
Topics In Micro Economics Research Proposal: Mixed Procurement Auctions, Winner’s Curse, and Collusion

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Abstract

Public procurement is often conducted through first-price sealed-bid (FPSB) auctions, which foster price competition but expose bidders to winner’s curse risk under cost uncertainty. Average-bid auctions (ABA), which award to the bid closest to the mean, have been adopted to discourage excessively low bids but are highly susceptible to collusion. We study a mixed mechanism where bidders submit a single bid without knowing ex ante whether the auction will be FPSB or ABA; the format is realized after bids with FPSB probability α . Using a unified Monte Carlo framework with a fixed true cost baseline $c^*=100$, we compare expected procurement cost, cartel success, and conditional win probabilities. The implementation keeps parameters and random seeds consistent across with/without cartel regimes; only cartel formation behavior differs.

The provided model, is relatively simple and is meant as a starting point for further exploration of this mechanism.

1. Introduction

Public procurement auction design shapes prices and strategic behavior. Two prominent formats are the first-price sealed-bid (FPSB) auction, which fosters strong competition but is prone to winner’s curse in common-value environments (De Silva & Rosa, 2023), and the average-bid auction (ABA), intended to discourage excessively low bids but empirically vulnerable to collusion (Decarolis, 2013; 2024) and theoretically prone to inefficient equal-bid equilibria (Albano et al., 2006). While FPSB is generally less conducive to stable collusion due to undercutting incentives (Marshall & Marx, 2007), it can produce bids below true costs when uncertainty is not properly accounted for.

We study a mixed mechanism in which bidders submit a single bid and the format is realized ex post—FPSB with probability α and ABA with probability $1 - \alpha$. Using a unified Monte Carlo framework with fixed true cost $c^* = 100$ and consistent parameters/seeds across regimes, we

quantify how format uncertainty affects, (i) cartel success, and (ii) share of winners that loose moeny (winners curse). The implementation keeps bidding heuristics simple (FPSB shading with noise; ABA markups) and toggles only cartel formation, isolating the role of α in trading off collusion resistance versus winner’s curse exposure.

2. Environment and Parameters

We consider n risk-neutral bidders and a fixed true cost $c^* = 100$. Each bidder observes a noisy signal $c_i = c^* + \eta_i$ with $\eta_i \sim \mathcal{N}(0, \sigma_\eta^2)$, independently. Parameters are shared across regimes.

Table 1. Simulation parameters (constant across regimes).
oprule Parameter Value / Note

n	15 bidders
draws	10,000 Monte Carlo runs per α
c^*	100 (fixed true cost)
μ_c, σ_c	100, 10 (signal baseline components)
σ_η	10 (signal noise)
δ	2.0 (FPSB misspecification noise)
m	5.0 (non-cartel ABA markup)
ρ	0.3 (cartel share)
q	5.0 (cartel markup over internal mean)
σ_{cluster}	1.0 (cartel clustering tightness)
α	{0, 0.1, . . . , 1.0} (FPSB probability)

Reproducibility is controlled by a global seed and per-figure seeds.

Shading function. For FPSB we use the standard symmetric equilibrium shading term for value v with n bidders and CDF F of signals:

$$s(v; n, F) = \frac{\int_v^\infty [1 - F(x)]^{n-1} dx}{[1 - F(v)]^{n-1}},$$

with F taken to be $\mathcal{N}(\mu_c, (\sigma_c^2 + \sigma_\eta^2)^{1/2})$. In implementation, $s(\cdot)$ is precomputed on a grid and linearly interpolated.

3. Auction Formats and Bidding Heuristics

Bidders submit a *single* bid ex ante (before format realization). We model behavior via simple heuristics consistent

with the simulation code.

FPSB component. Given signal c_i , bidder i forms an FPSB bid

$$b_i^{\text{FPSB}} = c_i + s(c_i; n, F) + \delta \epsilon_i, \quad \epsilon_i \sim \mathcal{N}(0, 1).$$

ABA component (non-cartel). Non-cartel bidders use a fixed markup

$$b_i^{\text{ABA}} = c_i + m.$$

Cartel ABA component. A fraction ρ of bidders are cartel members. Let \mathcal{C} denote this set in a draw, and let $\bar{c}_{\mathcal{C}} = \frac{1}{|\mathcal{C}|} \sum_{i \in \mathcal{C}} c_i$ be the internal mean of signals. Cartel members coordinate on a collusive ABA target

$$T_{\mathcal{C}} = \bar{c}_{\mathcal{C}} + q,$$

then submit clustered ABA bids

$$b_i^{\text{ABA}} = T_{\mathcal{C}} + \varepsilon_i, \quad \varepsilon_i \sim \mathcal{N}(0, \sigma_{\text{cluster}}^2), \quad i \in \mathcal{C}.$$

Final submitted bids. - Non-cartel bidders submit a convex combination

$$b_i = \alpha b_i^{\text{FPSB}} + (1 - \alpha) b_i^{\text{ABA}}.$$

- Cartel members submit their *collusive ABA* bids regardless of α (no mixing).

Format realization and winner selection. After bids are submitted, the auction format is realized: FPSB with probability α , otherwise ABA. - Under FPSB, the lowest *submitted* bid wins. - Under ABA, the winner is the bidder whose *ABA* bid is closest to the mean of all submitted bids (as implemented).

4. Monte Carlo Design

For each α :

1. Fix $c^* = 100$ and draw signals $c_i = c^* + \eta_i$ with $\eta_i \sim \mathcal{N}(0, \sigma_{\eta}^2)$ for all i .
2. Compute b_i^{FPSB} using the interpolated shading function with noise $\delta \epsilon_i$.
3. Construct ABA bids: non-cartel $c_i + m$; cartel clustered around $\bar{c}_{\mathcal{C}} + q$ with variance $\sigma_{\text{cluster}}^2$.
4. Form submitted bids b_i : non-cartel mix FPSB/ABA with weight α ; cartel use collusive ABA.
5. Realize the auction format: FPSB with probability α , else ABA.

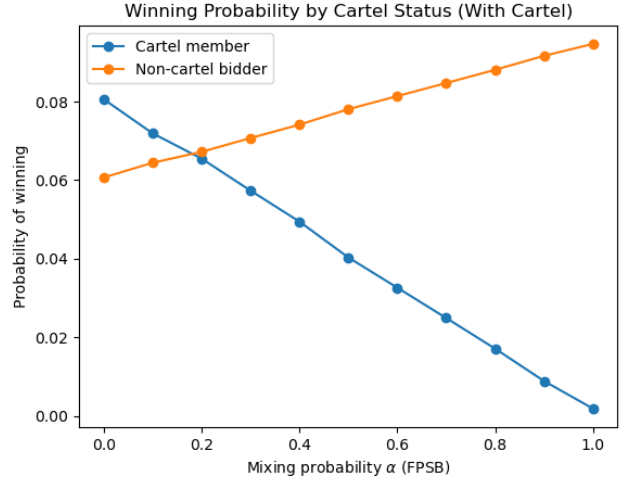


Figure 1. Win probability by cartel status

6. Determine the winner according to the realized format (as above) and record the winning bid and whether the winner is a cartel member.

We repeat this for 10,000 draws per α .

5. Outcomes and Analysis

We report:

- Expected procurement cost as a function of α for both regimes (with/without cartel).
- Cartel success probability (share of runs in which a cartel member wins, conditional on cartel presence).
- Conditional win probabilities by cartel status (probability that a cartel/non-cartel bidder wins per participation).
- Additional visualizations: single-draw bid scatterplots across α , and histograms of realized winning prices with source mix (FPSB vs. ABA) in the no-cartel case.

All figures and tables are generated from a single, unified code path with consistent seeds; only the cartel formation toggle differs between regimes.

6. Results

6.1. Cartel formation

For data largely see Table 2.

We see that for our current setup just mixing a little bit results in cartel formation being unprofitable

Mixed Procurement Auctions with Format Uncertainty

Table 2. Summary across mixing probability α . Exp(NoC) = expected procurement cost without cartel; Exp(WC) = with cartel. CartelSucc = cartel success probability; P(Win|Cartel), P(Win|NonC) are conditional win probabilities by bidder type.

oprule Alpha	Exp(NoC)	Exp(WC)	CartelSucc	P(Win Cartel)	P(Win NonC)
0.00	105.014	105.062	0.367	0.081	0.061
0.10	102.611	102.964	0.328	0.072	0.064
0.20	100.350	101.063	0.295	0.065	0.067
0.30	98.231	99.159	0.259	0.057	0.071
0.40	96.194	97.388	0.223	0.049	0.074
0.50	94.235	95.623	0.185	0.040	0.078
0.60	92.402	93.871	0.149	0.033	0.081
0.70	90.705	92.229	0.114	0.025	0.085
0.80	89.120	90.573	0.079	0.017	0.088
0.90	87.571	88.937	0.040	0.009	0.092
1.00	86.129	87.489	0.008	0.002	0.095

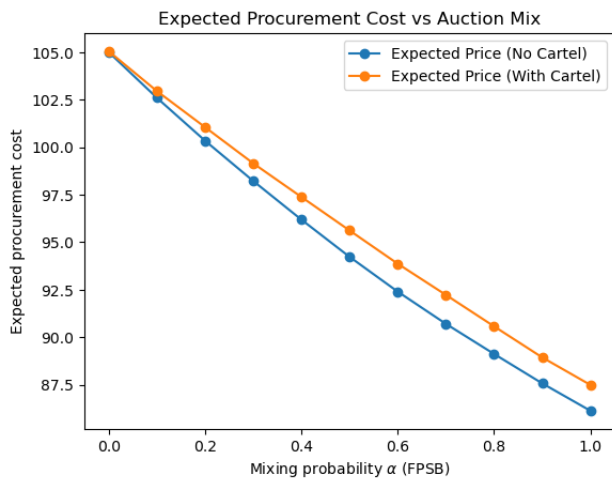


Figure 2. Expected procurement cost vs α

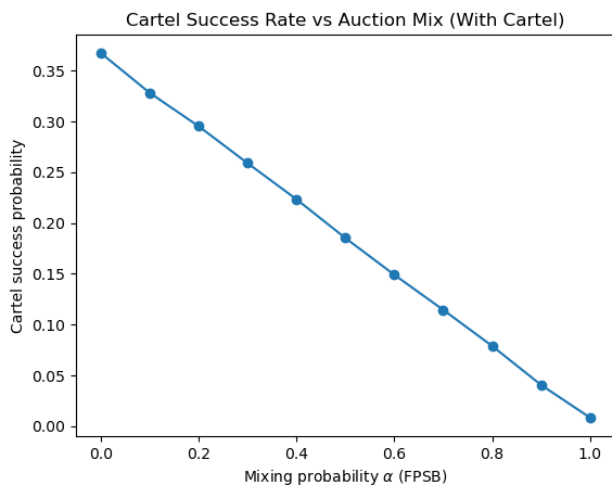


Figure 3. Cartel success against α

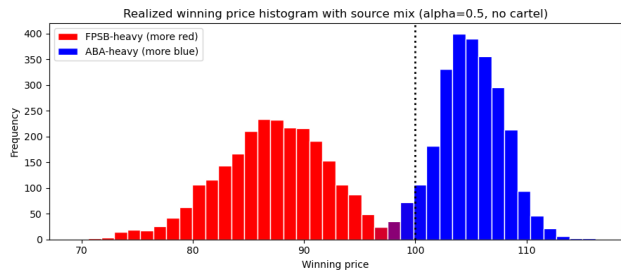


Figure 4. Distribution of winning bids

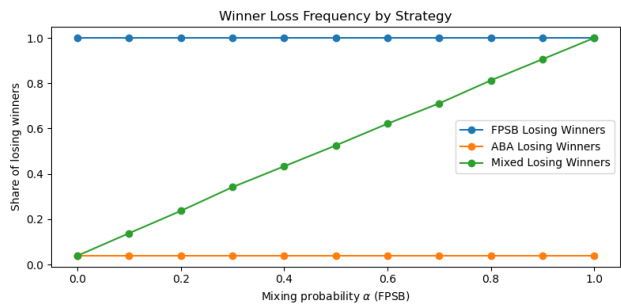


Figure 5. Winner's curse against α

6.2. Winners Curse

For our setup we see that when alpha is 0 and we have ABA the winning bid never loses money, while in FPSB the winning bid always loses money. Winning bids are multimodal, see 4 the diagram shows colormix between blue and red depending on staple composition. So the more we mix in ABA, the higher alpha, the less winners curse we will have. See 5

7. Discussion

7.1. Effect on cartel formation

We see in 3 that cartels are less likely to win the more we mix in FPSB; this relationship appears roughly linear in our setup. More interestingly, ?? shows that the winning probability conditional on being in a cartel is quickly overtaken by that of non-cartel members as we increase α . Thus, the collusive behavior rationalized in ABA when $\alpha = 0$ quickly becomes irrational for a mix around $\alpha = 0.25$. This suggests there may be a way to keep ABA participation relatively high while still breaking collusion. Of course, this conclusion is based on our simple model, and anticipatory behavior by bidders may alter the outcome.

7.2. Effect on winner's curse

In our setup, the ABA auction almost never results in a winner placing a bid below the true cost and losing money (winner's curse), while this is almost always true for the FPSB auction. This is specific to our parameter choices. We observe that winning bids form a multimodal distribution (4), confirming the separation between these two bidding behaviors in terms of facilitating winner's curse by having bids below (FPSB) or above (ABA) the true cost.

Naturally, with this clear separation, mixing between these two mechanisms produces an approximately linear relationship in α (5).

7.3. Further research

This simple model is intended as a starting point for further exploration of this mechanism. Future work could include solving for mixed-strategy equilibria if they exist, or testing the robustness of results across different seeds and parameter values. Studies could also be more closely tied to actual auction scenarios in Italy or similar contexts, and to real public procurement models in those settings.

Overall, I think a mechanism of this kind could be interesting and potentially useful if it mitigates some of the collusive behavior seen in ABA while producing more realistic bids akin to FPSB. However, the optimal mixed strategies would require deeper study.

References

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