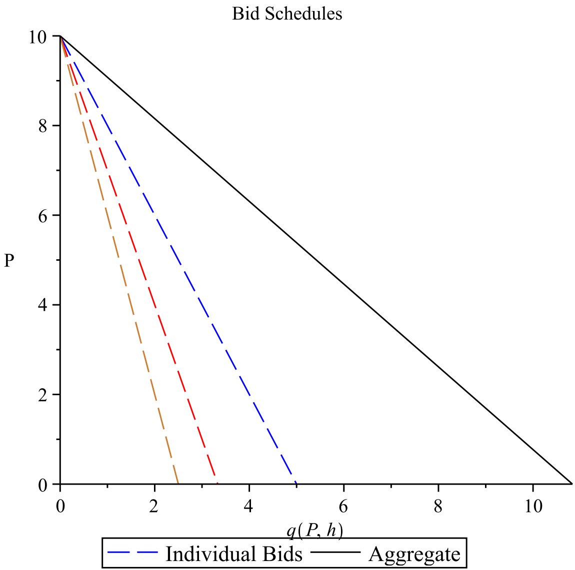


Auction

- Start by characterizing equilibrium in the auction stage.
- History $h = \left(p^{wi}, \left\{\theta_i^{wi}\right\}_{\mathcal{I}}\right)$ from the WI market:
  - p^{wi} - price of WI securities.
  - $\left\{\theta_i^{wi}\right\}_{\mathcal{I}}$ - WI positions.
- Stochastic quantity $Q \in \left[\underline{Q}, \overline{Q}\right] \subseteq \Re_{++}$ of a Treasury security.
- Dealer i submits a left continuous, weakly decreasing bid schedule $q_i^A(p, h) : \Re_+ \times \mathcal{H} \to \Re_+$.
- Stop-out price: $\tilde{p}^{so}$ such that $\sum_{\mathcal{I}} q_j^A(\tilde{p}^{so}, h) = \tilde{Q}$.
- *Single-price auction:* dealer i gets $\tilde{\psi}_i^A \equiv q_i^A(\tilde{p}^{so}, h)$ units of the good and pays $\tilde{\psi}_i^A \times \tilde{p}^{so}$.

Uniform Price Auction



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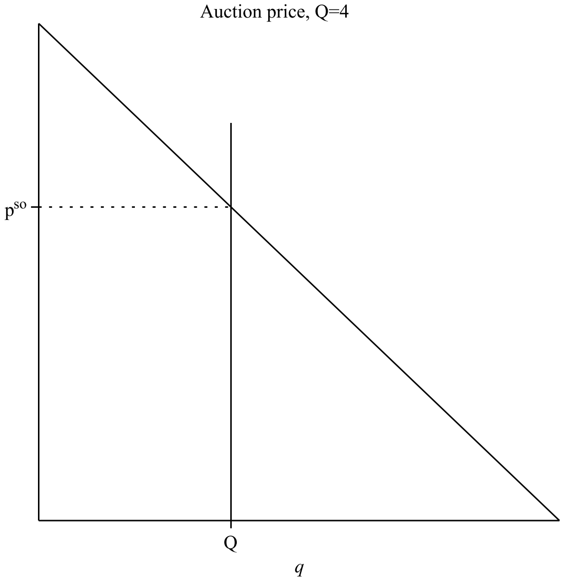

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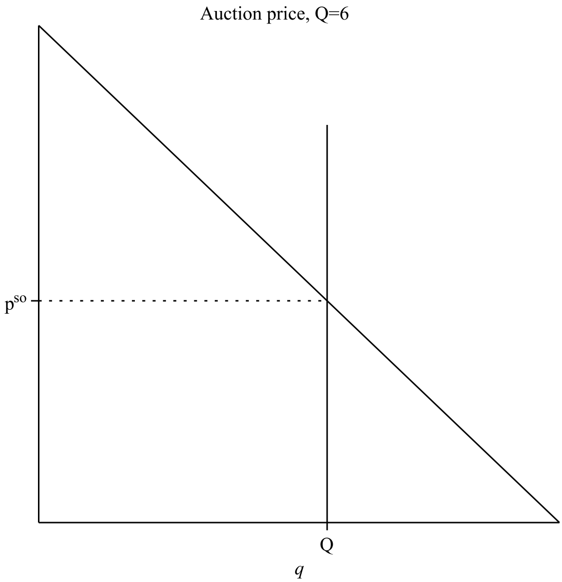

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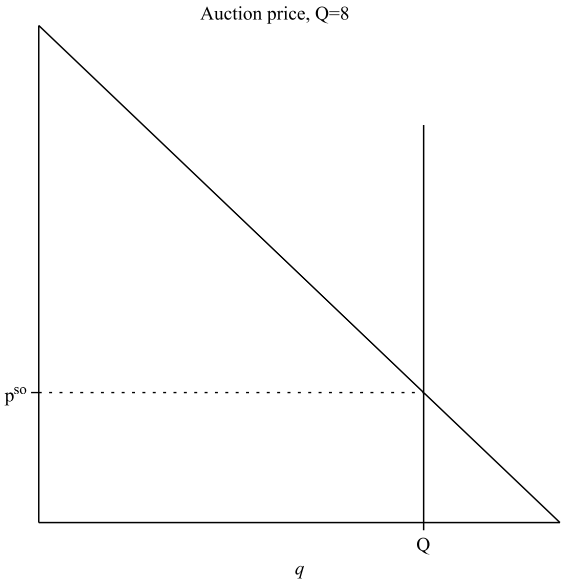

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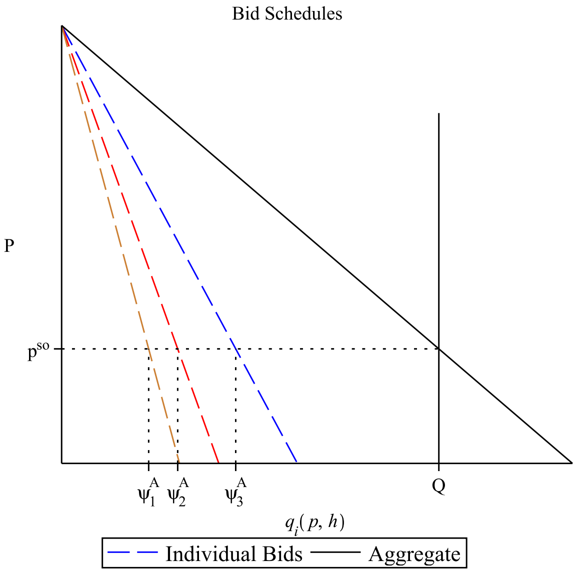

Auction Stage

- Dealer i faces the problem:

$$\max_{q_i(\cdot,h)} E\left[v_i\left(q_i\left(\tilde{p}^{so},h\right)+\theta_i^{wi}\right)-\tilde{p}^{so}q_i\left(\tilde{p}^{so},h\right)\right].$$

$$\text{subject to} \sum_{\mathcal{I}} q_j^A\left(\tilde{p}^{so},h\right)=\tilde{Q}.$$

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Proposition

Let $\gamma \equiv \frac{N-2}{N-1}$ *and* $\theta_i^{wi} \leq \overline{\theta^{wi}}$*, in the unique linear equilibrium, dealers submit:*

$$q_i^A\left(P,h\right)=\frac{\gamma}{\rho}\left(\upsilon_i-P\right)-\gamma\theta_i^{wi}. \tag{1}$$

For a given realization of $\tilde{Q}$*, the stop-out price satisfies*

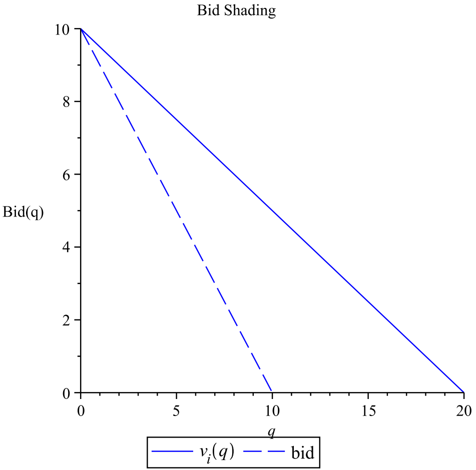
$$\tilde{p}^{so}=\tilde{p}^{W}-\rho\frac{1}{N-2}\frac{\tilde{Q}}{N}.$$

where $p^W \equiv$ *Walrasian Price*

Equilibrium: Auction

- Dealers "shade" their bids:

$$Bid(q_i^A) = \underbrace{v_i'\left(q_i^A + \theta_i^{wi}\right)}_{\text{Marginal Bennefit}} - \underbrace{\frac{dp^{so}}{dq_i^A} \times q_i^A}_{\text{Shade}}.$$



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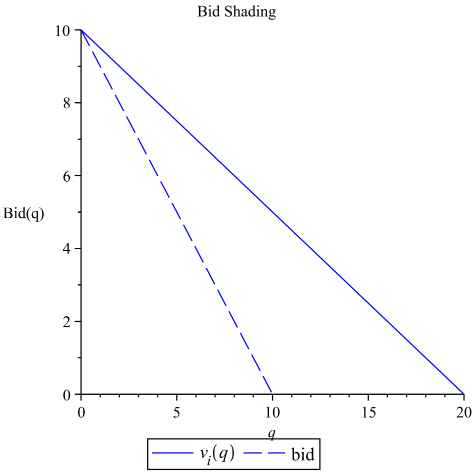

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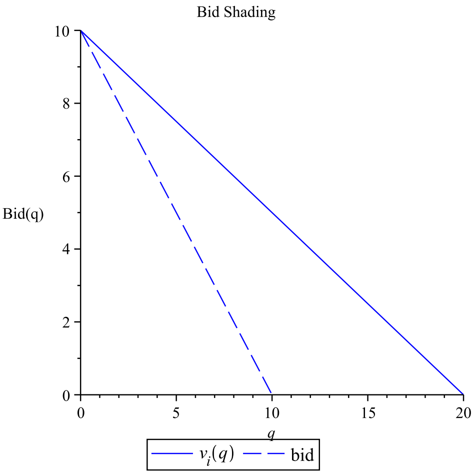

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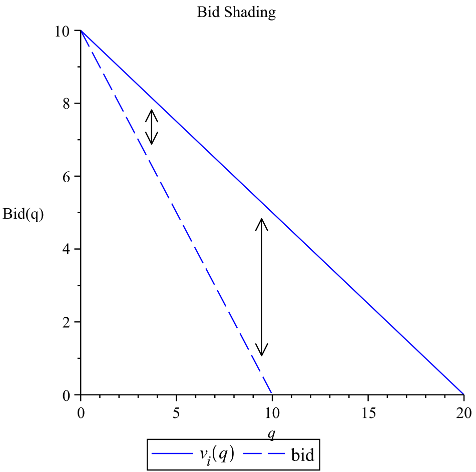

No When-Issued

Corollary

No when-issued trade, i.e., $\theta_i^{wi} = 0$ *for* $i \in \mathcal{I} \Longrightarrow$ *the outcome of the auction is not efficient:*

$$v_i > v_j \Longleftrightarrow v_i'\left(\tilde{\psi}_i^F\right) > v_j'\left(\tilde{\psi}_j^F\right).$$

- Dealers with higher valuation end up with a higher marginal valuation for the security.

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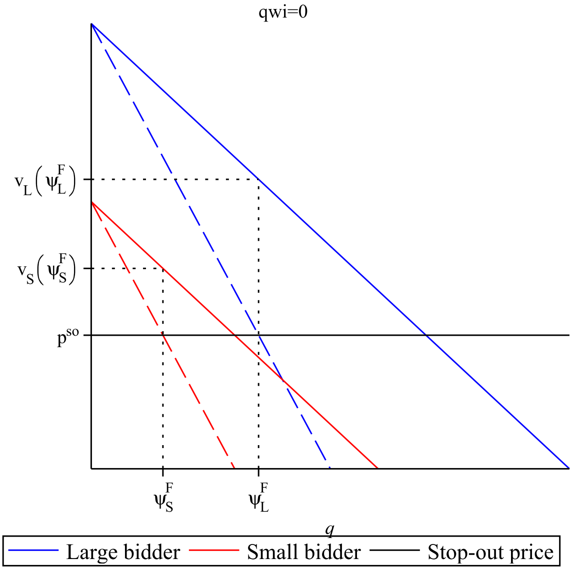

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- Dealers with higher valuation end up with a higher marginal valuation for the security.
- Can dealers improve the allocation trading when-issued securities?
- Yes. Larger dealers acquiring WI securities from smaller dealers.
- WI positions affect how much dealers acquire in the auction and their final holdings of securities:

$$\frac{d\tilde{\psi}_i^A}{d\theta_i^{wi}} = -\frac{N-2}{N-1}$$

$$\frac{d\tilde{\psi}_i^F}{d\theta_i^{wi}} = \frac{1}{N-1}$$

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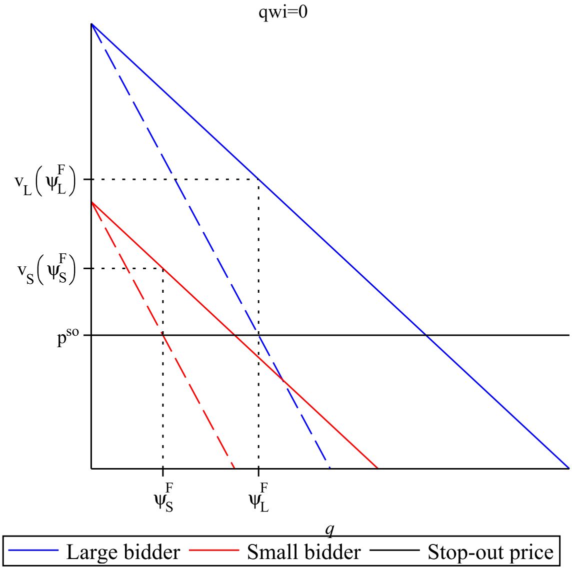

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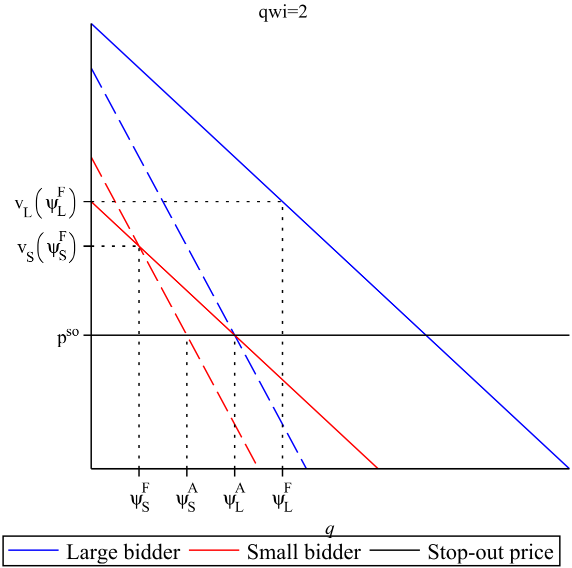

When-Issued Market

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- Dealer i gets $\theta_i^{wi} \equiv q_i^{wi}\left(p^{wi}\right)$ units of the good and pays $\theta_i^{wi} \times p^{wi}$.
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- Dealers anticipate the equilibrium in the auction will be the linear one described previously.

When-Issued

- Dealer *i*'s problem:

$$\max_{q_i^{wi}(\cdot)} E\left[v_i\left(\psi_i^F\right) - p^{so}\psi_i^A\right] - p^{wi}q^{wi}\left(p^{wi}\right)$$

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Proposition

There is a linear equilibrium where dealers submit the following bid schedules in the when-issued market:

$$q_i^{wi}(P) = \frac{\gamma}{(1-\gamma)^2}\frac{1}{\rho}\left(p^{wi} + (1-\gamma)^2\rho\theta_i^c - P\right) \qquad (2)$$

The equilibrium price and positions are given by:

$$\begin{aligned} p^{wi} &= (1-\gamma)E\left[p^W\right] + \gamma E\left[p^{so}\right] \\ \theta_i^{wi} &= \frac{\gamma}{\rho}\left(\upsilon_i - \bar{\upsilon}\right) \end{aligned}$$

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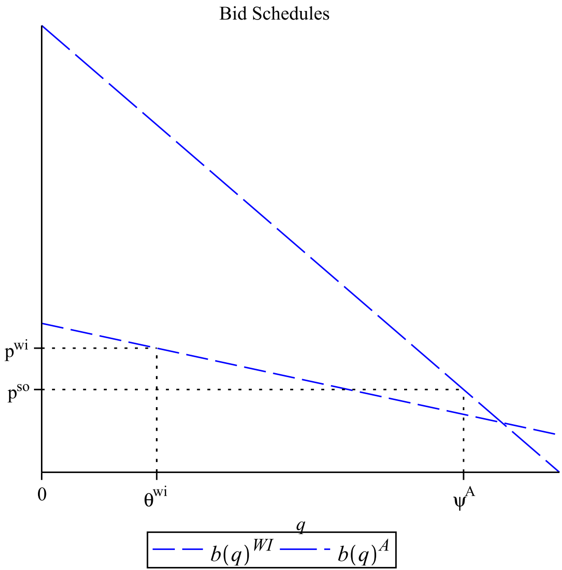
  - Increasing in the size of the auction $\frac{E[Q]}{N}$ and slope of the demand ρ
  - Decreasing in the number of dealers, N, even with constant $\frac{E[Q]}{N}$
- Dealers with higher (lower) than average υ_i will take long (short) positions in the WI market.

When-Issued

- **Limits to arbitrage:**
  - What is the payoff of a "sell high and buy low" strategy?
  - Gain: $p^{wi} + \frac{\partial p^{wi}}{\partial \theta_i^{wi}} \theta_i^{wi}$
  - Cost: $p^{so} + \frac{\partial p^{so}}{\partial \psi_i^{A}} \psi_i^{A}$
  - In equilibrium, net gain $= -(1-\gamma)\,\rho E\left[\frac{Q}{I}\right] < 0$

When-Issued



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- Ranking Single vs. Multiple-price auction mechanisms using when-issued prices may be misleading
- e.g. Nyborg and Sundaransen (1996); Malvey and Archibald (1998); Goldreich (2007)
  - The equilibrium value of p^{wi} is affected by the auction mechanism.
  - Future research!

When-Issued: Sequence of Auctions

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- T when-issued rounds before the auction.
- Let $\theta_i^c \equiv \frac{1}{\rho}\left(\upsilon_i - \bar{\upsilon}\right)$.

Proposition

There is a unique linear sub game perfect equilibrium where dealers submit bid schedules at each period $t = -T, ..., 1$:

$$q_i^{wi,t}(P) = \frac{1}{(1-\gamma)^{-2t}} \frac{\gamma}{\rho}\left(A_i^t - P\right) - \gamma\theta_i^{t-1}. \tag{3}$$

where $A_i^t \equiv p^{wi,c} + (1-\gamma)^{-2t}\rho\theta_i^c$.

Corollary

The when-issued prices $\{p^t\}_{t=-T}^{1}$ *are the same on all* $t = -T, .., 1$ *and given by*

$$p^t = p^{wi}.$$

(57)

When-Issued: Sequence of Auctions

- Positions are build up over the entire when-issued period:

$$\theta_i^t = \gamma\theta_i^c + (1-\gamma)\,\theta_i^{t-1}.$$

- Volume - Let $\Upsilon^T \equiv \frac{\sum_{i,T}\left(q_i^{wi,t}\right)^2}{N}$, in equilibrium,

$$\Upsilon^T = s_\upsilon^2 \left(\frac{1-(1-\gamma)^T}{\rho}\right)^2.$$

where $s_\upsilon^2 \equiv \frac{1}{N}\sum(\upsilon_i - \bar{\upsilon})^2$.

Corollary

Efficient outcome in the limit. When $T \to \infty$,

$$\tilde{\psi}_i^F \to \tilde{\psi}_i^W.$$

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Conclusion

- First to model the strategic behavior of bidders when they participate in a when-issued market prior to a multiple unit auction.
- Market power + Single-Price auction$\Rightarrow$ When-issued trading + Underpricing.
- Prices in the when-issued market are a biased proxy to the true market value of the underlying security.
- When-issued market mitigates/vanishes uniform-price inefficiencies.

Thank you.

Equilibrium: Auction

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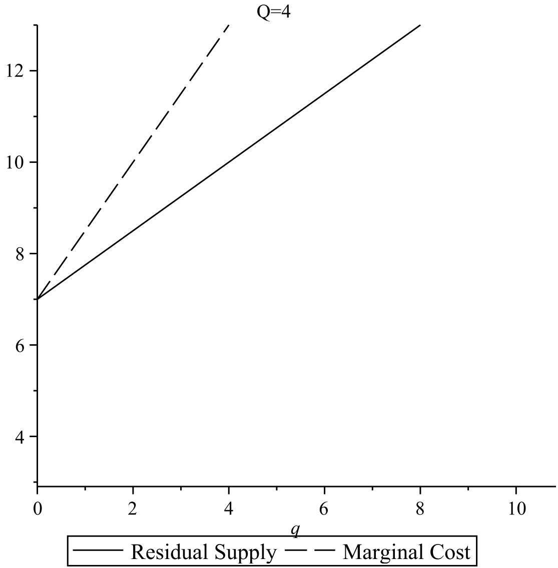
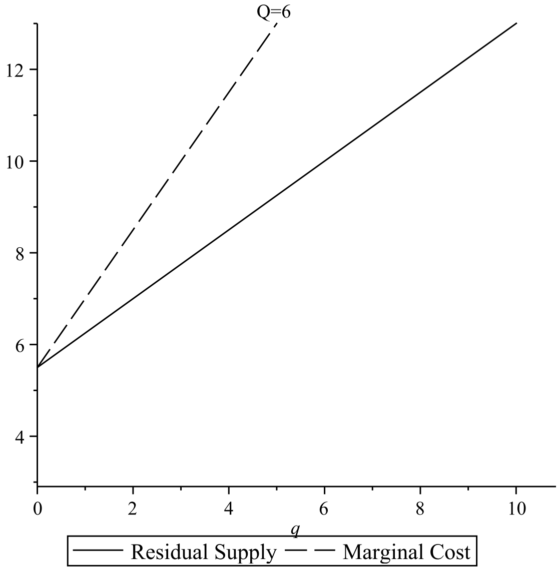


Equilibrium: Auction



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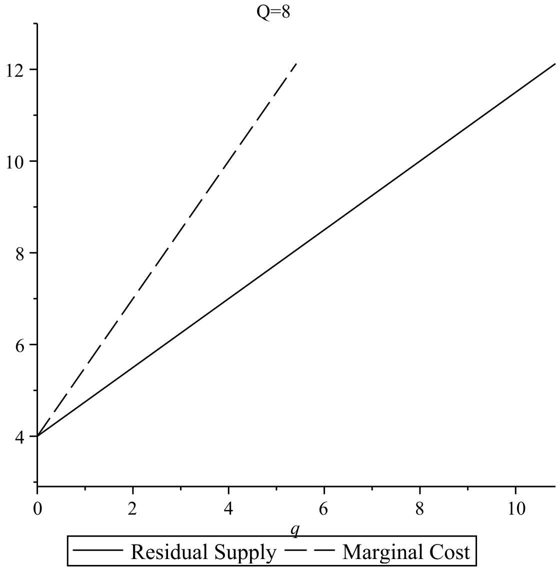
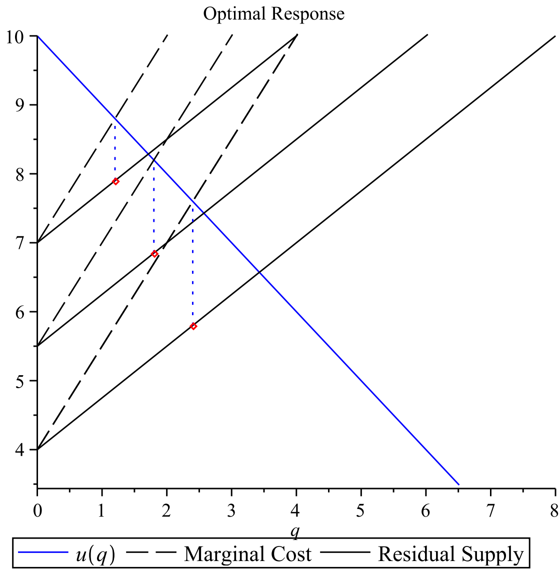


Equilibrium: Auction



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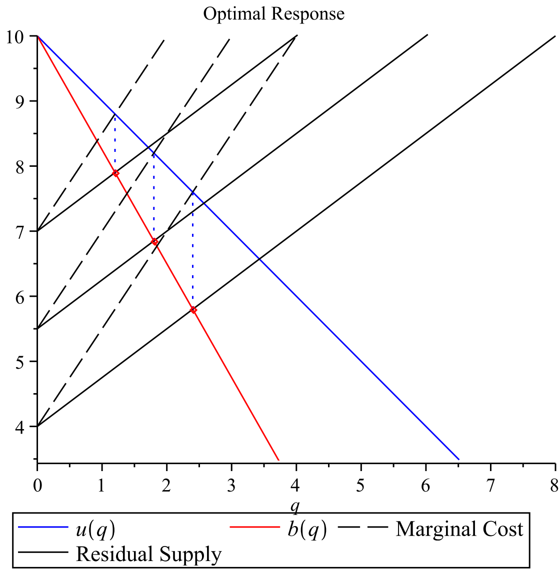

Equilibrium: Auction

(1)

Equilibrium: When-Issued

When-Issued

- Similar to the auction stage.
- However, marginal valuations functions are different. Remember that:

$$\begin{aligned} \frac{d\tilde{\psi}_i^A}{d\theta_i^1} &= -\gamma \\ \frac{d\tilde{\psi}_i^F}{d\theta_i^1} &= (1-\gamma) \end{aligned}$$

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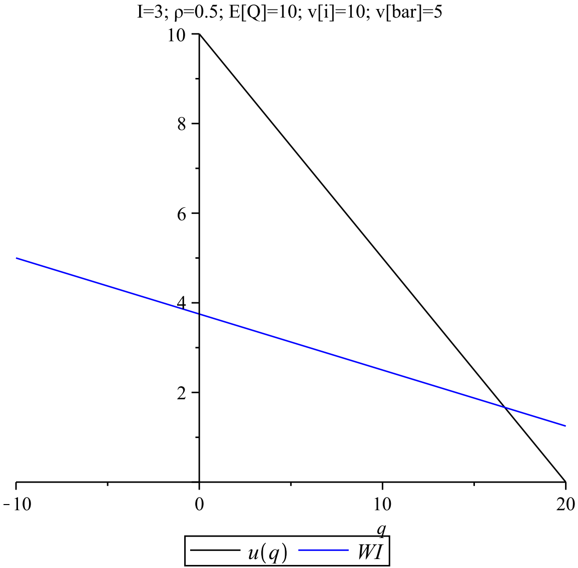
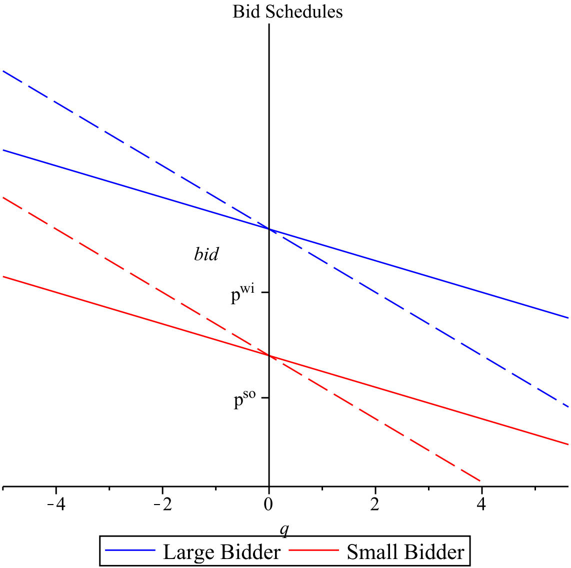
  - Decreases the cost in the auction stage by $\gamma \times p^{so}$ (constant)

When-Issued



When-Issued



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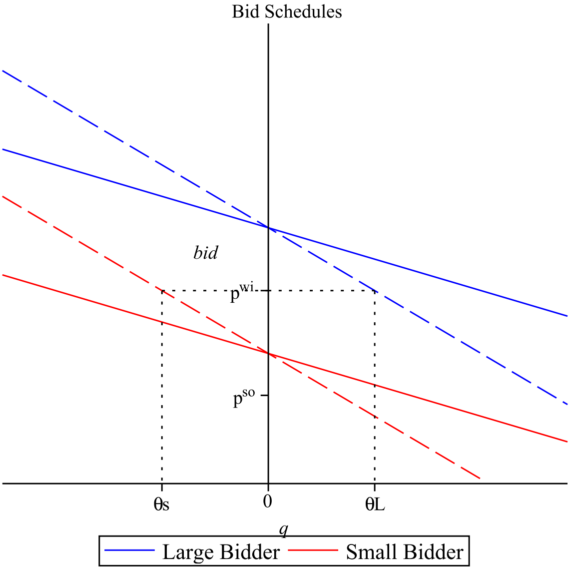
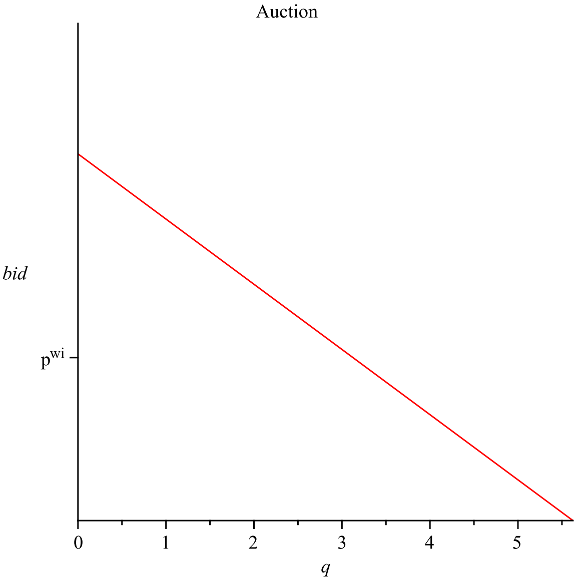


When-Issued

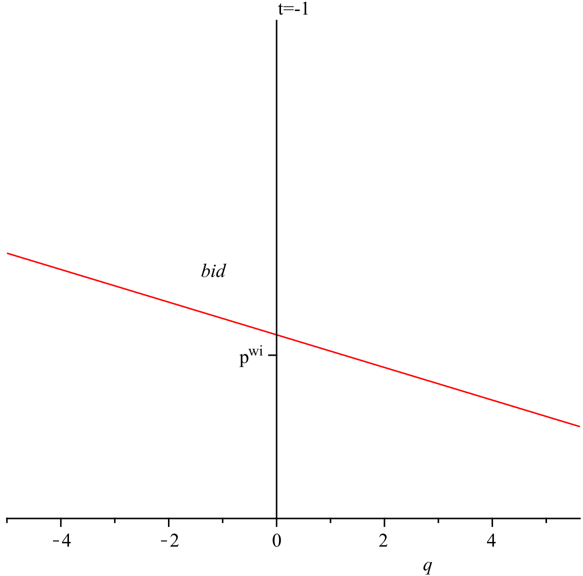
(2)

Sequence of Auctions: Bid Schedules

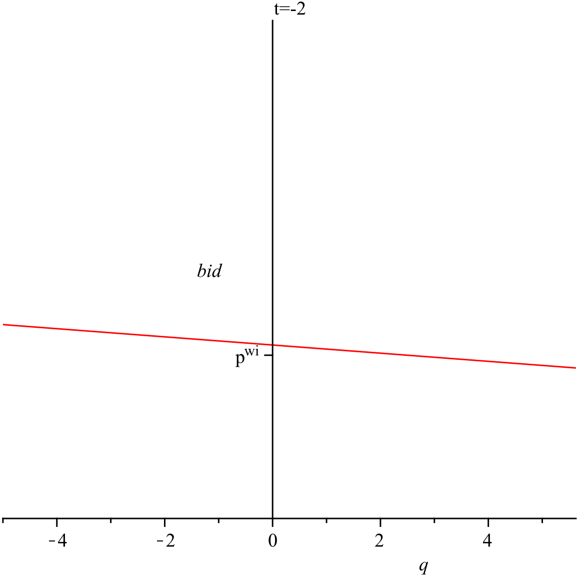
When-Issued: Sequence of Auctions



When-Issued: Sequence of Auctions



When-Issued: Sequence of Auctions



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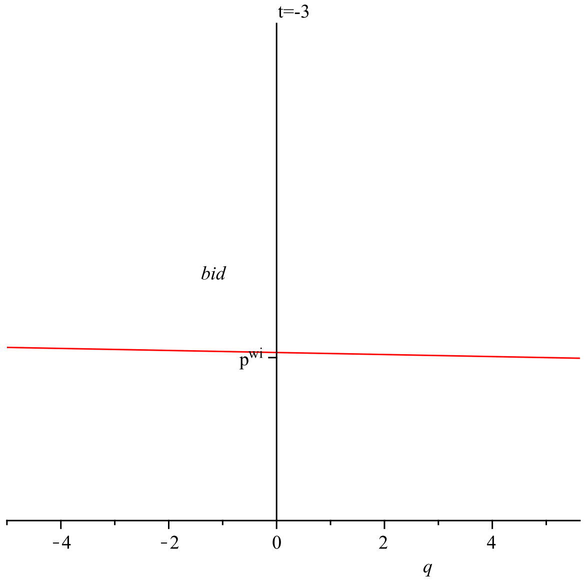

Bid Sequential Auction

(3)