Lecture 4
Procurement Contracts

Increasing the number of bidders who compete with each other is one way of obtaining a more favorable price. Another way is to estimate their costs and offer a select number of contracts from which they can choose. This lecture explains why the second method is sometimes more profitable than the first.

Procurement by auction

- When a buyer conducts a standard auction to obtain a product or some services:
  1. the number of sellers typically plays a critical role in the terms of trade.
  2. there is usually no attempt to discriminate between sellers.

- For example in a first price sealed bid auction:
  1. a single bidder can extract all the surplus of the project if there is no reserve price.
  2. If there are multiple bidders in the auction, they compete with each other, driving down the price the buyer pays for the service.

Many federal contracts only attract a single bid

- Procurement contracts account for more than 10% of the US federal government budget.
- Yet there is no competition for many of them!
- For example, in Fiscal Year 2010:
  1. $241 billion or 45% were payments for contracts attracting a single bid.
  2. 51% or 1.2 million contracts were awarded without full and open competition.

Why do so many federal contracts attract so few bids?

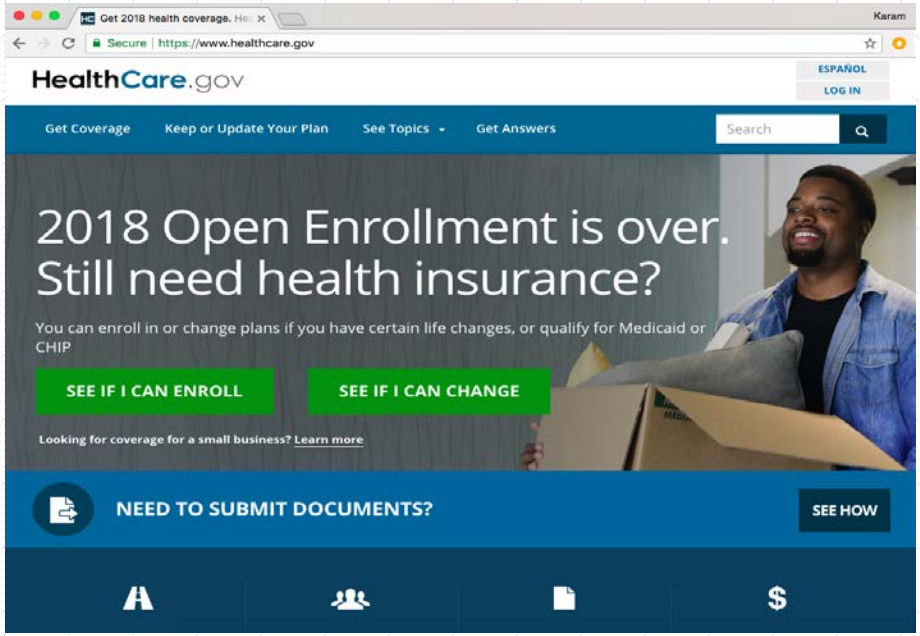
- Perhaps few bids are symptomatic of weak governance:
  - *The scope and depth of government activity is huge.*
  - *Taxpayers and voters, overlapping but distinct groups, exercise little oversight of these activities.*
- Two important institutional features are that:
  1. *Procurement agencies (buyers hereafter) choose the extent of competitive bidding.*
  2. *The final contract price can differ from the initially agreed upon price.*
- The regulations give the buyer considerable discretion in determining the:
  - *contract terms.*
  - *extent of competition.*

Procurement in information technology and telecommunications

- Professor Kang and I have recently studied this issue (2022).
- We analyze definitive contracts and purchase orders in information technology and telecommunications (ITT) :
  - *Products include computer hardware, software, and telecommunications equipment.*
  - *Services include ITT strategy, architecture, programming, cyber security, Internet service.*
- We restrict our attention to the contracts that satisfy:
  - *The base price is between US 2010 $150,000 and $1 million.*
  - *The base duration between 30 days and 400 days.*
  - *The final contract end date before the end of FY 2017.*
- This yields 17,123 contracts costing US 2010 $6.2 billion in total.

An example

- This example shows a cover page to some software designed for the federal government to help people enroll in health insurance provided by the government.



Competition for IT Contracts (2004 –15)

	Obs.	Final price ($K)		Number of bids		
		Mean	SD	Mean	Median	Fraction one bid
Panel A: Competed or not						
Full and open competition	5,030	350.00	234.94	3.02	2	0.35
Set-aside for small business	2,534	343.04	232.24	4.11	3	0.27
No competition by regulation	3,376	423.60	293.81	1.03	1	0.99
No competition by discretion	6,183	359.37	228.49	1.00	1	1.00
Panel B: Solicitation procedures						
Negotiated proposal/quote	4,395	366.63	248.31	2.89	2	0.45
Simplified acquisition	5,964	344.70	229.29	2.49	1	0.58
Other procedures†	143	365.05	228.07	3.42	2	0.43
No solicitation	6,067	386.47	252.77	1.03	1	0.99
Not specified	554	393.12	322.07	1.82	1	0.80

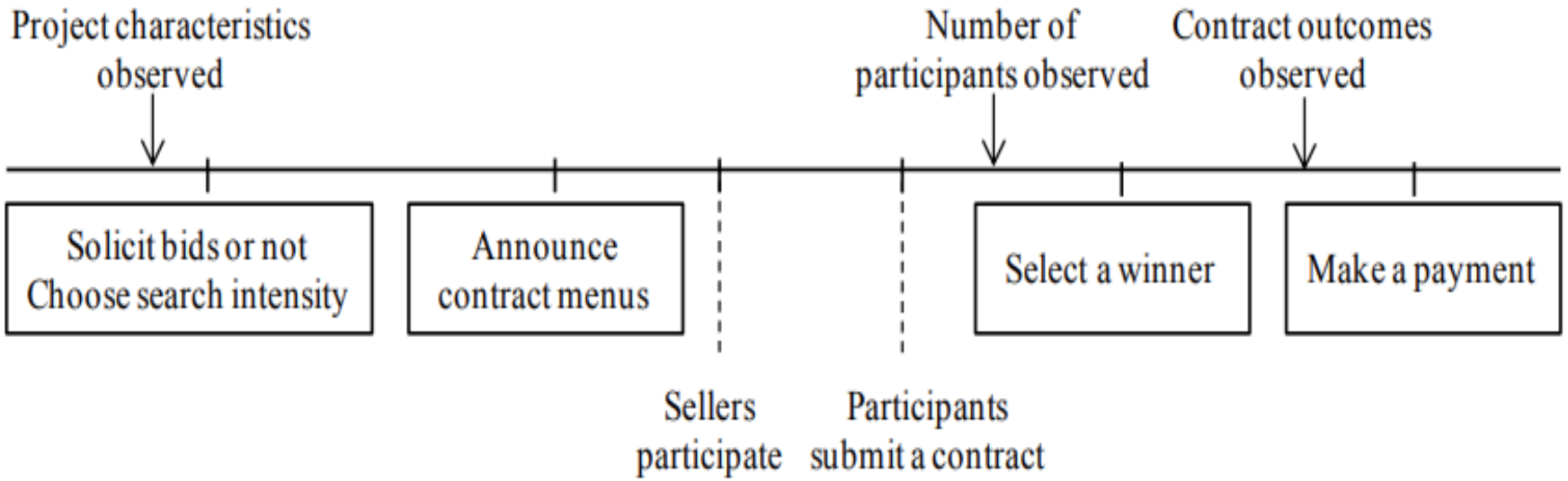
- The sample comprises 6,981 contracts (worth $2.5 billion) comprising:
  - 2,375 contracts with full and open competition
  - 4,606 with no competition by discretion
- We discarded:
  - *set-asides for small business* and *no competition by regulation* from Panel A
  - *simplified acquisition, other procedures* and *not specified* from Panel B.

Price and duration of IT Contracts

	Mean	SD	Mean difference: Competitively solicited vs. not	Mean difference: Firm-fixed vs. other
	All			
Price (in thousand 2010 dollars)				
Final	363.71	232.98	-9.43 (5.88)	-87.78 (14.58)
Base	336.75	188.77	-3.63 (4.77)	-23.83 (11.84)
Ex-post adjustments due to				
Work changes	6.03	65.01	-4.74 (1.64)	-25.02 (4.07)
Exercise of options and funding	22.86	106.82	-0.67 (2.70)	-47.04 (6.70)
Administrative actions	-1.94	39.51	-0.39 (1.00)	8.11 (2.48)
Duration (in days)				
Final	297.54	310.13	-28.73 (7.83)	-160.80 (19.36)
Base	210.44	130.97	-24.41 (3.30)	-39.23 (8.20)
Ex-post adjustments due to				
Work changes	17.79	101.45	-4.83 (2.56)	-19.92 (6.36)
Exercise of options and funding	42.84	183.58	3.42 (4.64)	-72.13 (11.49)
Administrative actions	26.46	152.22	-2.91 (3.85)	-29.52 (9.55)
Competitively solicited†	0.34	0.47	-	0.03 (0.03)
Number of bids	1.64	1.92	1.87 (0.04)	0.23 (0.12)
Contract type: Firm-fixed-price†	0.96	0.19	0.006 (0.005)	-

- Standard errors are in parentheses. Firm fixed price contracts are cheaper, and there are fewer work changes (aside from administrative actions initiated by buyer).

Timeline for a procurement project



- There are two seller types, high cost and low cost.
- Sellers know their own type, but not the buyer.
- The buyer:
  - spends resources advertising project
  - announces a contract menu (with two items on it)
  - for sellers to select their preferred contract
  - chooses winning contract (randomly amongst those picking the same one)

Optimal contract when seller type observed

- Consider the following basic framework:
  - There are two types of sellers with costs L and H, where L < H.
  - Both types prefer fixed to variable contracts because of liquidity considerations.
  - π is the probability of a seller being type L, where $0 < \pi < 1$.
  - c is the buyer's cost to find (or search) for another potential seller.
  - The buyer's total search from finding n potential sellers is cn.
  - The probability of drawing n high-cost sellers is $(1 - \pi)^n$.

- We consider the following three scenarios:

1. If the buyer can recognize the type, then they would:
   - pay only cost (L or H) to the seller selected for the contract.
   - choose a low-cost seller if there is one.
   - choose n to minimize:

$$(1 - \pi)^n H + [1 - (1 - \pi)^n] L - cn.$$

Optimal contracting (an auction) when buyer does not observe seller type

2. If the buyer has no information about the type, she can set a reserve price of H (to assure herself of transacting), and a lower contract price for sellers who want priority:

- A high-cost seller selects H (since he incurs a loss by bidding any lower).
- A low-cost seller balances the probability of losing to another low-cost seller, with the profit made by only competing with other high-cost sellers.
- The buyer knows this and sets a low price that is just high enough to attract the low-cost seller. The contract price, p(n), depends on the number of sellers:

$$p(n) = L + \pi(1 - \pi)^{n-1} [1 - (1 - \pi)^{n}]^{-1} (H - L)$$

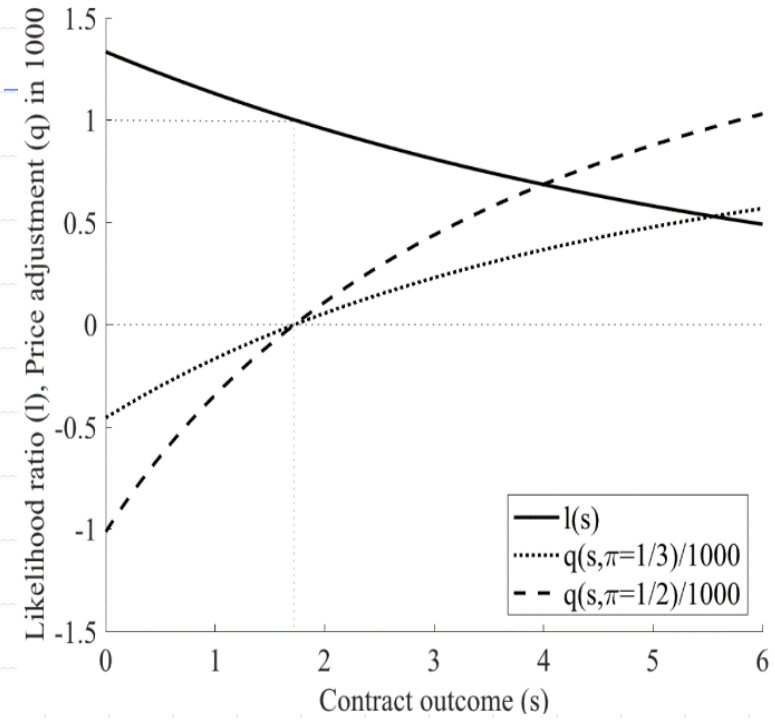
- Note that p(n) is decreasing in n, that p(1) = H and p(infinity) = L.

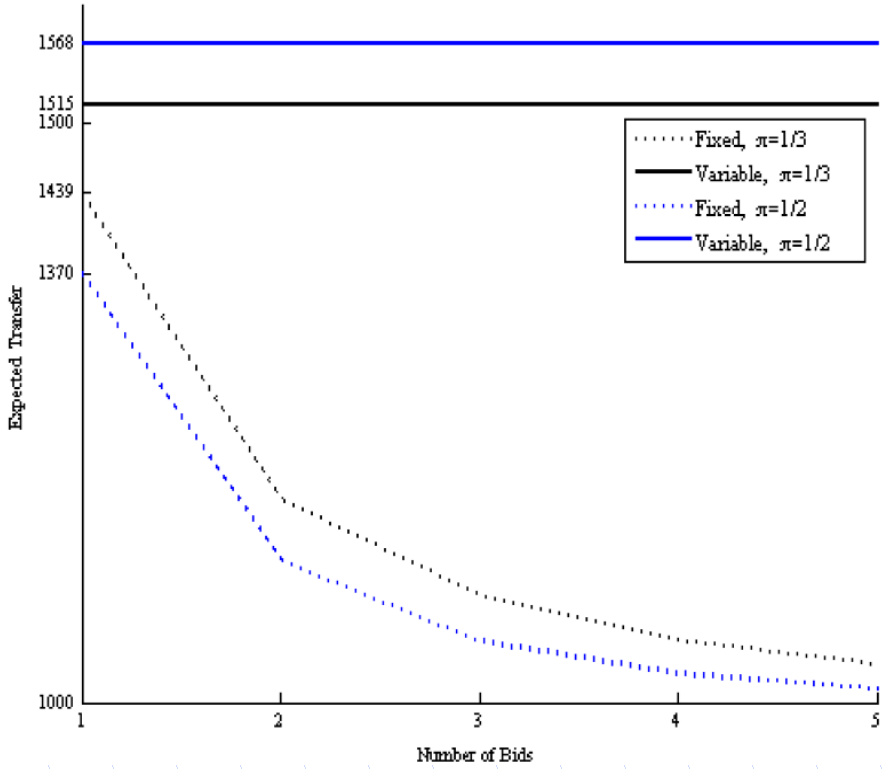
- This contract menu replicates a FPSB auction.
- Knowing low-cost sellers will pick p(n) and high-cost sellers will pick H, the buyer then chooses n in an analogous way to that shown on the previous slide.

3. Optimal contracting when buyer has information correlated with seller type

- Suppose the buyer cannot directly observe a seller's type but does observe a signal s. The signal s could be:
  - a resource that L is more likely to use than H.
  - a bi-product that s is more likely to produce.
- Let l(s) denote the likelihood that s is produced or revealed by L. Set:
  - l(s) = 0 when an H definitely produced s.
  - 0 < l(s) < 1 when it is more likely that an H than an L revealed this s.
  - l(s) =1 when no information about H versus S is revealed by this s.
  - l(s) >1 when it is more likely that an L revealed this s than an H.
- The seller should design two contracts:
  - a *fixed* contract, with a relatively low price, that has priority over the other one.
  - a *variable contract*, that offers positive adjustments (bonuses) when l(s) < 1 and negative adjustments (penalties) l(s) > 1.
  - such that H prefers the variable contract and is offered enough to bid, while L prefers the fixed contract to the variable one.

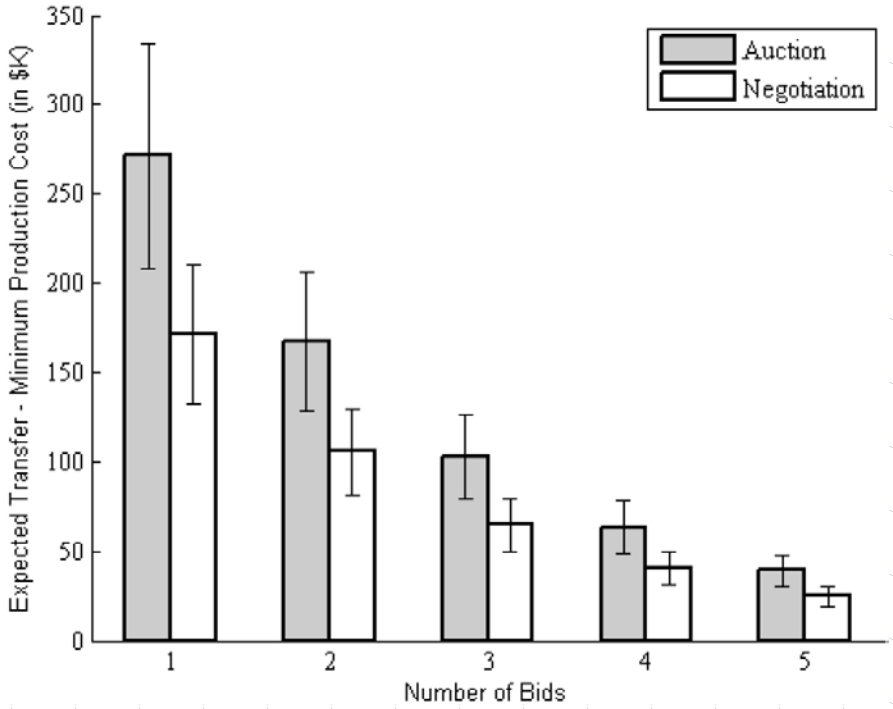
Example of an optimal contract menu

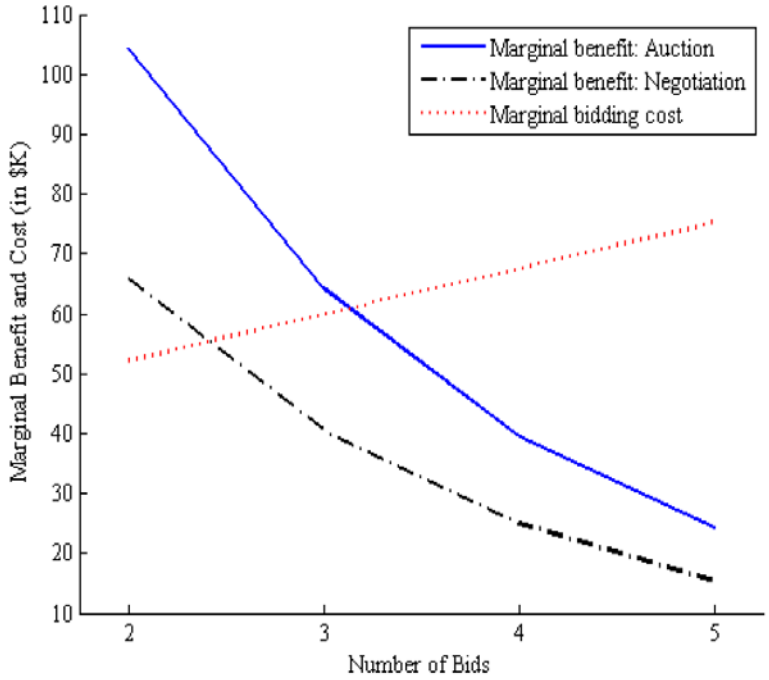




- Notation:
  - L =1000 and H = 1500
  - s is the contract outcome observed by seller
  - l(s) is the likelihood of an L seller producing s relative to an H seller
  - π is the probability the bidder is an L seller.
  - q(s, π) is variable component of a flexible contract

Comparing contract menus with auctions





- Relative to an auction negotiating contract terms:
  - helps the buyer extract a larger portion of seller's informational rent.
  - lowers the marginal benefit of extra sellers.
  - is less valuable when many sellers are willing to bid in an auction.

The costs and benefits of competition when contracting optimally

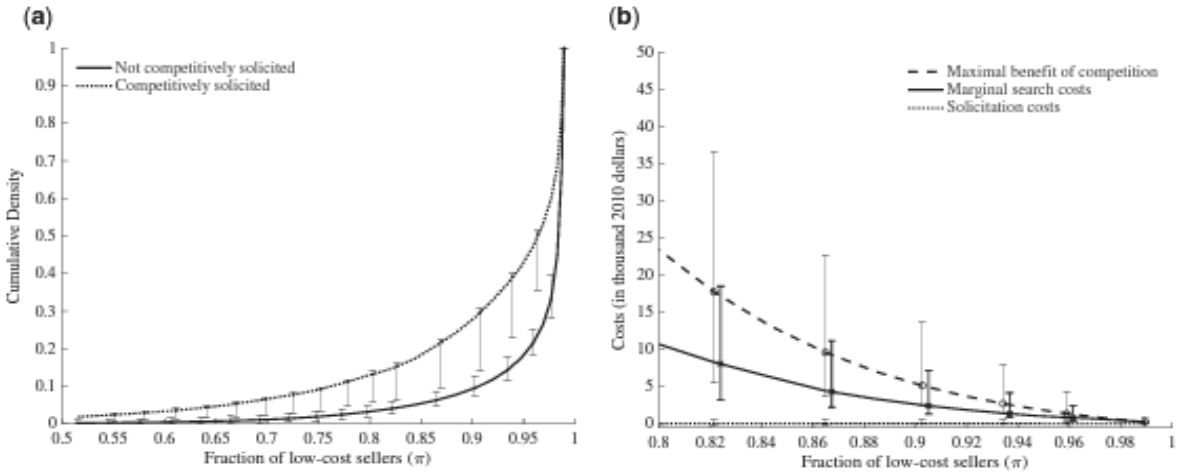


FIGURE 2

The fraction of low-cost sellers and procurement costs

Notes: Based on the estimated parameters, Panel (a) shows the cumulative distribution function of π conditional on whether or not the contract is competitively solicited, averaged across sample observations, and Panel (b) provides the buyer's marginal search costs and solicitation costs, as well as an upper bound of the benefit of competition, as defined in (6.1). The error bars represent the 95% confidence intervals based on bootstrapping.

- The maximal benefit of competition is the cost difference from selecting an L seller and the expected cost from randomly selecting a seller.

- Relative to no competition:
  - At $\pi = 0$ (all high cost) and $\pi = 1$ (all low cost) sellers are identical so there is no value from competitive bidding.
  - Note the value of competition also depends on the difference between H and L sellers.
  - lowers the marginal benefit of extra sellers.
  - is less valuable when many sellers are willing to bid in an auction.

Counterfactual Analyses

Counterfactual analyses

Panel A: Why so little competition?

	Change in number of bids
Seller cost distribution	
Homogenous fraction of low-cost sellers (π)	
0.94 (Average in the sample)	+0.799 [0.654, 0.894]
0.5	+4.886 [4.783, 5.305]
0.25	+9.241 [9.010, 9.984]
Doubled cost differences ($c_2 - c_1$)	+0.664 [0.521, 0.747]
Buyer's ability to negotiate	
First-price sealed-bid auction	+2.728 [1.462, 3.375]
First-price sealed-bid auction with halved κ	+3.432 [1.989, 4.108]
Search and solicitation costs	
Halved κ	+0.577 [0.393, 0.679]
Halved η	+0.012 [0.004, 0.058]

Panel B: Effects of policies to mandate more competition

		Minimum search intensity ($\lambda^o \geq 1$)	
	Base	No	Yes
Number of bids	1.609 [1.453, 1.656]	+0.025 [0.010, 0.167]	+0.790 [0.773, 0.875]
Payments	363.38 [358.54, 371.75]	−0.01 [−0.10, −0.004]	−0.95 [−1.69, −0.61]
Search costs	0.66 [0.25, 1.02]	+0.01 [0.003, 0.07]	+1.34 [0.84, 2.34]
Solicitation costs	0.01 [-0.02, 0.04]	+0.05 [0.02, 0.39]	+0.05 [0.02, 0.39]

Notes: Both counterfactual policies in Panel B mandate competitive solicitation; the first one requires no minimum search efforts, while the second one requires that search efforts are at least one so that the expected number of bids is two or more. All cost and payment estimates are in thousand 2010 dollars. Bootstrap 95% confidence intervals are provided in brackets.

- Relative to an auction negotiating contract terms:
  - helps the buyer extract a larger portion of seller's informational rent.
  - lowers the marginal benefit of extra sellers.
  - is less valuable when many sellers are willing to bid in an auction.

Summarizing the empirical analysis

- Given the number of bidders, procurement agencies can extract more rent from a winning seller by negotiating, compared to an auction.
- Negotiation reduces their marginal value from promoting competition and attracting more bids.
- In the ITT setting we investigate, stripping agencies of their discretion in designing and negotiating contracts would more than double the average number of bids, but hardly reduce payments to winning sellers.
- Allowing procurement agencies to exercise some discretion to use their knowledge of the supply side can reduce procurement costs, even if they simultaneously engage in some rent-seeking behavior.
- Our findings are not very sensitive to the costs of soliciting competition; agencies would, however, increase their search intensity, and enlarge the pool of sellers if there was greater heterogeneity in the seller costs.

Principles for Auction Design

- The factors to focus upon when designing auctions fall into around two categories:
  1. Supposing the auctioneer assiduously follows the rules of the auction and the bidders do not collude, which auction format is:
     a) most efficient? (This might be relevant for internal allocation within a company.)
     b) maximizes revenue? (The firm might trade upstream and/or downstream.)
  2. What is the scope for corrupting the system by:
     a) the auctioneer? (An auctioneer, acting as an intermediary, might take bribes.)
     b) bidders? (They might collude.)

- On the first category:
  - Are the auctions under consideration strategically or revenue equivalent?
  - What are the costs and benefits of attracting more bidders?
  - What are the costs and benefits to the auctioneer from obtaining more precise estimates of bidder valuations (in order to design contract menus that extract rent from high valuation bidders)?

Integrity of the trading mechanism

- Corrupting a trading mechanism typically discourages participation.
  - For example bidders are less willing to participate if a privileged subset is given superior information about the auctioned item prior to bidding.
- Are some auction designs more susceptible to collusion than others?
  - In an ascending auction with continuous increments, bidders can invent language and communicate with incremental increases over round numbers.
  - *For example, instead of bidding $1 million, one might bid $1,000,639.08, where the $639.88 is a message to be decoded.*
  - In a SPSB auction, collusion is easier to enforce because it is potentially very expensive to defect.
  - *For example, 3 bidders bid between $5,000 to $7,000 and the fourth bids $1 million. The winner pays $7,000 but a defector would pay $1 million.*
  - Neither FISB nor a Dutch auction are susceptible to either form of collusion.
- Can the administrators of the auction commit to the mechanism?
  - Auction mechanisms are a means for conveyancing (transferring property rights).
  - *Our discussion of the Texas CD auctions briefly compared the system of negotiations that preceded it. Apparently, this system was preferred to a more lucrative and more efficient uniform price auction.*