Past Performance and Procurement Outcomes

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Motivation

This paper

This paper is about an experimental procurement design combining scoring auction with past performance reputation by ACEA.

Scoring auction:

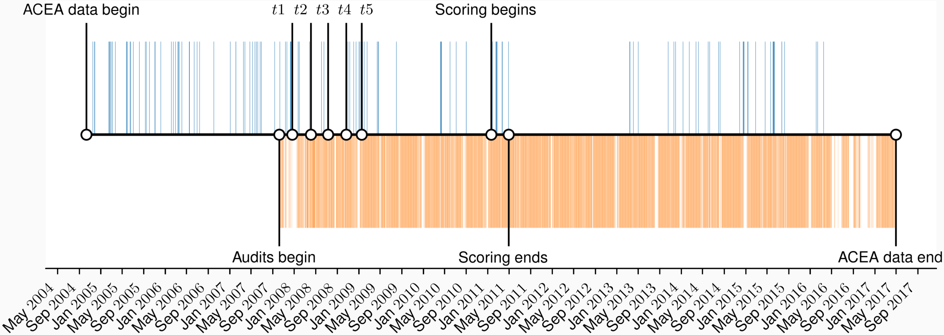
$$s = \alpha \cdot \text{discount} + (1 - \alpha) \cdot RI$$

where RI (reputation index) is average performance over past year.

Other popular designs:

- LoLA (Lopomo, Persico and Villa, AER forthcoming)
- Korean "right price" auction (Eun, 2022)
- Average bid auctions (Decarolis, IER 2018)
- A+B bidding for time incentives (Lewis and Bajari, QJE 2011)

Timeline



- Blue ticks - auctions
- Orange ticks - audits
- ti - announcements

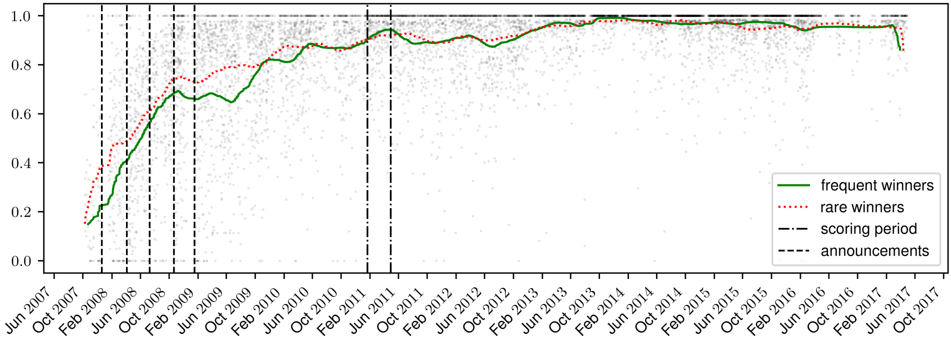
Quality

Audit Dataset

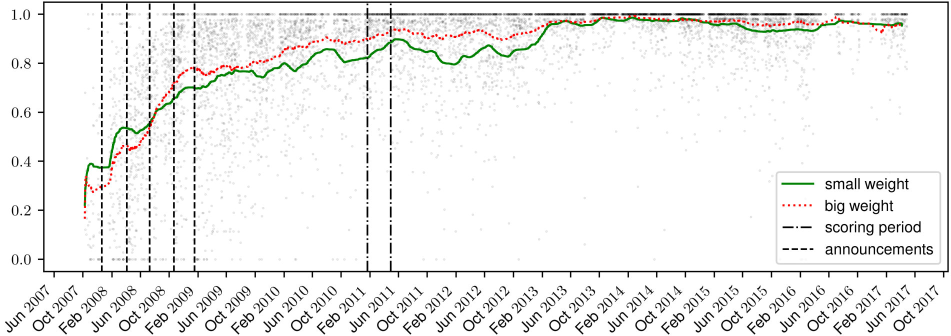
Table 1: Summary Statistics - Audit Data

Parameter	Share Compliant Parameters				Number of
Category	Pre t1	Post t1	SR period	Post SR	observations
Documentation	0.33	0.65	0.84	0.93	53,121
Equipment and machinery	0.70	0.93	0.96	0.95	44,266
H.T. works site controls	.	0.79	0.93	0.97	2,507
Personnel	0.32	0.67	0.91	0.96	21,513
Works execution	0.19	0.84	0.97	0.98	30,663
Works site regularity	0.10	0.61	0.84	0.94	59,531
Works site safety	0.31	0.75	0.92	0.96	78,338
Works on joints	1	0.96	1	1	1,746
Customer relationship mgnt	1	0.94	.	1	85
Air works	.	0.98	1	1	146
Underground works	0.40	0.69	0.91	0.89	10,450
Works on transformer station	1	1	1	1	268

Average (Weighted) Compliance by firm type



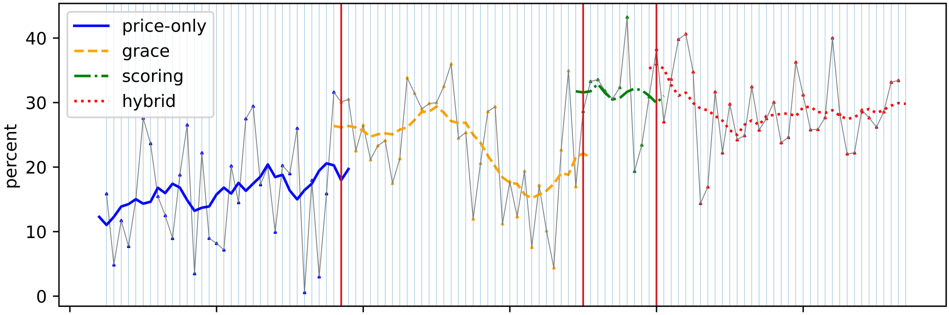
Average (Weighted) Compliance by parameter importance



Prices

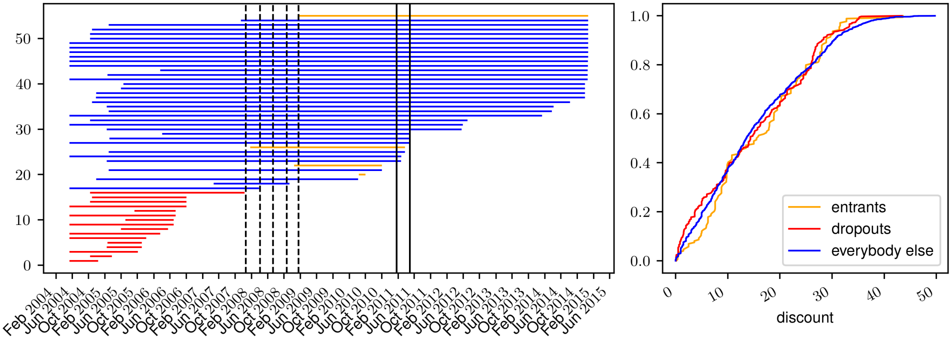
Discount

$$\text{discount} = 100(\text{reserve - price})/\text{reserve}$$



Entry/Exit

Entry/Exit



0
10
20
30
40
50
Feb 2004
Jun 2004
Oct 2004
Feb 2005
Jun 2005
Oct 2005
Feb 2006
Jun 2006
Oct 2006
Feb 2007
Jun 2007
Oct 2007
Feb 2008
Jun 2008
Oct 2008
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Jun 2011
Oct 2011
Feb 2012
Jun 2012
Oct 2012
Feb 2013
Jun 2013
Oct 2013
Feb 2014
Jun 2014
Oct 2014
Feb 2015
Jun 2015
0.0
0.2
0.4
0.6
0.8
1.0
entrants
dropouts
everybody else
0
10
20
30
40
50
discount

Recap

Recap of results

Let's recap

- scoring auction
- past performance

And our empirical evidence is

1. quality goes up $\uparrow$
2. prices go down $\downarrow$
3. no obvious entry/exit

This triad poses an empirical puzzle

The paradox

We have a Giffen-style paradox on our hands

Our solution to this paradox is that, while the winner's costs have increased, as they should, their informational rents must have decreased even more, creating an illusion of cheaper and better procurement.

$$bid \downarrow = cost \uparrow + info.rent \downarrow\downarrow$$

In other words, there was a massive transfer of wealth towards the buyer. This also explains why the firms were dissatisfied with this shakedown.

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The paradox

There will be three key ingredients in the solution:

- theory of scoring auction (classical, risk neutral)
- sunkness of costs (it helps but it is not necessary)
- some extra heterogeneity of firms (necessary)

The last ingredient is, perhaps, the most bizzare.

Sunkness of investment costs

First step: a stylized model

Setting

Consider n firms that have the following profit function:

$$\pi_i = (\rho - s)Pr(win|s) - C_i(q) \to \max_{s, q \geqslant \underline{q}_i}, \quad C_i(q) = \frac{(q - \underline{q}_i)^2}{2\beta}$$

in a scoring auction where

$$s = \alpha q + (r - b), \quad \rho = \alpha q + (r - c)$$

and the scoring weight α switches from 0 to 1 (to 1/3 in the data).

The quadratic term captures the opportunity cost of building up quality q via past performance, while β is a model tuning parameter.

Finally, $\underline{q}_i$ captures firm heterogeneity in their ability to invest in q.

The (hidden) type $(c, \underline{q}_i)$ is drawn iid.

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and the scoring weight α switches from 0 to 1 (to 1/3 in the data).

We are interested in a symmetric equilibrium with a monotone strategy

$$\sigma : \rho \mapsto s$$

hopefully, independent of firm heterogeneity $\underline{q}_i$.

Pseudo-type is the key to everything, including info. rents.

Equilibrium

Prop 1: there exist a unique symmetric equilibrium, which

- has full participation
- pseudo-type ρ depends on $c, \underline{q}_i$
- strategy σ indeed does not depend on $\underline{q}_i$
- strategy $\sigma : \rho \mapsto s$ is strictly monotone
- the pseudo-type ρ is monotone in c (this is important)

under minor regularity assumptions.

Proof: It is just and ODE. The only tricky part is checking the second order conditions which are satisfied due to single crossing w.r.t. type c.

Equilibrium

Corollary: I can write out the first order conditions

$$(\rho - s)\frac{\partial G}{\partial s}(s) - G(s) = 0, \tag{1}$$

$$\alpha G(s) - \frac{\partial C}{\partial q}(q - \underline{q}_i) = 0. \tag{2}$$

where $C(q)$ is the cost function and $G(s)$ is the equilibrium probability of winning with score s.

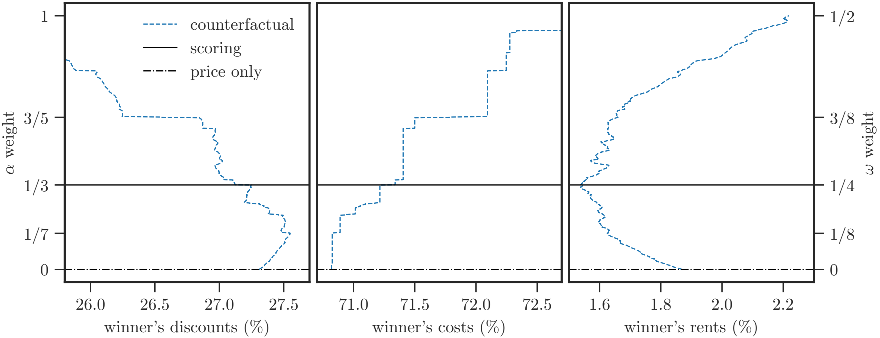
If the shape of $C(.)$ is known, the joint distribution of $(c, \underline{q}_i)$ is identified.

On the other hand, if $C(.)$ is unknown, or even misspecified, the marginal distribution of c is correctly identified, which is enough for me to simulate a counterfactual first-price auction.

Second step: estimation

Equilibrium

The model is estimated with quadratic costs, quality fixed ($\beta = 0$), and simulated counterfactuals. Crucially, the counterfactual of interest ($\alpha = 0$) does not depend on β or the shape of the cost function.



As you can see, winner's costs increase, but informational rents decrease, leaving the discounts virtually unchanged (statistically insignificant).

Third step: try to produce the paradox

No heterogeneity

Let there be no firm heterogeneity (all $\underline{q}_i$ are the same and $= 0$).

Below is an example where $\theta = 1 - c$ is the efficiency parameter, distribtuted uniformly on $[0, 1]$ and there are $N = 2$ firms.

design	total profits	auction profits	discount	quality
price-only	$\theta^2/2$	$\theta^2/2$	$\theta/2$	0
scoring	$\theta^2/2$	$(1+\alpha^2)\theta^2/2$	$(1-\alpha^2)\theta/2$	$\alpha\theta$

The firm's auction profits are higher in the scoring auction, because she has to compensate for the investments made. The firm's total profits, however, are the same.

No heterogeneity

I then quickly proved the following simple result.

Prop 2: If there is no firm heterogeneity (all $\underline{q}_i$ are the same), expected quality increases, but expected discount decreases (bid increases), when moving from the first-price to the scoring auction.

In other words, the paradox is impossible.

Let's prove it. First part is obvious, so let's go straight to expected payment to the auctioneer.

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No heterogeneity

Proof:

Recall that the score is monotone in ρ, which, in turn is monotone in c.

Thus, for any weight α, the cost-efficient firm always wins. In a sense, a scoring auction is just another screening mechanism.

Thus, by Revenue Equivalence, the firm's expected profits are the same.

$$\pi_i = (b - c)Pr(win|s) - C_i(q)$$

but they have paid their investment costs $C_i(q)$, thus their expected payment to the auctioneer must decrease by that exact amount.

Which completes the proof.

Fourth step: break revenue equivalence

What to do?

To break the Revenue Equivalence, we need to make sure that the ranking of firms changes, for any given selection of firms, when we counterfactually change the scoring weight α.

As we have seen, it is impossible without heterogeneity.

Heterogeneity

If, however, firms also vary in their cost functions $C_i(.)$ the ranking can be easily changed.

This would open a possibility for a transfer of a fraction of informational rents to the buyer.

But, let's not get ahead of ourselves.

Heterogeneity

Let's list down all the forces that may act on the winning bid when you switch from a first-price auction to the scoring auction

1. entry
2. endogenous cost
3. winner selection
4. info. rents

The first two forces are muted, because of full participation and the sunkness of costs (remember, we said that sunkness helps).

Heterogeneity

Let's list down all the forces that may act on the winning bid when you switch from a first-price auction to the scoring auction

1. ~~entry~~
2. ~~endogenous cost~~
3. winner selection (push the price up)
4. info. rents (push the price up or down)

Since the first-price auction was cost-efficient, the cost of the winner in the scoring auction can only go up. Indeed, the scoring auction is not cost-efficient in the way it selects the winner.

So, it is two forces: selection vs info. rents.

If the informational rents are significantly compressed, it might outweigh the higher costs associated with inefficient screening.

Fifth step: proof of concept

Heterogeneity

We need an example, where the squeezing of rents is greater than the loss in efficiency. We want the rents to be large to begin with, so $N = 2$. For simplicity, the score is

$$s = \alpha q + \theta, \quad \theta = \text{efficiency}$$

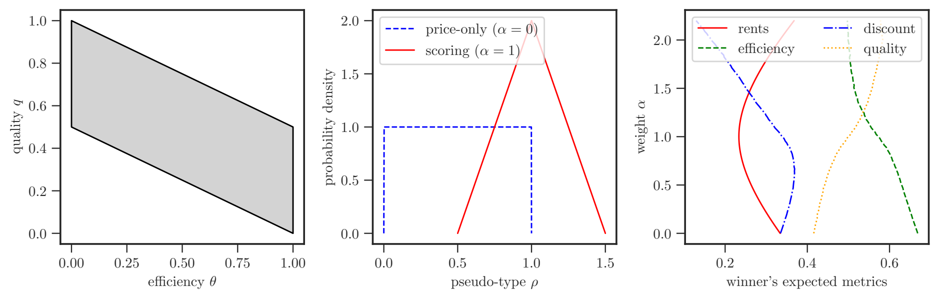
and α switch from 0 to 1.

design (weight)	equilibrium pseudo-type cdf	expected winner's efficiency	expected winner's info. rent	expected winner's discount
price only ($\alpha = 0$)	$\rho, \ \rho \in (0, 1)$	40/60	20/60	20/60
scoring ($\alpha = 1$)	$\begin{cases} 2\rho^2 - 2\rho + 1/2 \\ -7/2 + 6\rho - 2\rho^2 \end{cases}$	37/60	14/60	23/60

How did I make it?

Heterogeneity

The idea is that the equilibrium distribution of efficiency (θ) and quality (q) should be such that the equilibrium pseudo-type ($\rho = \alpha q + \theta$) distribution is more concentrated for $\alpha = 1$ than for $\alpha = 0$.



This will produce the necessary effect of compression of informational rents, and it covers the loss in cost-efficiency, just barely enough.

Conclusion

Heterogeneity

You probably noticed that the correlation between quality and efficiency was somewhat negative. It is a version of something, which is referred in the literature as

- adverse selection
- or quality considerations see Lopomo Persico Villa (2023).

In layman terms, it means that the firm which is cost efficient is not necessarily the best in terms of quality.

Question to the audience: does it make sense? (as an assumption)