Speculation in Procurement Auctions

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Section 1

Introduction

Motivation for Speculation

- Consider a procurement auction that is scheduled to take place in the future.
- Before the auction, some economic agent (speculator) may have an incentive to consolidate the market by acquiring items from different sellers.
- Because by doing so, he gains market power and can reduce competition in the auction. Therefore, his revenue from the procurement auction may be high and more than enough to cover the acquisition costs.

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- Because by doing so, he gains market power and can reduce competition in the auction. Therefore, his revenue from the procurement auction may be high and more than enough to cover the acquisition costs.
- This economic agent may not even be interested in the (items to be traded in the) auction, but simply wants to make some profit by trading.

Profitability of Speculation: A Real-World Example

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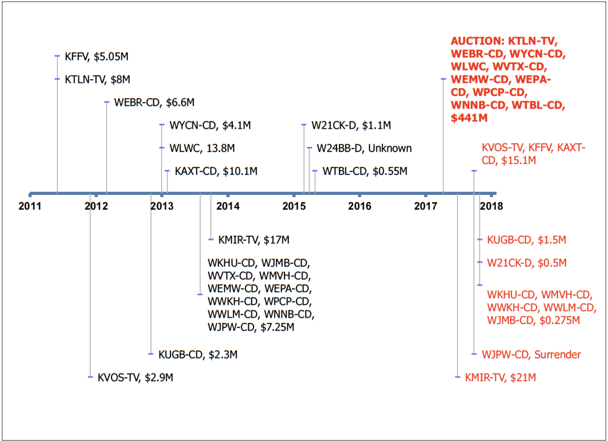
- Some private equity firms acquired a lot of TV stations before the reverse auction and then seemed to engage in strategic supply reduction in the auction (Doraszelski et al., 2019).

Profitability of Speculation: A Real-World Example

Timeline of OTA's acquisitions (black) and sales (red) of TV stations.



Source: Figure S5 in Online Appendix C of Doraszelski et al. (2019).

Profitability of Speculation: A Real-World Example

Below are some activities of OTA Broadcasting (PIT), LLC, in the Pittsburgh market.

<table>
<tr><th>Stations</th><th>Acquisition Price</th><th>Drop-out Price in the Reverse Auction</th><th>Outcome</th></tr>
<tr><td>WJMB-CD</td><td rowspan="7">OTA acquired these stations along with 4 others at a total price of $7.25M before the reverse auction.</td><td>$28.46M</td><td rowspan="5">Sold after the reverse auction at a total price of $0.275M. The total drop-out price is $264M.</td></tr>
<tr><td>WKHU-CD</td><td>$37.57M</td></tr>
<tr><td>WMVH-CD</td><td>$33.02M</td></tr>
<tr><td>WWKH-CD</td><td>$76.59M</td></tr>
<tr><td>WWLM-CD</td><td>$88.36M</td></tr>
<tr><td>WJPW-CD</td><td>$8.77M</td><td>Surrendered</td></tr>
<tr><td>WNNB-CD</td><td>$18.23M</td><td>Sold in the auction</td></tr>
</table>

Source: `https://auctiondata.fcc.gov/public/projects/1000/reports/reverse-bids`

Research Questions

- (When) is speculation profitable?
- How does speculation affect welfare (allocative efficiency, procurement costs, and sellers' expected payoffs)?
- How do the answers depend on the auction format?

Overview

Model

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- To study the profitability and welfare implications of speculation, I incorporate a speculator and a pre-auction acquisition stage in an independent private value procurement auction model.
- To capture the economic insights within a parsimonious setting, I consider a single-object auction.
- In the model, the auctioneer seeks to buy one item and many potential sellers each have one item for sale.[1] The speculator (who has no item for sale and no *private* value for any item) comes in before the auction and makes take-it-or-leave-it offers simultaneously to all potential sellers.

[1] In the case of contract procurement, the obligation to fulfill the contract is interpreted as an item for sale.

Model

- I study speculation in both second price auctions, which are the single-object analog to the deferred-acceptance auction design used by the FCC in the incentive auction,[2] and
- first price auctions, which are adopted commonly in government procurements.

[2] To be precise, (reverse) English auctions are the single-object analog to the deferred-acceptance clock auction used by the FCC in the incentive auction. But for the purpose of this paper, English auctions and second price auctions are equivalent.

Overview of Results: Profitability

- Profitability of the speculation scheme hinges on the auction format.
- In second price auctions, the speculator can always secure a positive expected payoff. In contrast, speculation could be unprofitable in first price auctions.
- Speculation is always more profitable in SPAs than in FPAs.

Overview of Results: Profitability

- Note that the speculator, if enters the auction successfully, becomes a strong bidder.
  - In a two-bidder asymmetric auction model, Maskin and Riley (RES, 2000) show that SPA is often more favorable for a strong bidder than FPA.

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- The driving force behind the comparison is the strategic response of the sellers who reject the acquisition offer and participate in the auction.
  - In a second price auction, the sellers do not respond to the speculator's participation in the auction, they still bid their true values as if no acquisition had occured.
  - However, in a first price auction, sellers respond to the speculator's entry in the auction by bidding more aggressively.

Overview of Results: Welfare

- Speculation activities would induce efficiency losses, because of private value destruction.
- Sellers are better off as the speculator overcompensates them.
- Therefore, the profit in speculation comes at the auctioneer's expense.
- A FPA is better for the auctioneer and efficiency in the cases where it renders speculation unprofitable.

Overview of Results: Who Sells to the Speculator?

- Sellers with lower realized private values for the items tend to accept the speculator's offer in equilibrium.
  - Although their prospects in the auction are good, the speculator's offer is more appealing to them.
  - In the incentive auction example, Doraszelski et al. (2019) report that "[f]ew of the 48 TV stations [acquired by the private equity firms] are affiliated with major networks and many of them are failing or in financial distress."

Related Literature

- Demand/supply reduction: Vickrey (JF, 1961), Ausubel et al. (RES, 2014), Doraszelski et al. (2019).
- Speculation in auctions with resale: Garratt and Troger (ECMA, 2006), Pagnozzi (AEJ:Micro, 2010).
  - Experimental followups: Saral (JEBO, 2012), Pagnozzi and Saral (EE, 2019), Garratt and Georganas (GEB, 2021).
- Bidder collusion:
  - Centralized coordination: Graham and Marshall (JPE, 1987), Mailath and Zemsky (GEB, 1991), McAfee and McMillan (AER, 1992), Marshall and Marx (JET, 2007).
  - Simple collusion initiated by a bidder: Eso and Schummer (GEB, 2004), Rachmilevitch(GEB, 2013; GEB, 2015), Troyan (JET, 2017), Lu et al. (GEB, 2021).

Section 2

Model

Model Setup

- ▷ An auctioneer seeks to buy an item.
- ▷ $N \geq 2$ risk-neutral sellers, indexed by the set $\mathcal{I} := \{1, 2, \cdots, N\}$, each has one such item for sale.
- ▷ Seller i's private value for the item is denoted by v_i, which is privately known to the seller.
- ▷ $v_i \overset{i.i.d.}{\sim} [0, 1]$. The CDF $F(\cdot)$ satisfies $F(0) = 0 < F(v)$ for all $v \in (0, 1]$. The PDF is $f(\cdot)$.

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- A risk-neutral speculator, who has no item for sale and no private value for the item, seeks to extract some surplus from the auction.

Timing

- The auctioneer announces the auction format and the reserve price, r.
- The acquisition stage:
  - The speculator makes a take-it-or-leave-it offer to every seller to buy his item at price p.
  - All the sellers simultaneously and independently decide whether to take the offer, or to participate in the auction.

Timing

- The auction stage:
  - If the speculator acquired at least one item, he proceeds to the auction along with all the sellers who rejected the acquisition offer.
  - At the beginning of the auction, the number of bidders and whether the speculator participates in the auction are announced to the bidders.
  - After the auction, if the speculator owns any surplus item(s), he uses the item(s) and derives a value of 0, or sells the item(s) to a third-party at a price of 0. This is relaxed in an extension.

Example

- $N = 2, v_1 = 2, v_2 = 3, r = 10, p = 4$.
  - Number of potential sellers: $N = 2$.
  - Seller 1's realized private value: $v_1 = 2$.
  - Seller 2's realized private value: $v_2 = 3$.
  - Reserve price: $r = 10$.
  - Acquisition price offered by the speculator: $p = 4$.

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- ▷ If seller 1 and seller 2 both reject the acquisition offer, they go to the auction and bid against each other. Speculator gets 0.
- ▷ If seller 1 and seller 2 both accept the acquisition offer, seller 1 gets $4 - 2 = 2$, seller 2 gets $4 - 3 = 1$. The speculator participates in the auction with no opponents and claims the reserve price, profit is $10 - 2 \times 4 = 2$.

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- If seller 1 accepts, and seller 2 rejects, seller 1 gets a net payoff of $4 - 2 = 2$, seller 2 and the speculator go to the auction. In an SPA, the speculator bids 0, seller 2 bids 3. The speculator incurs a loss: $3 - 4 = -1$.

Section 3

Speculation in SPAs

Equilibrium Characterization

- ▷ I first study the PBE of the speculation game, holding fixed an arbitrary price offer $p \in [0, r]$.
- ▷ Once the equilibrium characterization is obtained, I proceed to investigate the speculator's choice of p.

Equilibrium Characterization

- To obtain equilibrium characterization, use backward induction and consider the auction subgame first.

Assumption 1 (Dominant strategy equilibrium in the SPA)

In the SPA subgame, sellers bid truthfully and the speculator bids 0 for one of his items while withholding the rest from the auction.

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- Back to the acquisition stage. There exists $v^* \in [0, r]$ such that seller $i \in \mathcal{I}$ accepts the speculator's offer if and only if $v_i < v^*$.

More details

Equilibrium Characterization

Lemma 1

Under Assumption 1 and holding fixed $p \in [0, r]$, in any PBE of the SPA-speculation game, there exists $v^* \in [0, r]$ such that seller $i \in \mathcal{I}$ accepts the speculator's offer if and only if $v_i < v^*$.

- ▷ To characterize the PBE, the only thing left is to pin down the acceptance/rejection threshold.
  - If $p \leq \pi_0 := \int_0^r [1 - F(x)]^{N-1} dx$, $v^*(p) = 0$.
  - If $p > \pi_0$, $v^*(p)$ is the unique solution to the indifference condition,

$$p = v^* + \int_{v^*}^r [1 - F(x)]^{N-1} dx.$$

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$$p = \underbrace{v^*}_{\text{cost of giving up the item}} + \underbrace{\int_{v^*}^{r} [1 - F(x)]^{N-1} dx}_{\text{cost of skipping the auction}}.$$

Equilibrium Characterization

Proposition 1

Under Assumption 1 and holding fixed $p \in [0, r]$, there exists a unique PBE of the SPA-speculation game. In the equilibrium, seller $i \in \mathcal{I}$ accepts the speculator's offer if and only if $v_i < v^*(p)$.

Profitability in the SPA-Speculation Game

- It is easier to think that the speculator chooses a cutoff $v^* \in [0, r]$, rather than p.
- For a fixed equilibrium cutoff $v^* \in [0, r]$, the corresponding price is

$$p^*(v^*) := v^* + \int_{v^*}^{r} [1 - F(x)]^{N-1} dx, \text{ for } v^* \in [0, r].$$

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- The speculator's expected profit is given by

$$\Pi^*(v^*) := \sum_{m=0}^{N-1} \binom{N}{m} [F(v^*)]^{N-m} [1 - F(v^*)]^m \times \left\{ v^* + \int_{v^*}^{r} \left[\frac{1 - F(x)}{1 - F(v^*)} \right]^m dx \right\} - NF(v^*)p^*(v^*).$$

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Profitability in the SPA-Speculation Game

- The speculator's expected profit consists of three parts.
  - First, the speculator gains from competition reduction;
  - Second, the speculator loses from overcompensating the sellers;
  - Third, the speculator loses from destroying private values.

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  - First, the speculator gains from competition reduction;
  - Second, the speculator loses from overcompensating the sellers;
  - Third, the speculator loses from destroying private values.
- This is most clearly seen in the $N = 2$ case: $\Pi^*(v^*; N = 2)$ is

$$\underbrace{[F(v^*)]^2 \left\{ r - \int_0^{v^*} xd\left[\frac{F(x)}{F(v^*)}\right]^2 \right\}}_{\text{gain from competition reduction}} - \underbrace{2\int_0^{v^*} [F(x)]^2 dx}_{\text{loss from overcompensating the sellers}} - \underbrace{\int_0^{v^*} xd[F(x)]^2}_{\text{loss from destroying private values}}.$$

Profitability in the SPA-Speculation Game

- As $v^* \to 0$, the gain from competition reduction dominates the losses.

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- This pertains to the general $N \geq 2$ case.

$$\lim_{v^* \to 0} \frac{\Pi^*(v^*)}{[F(v^*)]^2} = \binom{N}{2} \int_0^r [1 - F(x)]^{N-2} dx.$$

Profitability in the SPA-Speculation Game

Proposition 2

The speculator can always get a positive expected profit in the SPA-speculation game.

Welfare Implications

Corollary 1

Speculation results in efficiency losses in the form of private value destruction. Sellers are better off in the presence of the speculator, while the auctioneer is worse off.

Welfare Implications

- The inefficiency is not caused by strategic supply withholding alone.
- If a VCG auction is used for the procurement, there would be no strategic supply withholding in the auction,[3] yet the equilibrium outcome of the speculation game would not change.

[3] For instance, if the speculator had acquired three items, he would bid $(0, 0, 0)$ in the VCG auction. In contrast, he effectively bids $(0, \infty, \infty)$ in the second-price auction.

Welfare Implications

- The inefficiency is not caused by strategic supply withholding alone.
- If a VCG auction is used for the procurement, there would be no strategic supply withholding in the auction,[3] yet the equilibrium outcome of the speculation game would not change.
- Although VCG auctions can restore efficiency by eliminating strategic supply reduction in a setting where the ownership structure is fixed, they cannot eliminate the incentive to become a multi-unit owner in a setting where endogenous changes to the market structure can happen.

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Section 4

Speculation in FPAs

Clarification

- ▷ For the FPA-speculation game, focus on symmetric PBE. Symmetry in strategies is not assumed for the SPA-speculation game, but in equilibrium, sellers do use symmetric strategies.

The Cutoff Structure

Lemma 2

Holding fixed $p \in [0, r]$, in any symmetric PBE of the FPA-speculation game, there exists $v^\star \in [0, r]$ such that seller $i \in \mathcal{I}$ accepts the speculator's offer if and only if $v_i < v^\star$.[4]

- Because of this cutoff structure, if a seller rejects the acquisition offer, it can be inferred that the seller has a value above $v^\star$.

[4] More precisely, there exists a F-measure 0 set $\mathcal{E}$ such that seller i accepts the speculator's offer if and only if $v_i \in [0, v^\star) \setminus \mathcal{E}$.

The Auction Subgame

- In light of Lemma 2, it is useful to consider the subgame in which the speculator and $m \geq 1$ sellers compete with each other.
- The speculator has no value for the item for sale, while each seller's value is independently drawn from $[v^\star, 1]$, with $v^\star \in [0, r]$, according to the CDF $G(\cdot; v^\star) := \dfrac{F(\cdot) - F(v^\star)}{1 - F(v^\star)}$.

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Assumption 2 (Undominated bidding in the FPA)

In the FPA subgame, bidders never bid below their valuations.

The Auction Subgame

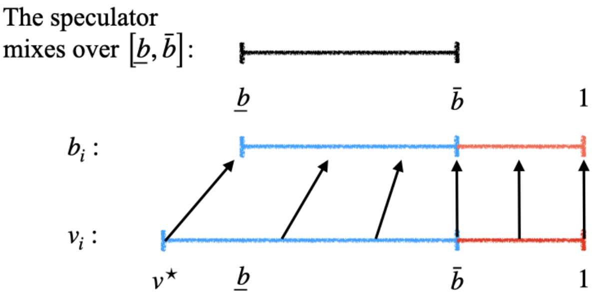

Figure: Illustration of an equilibrium of the FPA.

The Auction Subgame

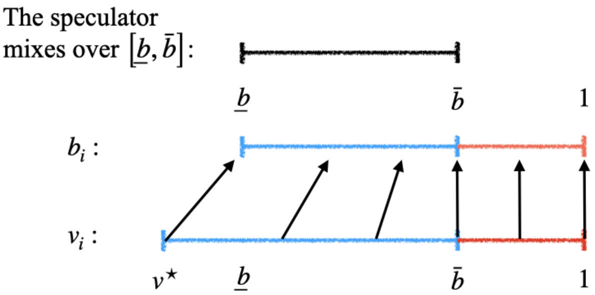

Figure: Illustration of an equilibrium of the FPA.

▷ If $v^\star \in \arg\max_{r \geq b \geq v^\star} b[1 - G(b; v^\star)]^m$, then $\underline{b} = \bar{b} = v^\star$. The speculator bids $v^\star$ for sure and the sellers bid truthfully.

The Auction Subgame

Lemma 3

Under Assumption 2, the following statements hold in any symmetric BNE of the FPA subgame $\Gamma = \langle r, m, G(\cdot; v^\star)\rangle$.

(i) The equilibrium payoff of the speculator (in the subgame Γ*) is*

$$\underline{b}(m, v^\star) := \max_{r \geq b \geq v^\star} b[1 - G(b; v^\star)]^m.$$

(ii) The interim equilibrium payoff of a seller with value $v^\star$ *is* $\underline{b}(m, v^\star) - v^\star$.

Equilibrium Cutoff

- Lemma 3(ii) helps pin down the equilibrium cutoff $v^\star$.
- The indifference condition is

$$p - v^\star = \int_{v^\star}^{r} [1 - F(x)]^{N-1} dx + \sum_{m=0}^{N-2} \binom{N-1}{m} [1 - F(v^\star)]^m [F(v^\star)]^{N-1-m} [\underline{b}(m+1; v^\star) - v^\star].$$

Equilibrium Characterization

Proposition 3

Under Assumption 2 and holding fixed $p \in [0, r]$, the following statements hold in the FPA-speculation game.

(i) In any symmetric PBE, seller $i \in \mathcal{I}$ accepts the speculator's offer if and only if $v_i < v^\star(p)$.

(ii) The cutoff acceptance strategy and the bidding strategies in Lemma 4 (with $v^\star$ replaced by $v^\star(p)$) constitute a symmetric PBE.[5]

[5] If all the sellers sold their items to the speculator, the speculator bids r in the procurement auction; if all the sellers rejected the acquisition offer, they bid as in a standard FPA model with symmetric bidders.

Profitability in the FPA-Speculation Game

- For any equilibrium cutoff $v^\star \in (0, r]$, the corresponding price p is given by

$$p^\star(v^\star) := v^\star + \int_{v^\star}^{r} [1 - F(x)]^{N-1} dx + \sum_{m=0}^{N-2} \binom{N-1}{m} [1 - F(v^\star)]^m [F(v^\star)]^{N-1-m} [\underline{b}(m+1; v^\star) - v^\star].$$

- The speculator's expected profit is given by

$$\Pi^\star(v^\star) := \sum_{m=1}^{N-1} \binom{N}{m} [1 - F(v^\star)]^m [F(v^\star)]^{N-m} \underline{b}(m; v^\star) + [F(v^\star)]^N r - N[F(v^\star)] p^\star(v^\star).$$

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Proposition 4

Speculation could be unprofitable in first-price auctions.

Example 1

Fix $N = 2$ and let $F(v) = v^{\eta}$, with $\eta > 0$. Since sellers are more likely to have high valuations (and be *less* competitive in the procurement auction) with a larger η, η can be thought of as a measure of sellers' competitiveness. Figure 2 shows how the profitability of speculation in first-price auctions changes with the reserve price r, and the competitiveness parameter η.

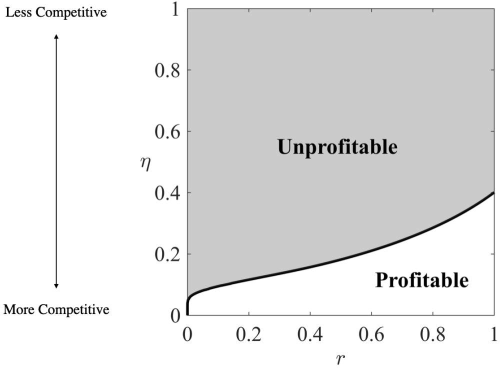

Figure: Profitability of speculation in FPAs, with $N = 2$ and $F(v) = v^{\eta}$.

Profitability in the FPA-Speculation Game

- For a fixed η, speculation is profitable if r is high enough and unprofitable otherwise.
  - Since the speculator's profit comes from the auctioneer, it is not surprising that a higher willingness-to-pay of the auctioneer leaves more room for speculation.

Profitability in the FPA-Speculation Game

- For a fixed r, speculation is profitable if η is small enough and unprofitable otherwise.
  - A small η implies that a seller is more likely to have a low valuation, so the seller would be willing to accept the acquisition offer at a low price.
  - In the meantime, a small η means that other sellers are likely to have low valuations, so the competition in the procurement auction would be fierce. This further reduces the seller's willingness-to-accept for the acquisition offer.
  - As a result, the speculator benefits from sellers' competitiveness.

Section 5

Comparison

Comparison of Profitability

Proposition 5

Speculation is strictly more profitable in second-price auctions than in first-price auctions.

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Speculation is strictly more profitable in second-price auctions than in first-price auctions.

▷ For any fixed equilibrium cutoff $v^\dagger \in (0, r]$,

$$p^\star(v^\dagger) - p^*(v^\dagger) \geq 0.$$

A seller's prospect in the FPA is better than in the SPA when some other seller accepts the acquisition offer. That calls for more compensation.

Comparison of Profitability

Proposition 5

Speculation is strictly more profitable in second-price auctions than in first-price auctions.

- For any fixed equilibrium cutoff $v^\dagger \in (0, r]$,

$$p^\star(v^\dagger) - p^*(v^\dagger) \geq 0.$$

  A seller's prospect in the FPA is better than in the SPA when some other seller accepts the acquisition offer. That calls for more compensation.

- Fix $\Gamma = \left\langle r, m, G(\cdot; v^\dagger) \right\rangle$. The speculator is better off in the SPA than in the FPA.

$$v^\dagger + \int_{v^\dagger} [1 - F(x)]^m dx > \underline{b}(m; v^\dagger).$$

What's Driving the Comparison of Profitability?

- ▷ In the SPA subgame, sellers do not respond to the presence of a strong competitor, i.e., the speculator.
- ▷ In the FPA subgame, sellers bid more aggressively in response. Consider the following thought experiment...

What's Driving the Comparison of Profitability?

- In the FPA subgame $\Gamma = \langle r, m, G(\cdot; v^\star) \rangle$, if the sellers treat the speculator as a seller like them, their bidding strategy would be

$$\tilde{\beta}(v; m, v^\star) = \begin{cases} v + \int_v^r [1 - G(x; v^\star)]^m dx / [1 - G(v; v^\star)]^m, & \text{if } v^\star \leq v \\ v, & \text{if } v > r. \end{cases}$$

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- Validity of the benchmark: If the sellers bid as such in every FPA subgame $\Gamma = \langle r, m, G(\cdot; v^\star)\rangle$, the speculator's profit would be the same in the FPA-speculation game and in the SPA-speculation game.

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Lemma 5

In a FPA subgame, sellers bid more aggressively when they compete against the speculator than when they compete against another seller. Formally, $\beta(v; m, v^\star) < \tilde{\beta}(v; m, v^\star)$ *for all* $v \in [v^\star, r)$.

Comparison of Welfare

- A general welfare ranking is unavailable.
- But in the case where speculation is not profitable in FPAs, clearly FPAs are better for efficiency and the auctioneer, but worse for the sellers.

Corollary 2

In the presence of a speculator, provided that $\Pi^\star(v^\star) < 0$ for all $v^\star \in (0, r]$, FPA is better for the auctioneer and efficiency but worse for the sellers than SPA.

Section 6

Extensions to SPA

Limited Access and Asymmetric Sellers

- For all $i \in \mathcal{I}$, seller i's value v_i is drawn from [0,1] according to the CDF $F_i(\cdot)$. The corresponding PDF is $f_i(\cdot)$. Again, I assume $F_i(0) = 0 < F_i(v)$ for all $v \in (0, 1]$.
- The speculator is able to make (potentially different) acquisition offers only to a subset of the sellers, denoted by $\mathcal{A}$.
    - This limited access assumption is relevant when the speculator wishes to keep speculation discreet by operating on a limited scale, or when the speculator is subject to a budget constraint.

Limited Access and Asymmetric Sellers

- Define $\boldsymbol{v}^* := (v_j^*)_{j\in\mathcal{A}}$ and

$$p_j^*(\boldsymbol{v}^*) := v_j^* + \int_{v_j^*}^{r} \prod_{i\in\mathcal{I}\setminus\mathcal{A}} [1-F_i(x)] \prod_{s\in\mathcal{A}\setminus\{j\}} [1-F(\max\{x, v_s^*\})]\, dx.$$

Proposition 6

Suppose that the speculator offers $p_j = p_j^*(\boldsymbol{v}^*)$ to seller $j \in \mathcal{A}$, with $v_j^* \in [0, r]$. Then a PBE of the SPA-speculation game is described as follows. Seller $j \in \mathcal{A}$ accepts the speculator's offer if and only if $v_j < v_j^*$. In the procurement auction, sellers bid truthfully and the speculator engages in strategic supply withholding.

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Limited Access and Asymmetric Sellers

- Define $\boldsymbol{v}^* := (v_j^*)_{j \in \mathcal{A}}$ and

$$p_j^*(\boldsymbol{v}^*) := \underbrace{v_j^*}_{\text{cost of giving up the item}} + \underbrace{\int_{v_j^*}^{r} \prod_{i \in \mathcal{I} \setminus \mathcal{A}} [1 - F_i(x)] \prod_{s \in \mathcal{A} \setminus \{j\}} [1 - F(\max\{x, v_s^*\})] \, d}_{\text{cost of skipping the auction}}$$

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Limited Access and Asymmetric Sellers

Condition 1

There exists $\{k, k'\} \subseteq \mathcal{A}$, *such that for all* $i \in \mathcal{I} \setminus \mathcal{A}$,

$$\lim_{v \to 0} [vF_i(v)/F_k(v)] = 0 \text{ and } \lim_{v \to 0} [vF_i(v)/F_{k'}(v)] = 0.$$

In words, Condition 1 requires that the speculator can reach at least two sellers, who are not too weak (as compared with sellers the speculator cannot reach).

Proposition 2′

If Condition 1 is satisfied, speculation in the second price procurement auction is profitable.

Enhanced Speculation

- A fine-tuned approach may help avoid the loss from private value destruction.
- In the third stage that happens after the procurement auction, the speculator liquidates the leftover items by selling them back to the sellers (who had accepted the speculator's offer).
- I model this as a VCG auction.

Enhanced Speculation

- Define

$$\bar{p}_j^*(\boldsymbol{v}^*) := \int_0^{v_j^*} \prod_{s \in \mathcal{A} \setminus \{j\}} [1 - F(\min\{x, v_s^*\})]\, dx + \int_{v_j^*}^{r} \prod_{i \in \mathcal{I} \setminus \mathcal{A}} [1 - F_i(x)] \prod_{s \in \mathcal{A} \setminus \{j\}} [1 - F(\max\{x, v_s^*\})]\, dx.$$

Proposition 7

In the three-stage SPA-enhanced-speculation game, suppose that the speculator offers $p_j = \bar{p}_j^*(\boldsymbol{v}^*)$ to seller $j \in \mathcal{A}$, with $v_j^* \in [0, r]$. Then a PBE of the speculation game is described as follows. Seller $j \in \mathcal{A}$ accepts the speculator's offer if and only if $v_j < v_j^*$. Sellers bid truthfully in the procurement auction or in the return and refund auction. The speculator engages in strategic supply withholding in the procurement auction.

Enhanced Speculation

- Define

$$\bar{p}_j^*(\boldsymbol{v}^*) := \int_0^{v_j^*} \underbrace{\prod_{s\in\mathcal{A}\setminus\{j\}} [1 - F(\min\{x, v_s^*\})]}_{\text{probability of giving up the item}} dx +$$

$$\int_{v_j^*}^{r} \underbrace{\prod_{i\in\mathcal{I}\setminus\mathcal{A}} [1 - F_i(x)] \prod_{s\in\mathcal{A}\setminus\{j\}} [1 - F(\max\{x, v_s^*\})]}_{\text{probability of winning in the auction}} dx.$$

Proposition 7

In the three-stage SPA-enhanced-speculation game, suppose that the speculator offers $p_j = \bar{p}_j^*(\boldsymbol{v}^*)$ to seller $j \in \mathcal{A}$, with $v_j^* \in [0, r]$. Then a PBE of the speculation game is described as follows. Seller $j \in \mathcal{A}$ accepts the speculator's offer if and only if $v_j < v_j^*$. Sellers bid truthfully in the procurement auction or in the return and refund auction. The speculator engages in strategic supply withholding in the procurement auction.

Enhanced Speculation

Corollary 3

The enhanced speculation approach can generate more profit for the speculator (than the simple speculation approach).

- The enhanced speculation scheme can induce a given set of cutoffs at lower prices,

$$p_j^*(\mathbf{v}^*) := v_j^* + \int_{v_j^*}^{r} \prod_{i \in \mathcal{I} \setminus \mathcal{A}} [1 - F_i(x)] \prod_{s \in \mathcal{A} \setminus \{j\}} [1 - F(\max\{x, v_s^*\})] \, dx.$$

$$\bar{p}_j^*(\mathbf{v}^*) := \int_0^{v_j^*} \prod_{s \in \mathcal{A} \setminus \{j\}} [1 - F(\min\{x, v_s^*\})] \, dx + \int_{v_j^*}^{r} \prod_{i \in \mathcal{I} \setminus \mathcal{A}} [1 - F_i(x)] \prod_{s \in \mathcal{A} \setminus \{j\}} [1 - F(\max\{x, v_s^*\})] \, dx.$$

- The speculator gets revenue from the "return-and-refund" auction.

Enhanced Speculation

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The enhanced speculation approach can generate more profit for the speculator (than the simple speculation approach).

Corollary 4

If $\mathcal{A} = \mathcal{I}$, the speculator can "knock out" every seller and achieve the following outcome by setting $v_i^* = r$ for all $i \in \mathcal{I}$: It is as if the speculator conducts a second-price auction with a reserve price of r to buy an item from the sellers, and then sells the item to the auctioneer at a price of r.

This way, the speculator extracts the auctioneer's surplus entirely.

Comparison of Profitability: The Enhanced Speculation Case

Proposition 8

If $F(r) < 1$, complete knockout does not work in FPAs even if the speculator can conduct a VCG auction to return and refund the extra items.[6]

[6] If $F(r) = 1$, the speculator can threat to bid 0 if any seller rejects his offer. Then a complete knockout can be supported as a weak PBE. If $F(r) < 1$, because rejection happens with a positive probability on the equilibrium path, the threat would violate sequential rationality.

Comparison of Profitability: The Enhanced Speculation Case

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- If that works, the speculator would bid r in the procurement auction. Then for a seller with realized valuation v,

$$\underbrace{\int_v^r [1 - F(x)]^{N-1} dx}_{\substack{\text{Expected payoff from} \\ \text{accepting the speculator's offer}}} < \underbrace{r - v}_{\substack{\text{Expected payoff from} \\ \text{rejecting the speculator's offer}}} .$$

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Section 7

Conclusion

Summary

- ▷ Speculation by accumulating market power and reducing competition tends to be successful in SPAs but not so much in FPAs, due to that sellers respond differently to the speculator in the two mechanisms.
- ▷ Speculation harms efficiency in the form of private value destruction, especially when there is no well functioning post-auction market.

Thank You!

Lemma 4

A symmetric BNE (in which the bidders never bid below their valuations) of the FPA subgame $\Gamma = \langle r, m, G(\cdot; v^\star)\rangle$ *is given as follows.*

(i) The sellers bid according to

$$\beta(v; m, v^\star) = \begin{cases} \underline{b}(m, v^\star)/[1 - G(v; v^\star)]^m, & \text{if } v^\star \le v \le \bar{b}(m, v^\star), \\ v, & \text{if } v > \bar{b}(m, v^\star), \end{cases}$$

where

$$\bar{b}(m, v^\star) := \min \left\{ arg \max_{r \ge b \ge v^\star} b[1 - G(b; v^\star)]^m \right\}.$$

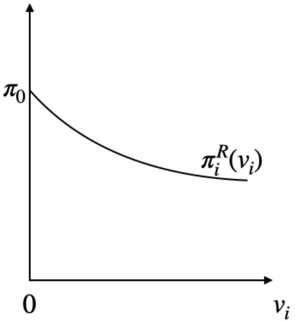
(ii) If $\underline{b}(m, v^\star) = \bar{b}(m, v^\star)$ *or, equivalently,*

$$v^\star \in arg \max_{r \ge b \ge v^\star} b[1 - G(b; v^\star)]^m,$$

the speculator bids $v^\star$ *for sure. Otherwise, the speculator mixes over* $[\underline{b}(m, v^\star), \bar{b}(m, v^\star)]$.

Equilibrium Characterization

- Recall that the interim expected payoff of a bidder in an auction is the integral of his winning probability.
  - $\dfrac{\partial \pi_i^R(v_i)}{\partial v_i} = -WinProb(v_i) \geq -1.$



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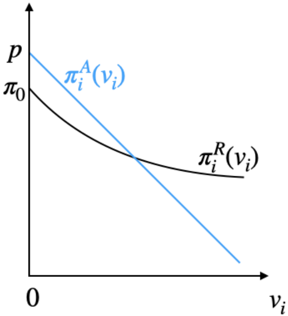

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