On Procurement Efficiency in Infrastructure for Developing Countries

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The goal of this presentation:

Sharing the results of recent empirical research on the experience of procuring infrastructure;

… based on data on development aid allocated to infrastructure

(roughly a summary of the recent book published by CEPR)

Overview

- **Some context**
- **Some recurring concerns**
- **The specific questions**
- **A quick review of earlier research**
- **The data**
- **The model**
- **The results**
- **The implications**

Some context:
How big is infrastructure procurement?

- **Infrastructure procurement in LDCs**
  - **Varies quite a bit in value**
    - **(driven by technology, initial stock levels ,…)**
  - **But ranges from 5-15% of GDP**
    - **(if all gvt levels & public enterprises are accounted for)**

What we know about how well the procurement of these projects works

- <u>Optimism demand bias</u> is quite common
  - KILLS budgets when demand does not follow
- …and so are <u>cost overruns</u> with already high costs megaprojects--most in infrastructure (av. 75%)
  - *See Flyvbjerg et al (2003-2007) for OECD*
  - *See some of the new results in Estache-Iimi (2009-2011) for LDCs*
- Transparency International (TI) Bribe Payers Index shows that public works contracts & construction are bribery intensive!
  - Total bribes in public procurement at +/-3.5% of world procurement spending).
  - Also observation that high costs markups are often strongly correlated with concerns about corruption and collusion

A few more things we know…

- **Long record of lack of competition in the sector**
  - **Efficient (i.e., competitive) public procurement has been called for by WTO for a long time.**

- **Still strong de facto reluctance of donors to open business opportunities to local actors to improve competition**
  - **Lack of experience and financial capacity arguments**

Our focus:
how could different rules of competition improve efficiency in infrastructure procurement ???

- **Empirical assessment of the design of competition in auctions on costs of projects procured and number of bidders**
  - **Focus on auction from development agencies**

- **So… start with the relevant dimensions of auctions for which we can find data**
  - ***The viewpoint of gvt?*** **minimize procurement costs or maximize bid generated for a given procurement cost**
  - ***The viewpoint of firms?*** **maximize the probability of winning and hence the net payoffs to the auction…how so?**

The dimensions of the procurement game from the government viewpoint

- Frequency of auctions (number of projects)
- Procurement arrangements (lot packages)
- Who could be contractors—domestic, international, joint ventures?
- International vs. local competitive bidding?
- Auction format....usually first-price sealed-bid...but could be different.
- Information disclosure
- Technical specification
- How to exclude those who are likely to fail to meet the contracts? Prequalification or two-envelope?

The dimensions of the procurement game from the firms' viewpoint

- Decision whether to participate in competition (yes vs. no),
- Assessing the likelihood to win and calculating the best bid
- Looking for possible bidding partners
- Room for collusion and/or corruption, low balling....?

What kind of knowledge are we starting with from academic research about auction in procurement?

- **Key stylized fact:** **ODA procurement relies on simple first-bid sealed price auctions=> all bidders have the incentive to submit their true equilibrium bid prices based on their private information**

- **Matching basic auction theory: The winning bid tends to approach the lowest possible procurement price, as competition becomes intense (even if there are exceptions…)**

- **Matching basic empirical evidence?**
  - **Generally supportive of basic theory**
  - **But the degree of competition required varies across sectors.**

Since we want to zoom on the efficiency gains from more competition in auctions, would be good to have a sense of how strong competition has to be

- **So…how many bidders are required for an auction to be seen as being competitive enough according to earlier research?**
  - **Does not have to be much (Tadelis et al. in a few papers)**
  - **But interesting to see that it is quite easy to come up with a reasonably robust measure**
    - **Find when the marginal impact of one more bidder on the equilibrium bid is no longer statistically significant …that's when you have the optimal number of bidders!!!**
    - **Evidence so far?**
      - **For road projects, 8 (Gupta, 2002).**
      - **For offshore oil markets, 7 to 10 (Brannman et al., 1987).**
      - **For ODA projects, 8 (Iimi, 2006).**

A look at new evidence on the relevance of auction design for the level of bids specific to various infrastructure sub-sectors

Our data (1)

- Procurement contracts from the World Bank and the Japanese Development Agency
- Three infrastructure sectors:
  - Roads, water and sewerage, and electricity.
- 211 auctions (contracts) for 69 projects in 29 developing countries from 1997 to 2007.
  - This means...our sample represents only 1% of total ODA or 5% of infrastructure assistance.
  - Country coverage is by no means all-inclusive.
  - Nature of projects may be biased by agency strategic choices
- But the data may be rich enough to analyze bidding behavior.
  - In 211 auctions, 862 bids (winning and losing).
  - In 862 bids, 1,637 firms in total.
  - All firms are identifiable.
- Note: no renegotiation in this data set!

Our data (2)

Expected Contract Size

	No. of contracts	Contract amount 1/ Mean	Std.Dev.	Min	Max	Total contract amount
Road	86	26.8	27.9	0.3	146.0	2,020
Water	78	15.9	21.7	0.3	154.3	1,217
Electricity	47	55.2	94.7	0.2	406.6	2,934

1/ The figures are calculated on the engineering cost estimate basis.

Technical Capacity per Contract

	No. of contracts	Technical capacity Mean	Std.Dev.	Min	Max
Length of roads (km)	86	53	72	2	448
(Waste)water treatment capacity (1,000 m3 per day)	29	179	174	2	600
Total water iron pipe length (km)	49	60	78	0	376
Power generation installed capacity (MW)	16	370	377	30	1200
Total power transmission/distribution line length (km)	13	139	203	4	765

Total Project Cost and Lot Division

	No. of projects	Total project cost (million US$) Mean	Std.Dev	Min	Max	Number of lots Mean	Std.Dev	Min	Max
Road	24	404	552	36	2,720	14.3	21.9	1	108
Water 1/	22	196	139	44	496	11.3	7.5	1	26
Electricity	22	322	252	84	858	6.9	4.6	1	20

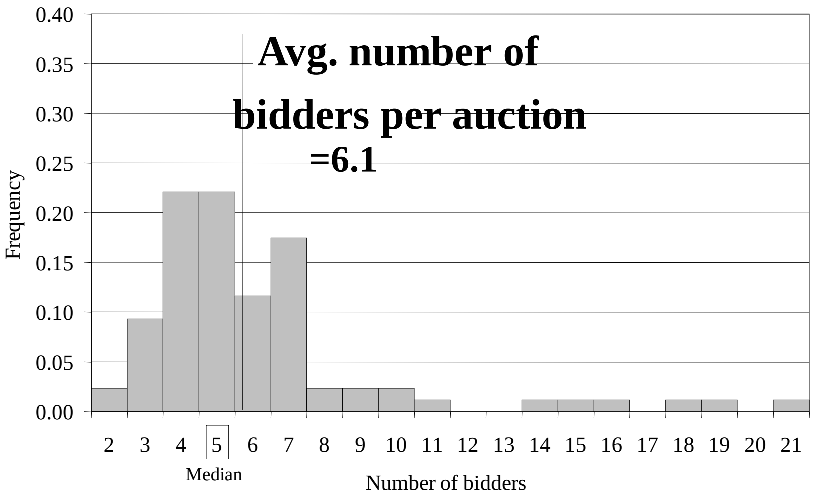
1/ Excluding a rural water project composed of more than 6,000 sub-projects.

Number of Firms Participating in Competitive Bidding

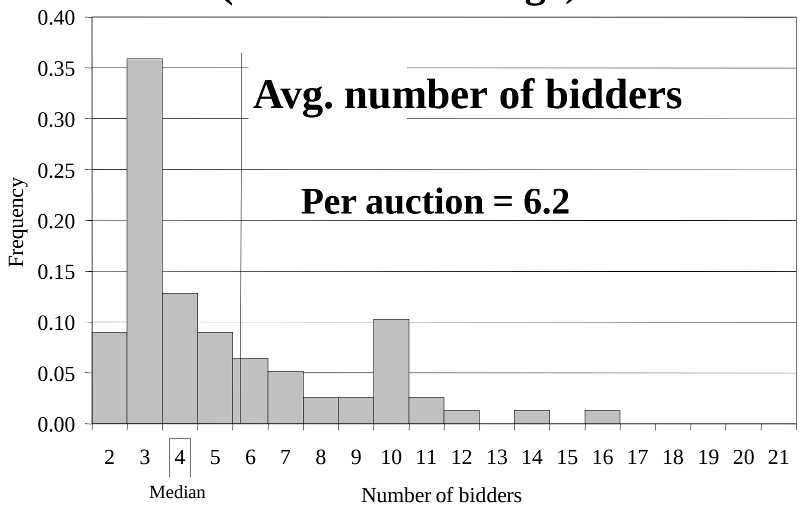
	Number of firms	Share of local (%)	Share of foreign (%)
Road	778	60.0	40.0
Water	546	74.9	24.2
Electricity	313	31.9	68.1
Total	1,637	59.6	40.4

Basic data analysis:
Competition in infrastructure procurements seems limited …especially in the water and electricity sectors.

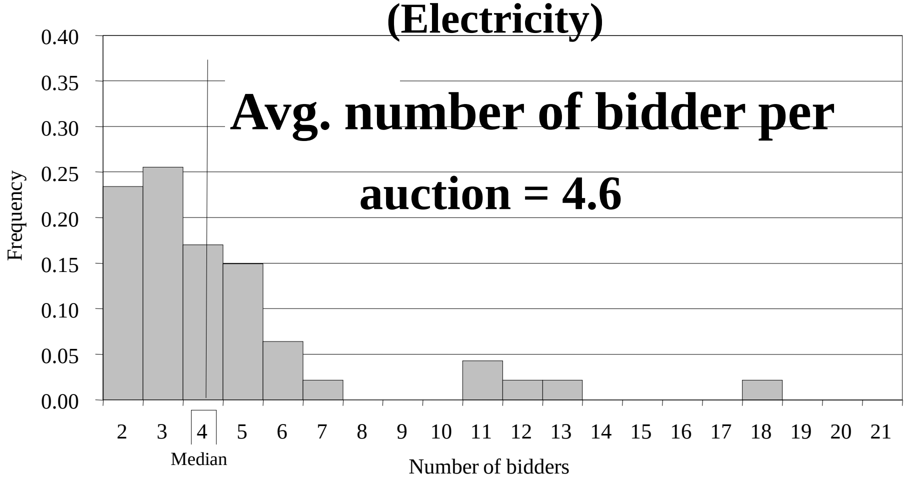
(Roads)



(Water and sewage)



(Electricity)



Number of bidders participating in auctions

	Number of bidders	Share of local (%)	Share of foreign (%)
Road	394	70.3	37.6
Water	329	79.6	29.2
Electricity	139	35.3	71.2
Total	862	68.2	39.8

Tracking the key variables through a bid function

- **We estimate a reduced form equilibrium bid function:**

$$b_{it} = COST_t \alpha_1 + MONTH_t \alpha_2 + X'_t \beta + Z'_i \gamma + g(N_t;\delta) + \varepsilon_{it}$$

b_{it} **= Firm *i*'s bid amount at auction *t*.**
  - **Accounts for all bids, winning and losing bids**

COST **= Engineering cost estimate.**

MONTH **= Estimated contract duration.**

X **= Sector specific technical aspect**

(i.e. rehabilitation vs new projects, size of projects, location, donor dummy since we have 2 donors…)

Z **= Bidder characteristics, i.e., nationality, expertise, …**

N **= Number of bidders who were prequalified and participated in auction**

Functional form?

- **We have no preconceived idea on the functional form for the bid function**
- **We test 4 specifications in terms of the impact of the number of bidders on bid level**
  - **Linear, quadratic, log-linear and “non-parametric”**
  - **“non parametric” simply means that we plug into the model all the details on the number of bidders and is simply a way of identifying as of how many bids, the efficiency gains are no longer statistically significant**
- **For each sector, we test 2 models:**
  - **In the first, engineering cost is an independent variable**
  - **In the second, it is not included**

An important footnote

- What do we get out of including engineering cost as an independent variable?
  - Some econometric value
    - it allows us to controls for unobservable technical heterogeneity across contracts which are expected to be reflected in the monetary valuation of the engineering costs.
  - Some useful policy insights: it tells something useful on cost over- and under-runs
    - If its coefficient is <1: engineering cost systematically overestimates the true cost => costs underruns take place
    - If its coefficient is >1: engineering cost systematically overestimates the true cost => costs overruns take place

Econometrics?

- all OLS reported here with white hetero
  - (We also have more robust versions of the model which allows for effective test of endogeneity of N and of risks of omitted variables)
- robust estimates for standard errors.
- Consistent with theory and earlier empirical auctions.
- No problem of omitted variables

Roads

	Linear	Quadratic	Log-linear	Non-parametric	Linear	Quadratic	Log-linear	Non-parametric
N	-0.52 ***	-0.12			-1.00 ***	-1.61 **		
	(0.09)	(0.63)			(0.11)	(0.81)		
N^2		-0.02				0.03		
		(0.03)				(0.04)		
ln(*N*)			-4.82 ***				-9.50 ***	
			(0.88)				(1.23)	
N=2				8.57 **				8.86 *
				(3.39)				(4.64)
N=3				6.54 **				16.93 ***
				(2.92)				(3.93)
N=4				6.37 ***				13.00 ***
				(1.98)				(2.29)
N=5				2.45 *				8.76 ***
				(1.40)				(1.81)
N=6				2.94 **				2.06
				(1.24)				(1.82)
N=7				1.39				5.45 ***
				(1.50)				(1.66)
N=8				-0.53				9.24 **
				(2.41)				(3.89)
N=9				2.31				10.11 ***
				(2.29)				(3.07)
N=10				4.56 ***				3.09 **
				(1.57)				(1.38)
N=11				0.14				-6.03
				(4.56)				(6.34)
Length	0.12	0.12	0.11	0.12	0.25 ***	0.24 ***	0.23 ***	0.29 ***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)
Length^2 1/	-0.41	-0.41	-0.39	-0.43	-0.65	-0.64	-0.61	-0.75
	(0.40)	(0.40)	(0.40)	(0.43)	(0.45)	(0.45)	(0.45)	(0.47)
Lane	12.57 ***	12.15 ***	12.98 ***	12.74 ***	14.62 ***	15.23 ***	15.58 ***	15.94 ***
	(1.86)	(2.04)	(1.97)	(2.27)	(2.12)	(2.41)	(2.27)	(2.57)
Lane^2	-1.10 ***	-1.06 ***	-1.13 ***	-1.10 ***	-1.22 ***	-1.28 ***	-1.31 ***	-1.30 ***
	(0.17)	(0.19)	(0.18)	(0.21)	(0.19)	(0.22)	(0.21)	(0.25)
$D_{\text{(New roads)}}$	4.23	4.50	3.76	3.06	10.49 ***	9.99 **	9.28 **	7.56 *
	(3.17)	(3.17)	(3.18)	(3.40)	(4.02)	(4.13)	(4.05)	(4.12)
$D_{\text{(Rehabilitation work)}}$	1.67	2.02	1.16	1.14	-0.65	-1.15	-1.72	-4.59
	(2.14)	(2.19)	(2.16)	(2.62)	(3.18)	(3.38)	(3.24)	(3.50)
Engineering cost	0.53 ***	0.53 ***	0.52 ***	0.54 ***				
	(0.04)	(0.04)	(0.04)	(0.05)				
Estimated duration	-0.30 ***	-0.29 ***	-0.31 ***	-0.25 ***	-0.09	-0.11	-0.12	-0.04
	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.11)
Donor 1	-6.48 **	-6.68 **	-6.13 **	-7.27 **	-6.06 *	-5.76	-5.35	-1.82
	(2.58)	(2.65)	(2.53)	(3.22)	(3.69)	(3.79)	(3.67)	(4.00)
Constant	-1.67	-3.14	3.25	-9.71	-4.95	-2.66	5.27	-27.25 ***
	(4.50)	(4.43)	(4.40)	(5.75)	(6.13)	(6.27)	(6.10)	(6.80)
Obs.	394	394	394	394	394	394	394	394
R-squared	0.932	0.932	0.932	0.933	0.903	0.903	0.905	0.909
Number of dummies								
Country	11	11	11	11	11	11	11	11
Bidder nationality	19	19	19	19	19	19	19	19

1/ For presentation purposes, the coefficients are multiplied by 1,000.

Note: The dependent variable is the bidding amount. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

- **FOR ROADS:**
- **Coef. of *N* is <u>negative and significant.</u>**
- **Nonparametric: <u>Coefs are steadily declining.</u>**
- **Coef. of engineering cost: 0.5 (<u>over-estimating at time of appraisal).</u>**

Water and Sewerage

	Linear	Quadratic	Log-linear	Non-parametric	Linear	Quadratic	Log-linear	Non-parametric
N	-0.08	-0.18			-0.49 ***	-1.55 ***		
	(0.08)	(0.34)			(0.13)	(0.49)		
N^2		0.01				0.06 **		
		(0.02)				(0.02)		
ln(N)			-0.42				-3.26 ***	
			(0.59)				(0.92)	
N=2				-0.88				-4.79
				(2.01)				(4.67)
N=3				0.04				5.06 ***
				(0.85)				(1.56)
N=4				0.77				5.12 ***
				(1.02)				(1.95)
N=5				-0.68				3.44 **
				(1.27)				(1.66)
N=6				2.64 **				3.62 **
				(1.33)				(1.63)
N=7				1.33 *				-1.01
				(0.78)				(1.47)
N=8				1.66 **				-3.64 **
				(0.72)				(1.50)
N=9				-3.05 **				3.43 *
				(1.42)				(1.86)
$D_{(Water)}$	0.95	0.93	0.94	1.01	1.76	1.52	1.68	1.71
	(1.65)	(1.66)	(1.65)	(1.66)	(2.38)	(2.35)	(2.38)	(2.56)
$D_{(Treatment\ plant)}$	1.29	0.79	1.48	1.83	-57.83 ***	-62.51 ***	-59.33 ***	-56.03 ***
	(6.88)	(7.31)	(7.10)	(7.61)	(14.31)	(14.68)	(14.42)	(17.14)
$D_{(Network)}$	5.31	5.27	5.38	5.90	-10.50 **	-10.73 **	-10.33 **	-12.20 **
	(3.48)	(3.52)	(3.48)	(3.81)	(5.10)	(5.12)	(5.12)	(5.09)
ln(*Treatment capacity*)	0.23	0.28	0.22	0.11	5.28 ***	5.67 ***	5.42 ***	5.04 ***
	(0.55)	(0.59)	(0.57)	(0.61)	(1.25)	(1.30)	(1.27)	(1.35)
ln(*Concrete tunnel length*)	-0.17 *	-0.17	-0.18 *	-0.27 **	0.58 ***	0.61 ***	0.58 ***	0.69 ***
	(0.10)	(0.11)	(0.10)	(0.11)	(0.17)	(0.17)	(0.17)	(0.19)
ln(*Iron pipeline length*)	-0.13	-0.12	-0.13	-0.19	0.92 ***	0.95 ***	0.92 ***	0.99 ***
	(0.13)	(0.14)	(0.14)	(0.16)	(0.21)	(0.21)	(0.21)	(0.22)
Engineering cost	0.79 ***	0.78 ***	0.79 ***	0.81 ***				
	(0.06)	(0.06)	(0.06)	(0.07)				
Estimated duration	-0.10 **	-0.09 **	-0.10 **	-0.10 *	0.08	0.10	0.10	0.04
	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)	(0.07)
Donor 1	137.70 ***	1.07	1.01	-1.42	31.48 ***	29.99 ***	29.28 ***	21.56 ***
	(14.87)	(2.25)	(2.25)	(8.16)	(8.62)	(9.02)	(8.95)	(7.94)
Constant	-3.69	-3.03	-4.43	-7.91	111.28 ***	122.98 ***	117.58 ***	107.95 ***
	(10.68)	(14.32)	(13.83)	(11.11)	(21.93)	(21.47)	(20.69)	(25.30)
Obs.	329	329	329	329	329	329	329	329
R-squared	0.964	0.964	0.964	0.966	0.907	0.908	0.907	0.916
Number of dummies								
Country	12	12	12	12	12	12	12	12
Bidder nationality	20	20	20	20	20	20	20	20

Note: The dependent variable is the bidding amount. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

- **FOR WATER AND SEWERAGE:**
- **Coef. of *N* is <u>negative and significant w/o engineering cost.</u>**
- **Nonparametric: Coefs <u>are steadily declining w/o engineering cost</u>.**
- **Coef. of engineering cost: 0.8 <u>(over-estimating).</u>**

Electricity

	Linear	Quadratic	Log-linear	Non-parametric	Linear	Quadratic	Log-linear	Non-parametric
N	-3.03 ***	-8.02 *			-3.61	-9.74		
	(0.99)	(4.71)			(2.96)	(10.58)		
N^2		0.36				0.44		
		(0.31)				(0.71)		
ln(*N*)			-19.53 ***				-23.78	
			(6.13)				(16.90)	
N=2				20.26 **				2.64
				(8.18)				(26.72)
N=3				6.91				-10.37
				(7.95)				(25.69)
N=4				-0.76				-0.85
				(5.00)				(15.18)
N=5				-12.73 *				-66.80 **
				(7.15)				(29.23)
$D_{(Dam)}$	-22.19 ***	-22.61 ***	-22.90 ***	-27.49 **	-28.14	-28.65	-29.12	-70.90
	(8.26)	(8.58)	(8.42)	(10.78)	(20.85)	(20.58)	(20.32)	(35.76)
$D_{(Generator)}$	3.46	2.29	1.36	2.52	46.98	45.52	44.19	44.52
	(7.91)	(7.73)	(7.49)	(6.71)	(31.18)	(32.42)	(32.18)	(29.77)
$D_{(Trans. lines)}$	18.79 **	20.20 *	21.43 **	12.14	47.30	49.02	50.91	22.61
	(9.06)	(10.30)	(10.24)	(12.38)	(49.15)	(50.03)	(49.03)	(49.22)
$D_{(Substation)}$	23.07 ***	23.49 ***	23.47 ***	22.05 ***	-46.17 **	-45.62 **	-45.63 **	-49.27 **
	(6.05)	(5.99)	(5.87)	(6.75)	(21.46)	(21.62)	(21.12)	(19.62)
$D_{(Civil work)}$	19.69 ***	20.46 ***	21.02 ***	25.01 ***	73.11 **	74.03 ***	74.78 ***	98.01 ***
	(4.23)	(4.37)	(4.44)	(5.09)	(28.54)	(28.24)	(28.19)	(34.95)
Installed capacity	-0.01	-0.01	-0.01	0.02	0.35 **	0.35 **	0.35 **	0.39 **
	(0.04)	(0.04)	(0.04)	(0.02)	(0.17)	(0.17)	(0.17)	(0.16)
Installed capacity^2 1/	-0.05	-0.05	-0.05	-0.05 **	-0.24 *	-0.24 *	-0.25 *	-0.23 *
	(0.04)	(0.03)	(0.03)	(0.02)	(0.15)	(0.14)	(0.14)	(0.13)
Number of turbines	7.83 ***	7.39 ***	8.06 ***	4.38 **	-8.13	-8.67	-7.74	-20.18 *
	(1.60)	(1.56)	(1.55)	(2.06)	(9.50)	(9.24)	(9.79)	(12.09)
Trans. line voltage	-0.27 ***	-0.23 **	-0.25 ***	-0.21 **	0.60	0.65	0.61	0.68 *
	(0.09)	(0.10)	(0.09)	(0.09)	(0.44)	(0.45)	(0.44)	(0.41)
Trans. line voltage^2 1/	0.51 ***	0.47 **	0.48 ***	0.46 **	-1.29 *	-1.35 *	-1.33 *	-1.23 *
	(0.16)	(0.18)	(0.16)	(0.18)	(0.78)	(0.79)	(0.78)	(0.72)
Trans. line length	0.06	0.00	0.03	-0.10	-0.76 *	-0.83 *	-0.78 *	-1.17 **
	(0.08)	(0.09)	(0.08)	(0.10)	(0.45)	(0.43)	(0.45)	(0.52)
Trans. line length^2 1/	-0.07	-0.05	-0.05	0.08	0.88 *	0.90 *	0.89 *	1.31 **
	(0.09)	(0.09)	(0.09)	(0.11)	(0.49)	(0.49)	(0.49)	(0.57)
Engineering cost	1.22 ***	1.22 ***	1.21 ***	1.19 ***				
	(0.10)	(0.10)	(0.10)	(0.09)				
Estimated duration	-0.40	-0.20	-0.23	-0.04	-1.13	-0.88	-0.92	-0.19
	(0.20)	(0.24)	(0.20)	(0.23)	(0.76)	(1.00)	(0.83)	(0.76)
Donor 1	43.86 **	39.10 ***	38.57 ***	33.44 ***	85.61	79.75	78.87	50.09
	(12.87)	(13.76)	(12.83)	(12.17)	(58.99)	(65.26)	(61.85)	(47.43)
Constant	16.30	26.93	27.71 *	2.14	44.77	57.83	58.68	13.74
	(13.90)	(19.17)	(15.24)	(16.53)	(39.23)	(52.50)	(42.45)	(51.41)
Obs.	139	139	139	139	139	139	139	139
R-squared	0.981	0.981	0.982	0.983	0.779	0.779	0.780	0.811
Number of dummies								
Country	12	12	12	12	12	12	12	12
Bidder nationality	15	15	15	15	15	15	15	15

1/ For presentation purposes, the coefficients are multiplied by 1,000.

Note: The dependent variable is the bidding amount. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

FOR ELECTRICITY

- Coef. of *N* is **negative and significant.**
- Nonparametric: Coefs are **steadily declining; but appear to drop fast** (too fast?).
- Coef. of engineering cost: 1.2 **(under-estimating at time of appraisal; cost overrun).**

Summary of key estimation results
(there are more, but focus on part of the story here)

- **Competition is good for procurement, for all sectors**.
  - The bids almost continue decreasing with *N*: COMPETITION CUTS COSTS!
- **We also have a sense of the optimal number of bidders**
  - For road and water: 7
  - For electricity, quickly diminishing…but may need at least 3.
- **Note that engineering cost estimates add information**
  - Overestimate project costs in roads and water
    - Estimated coef. 0.53 for road, 0.8 for water
  - Underestimate project costs in electricity
    - 1.2 for electricity
- **Now with this bid function and its detailed modeling of contract design (size, composition,…) , can do a lot of policy relevant simulations, i.e.**
  - ***How many bidders do we need to get efficiency?***
  - ***How does the package composition change efficiency?***
  - ***What is the potential saving from improvement in procurement rules?***

How much does the *average* infrastructure cost *per unit* change with competition?

….When evaluating the estimated equation at sample mean values….

Predicted Unit Bid of "Average" Contract Package (million US$)

	Bid amount per unit	Std. Err.
Road (per km)	0.50	(0.12)
Water & sewage (per million m3)	768.49	(137.01)
Only water supply (per million m3)	780.05	(143.29)
Only sewage (per million m3)	759 [illegible]	[illegible]
Electricity (per MW)	0 [illegible]	[illegible]

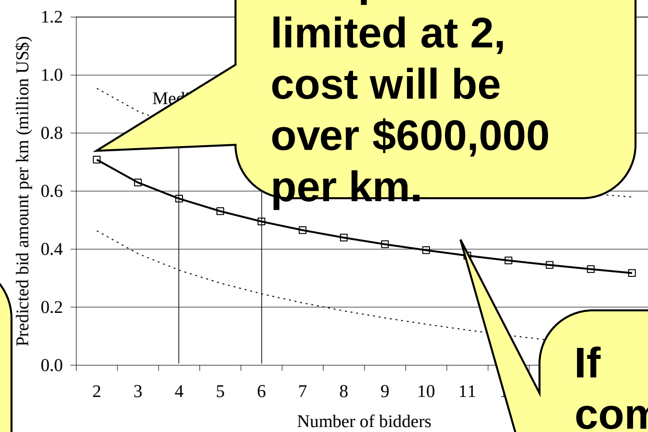
Note that the bid functions [illegible] evaluated at the mean [illegible]

Roads cost $500,000 per km.

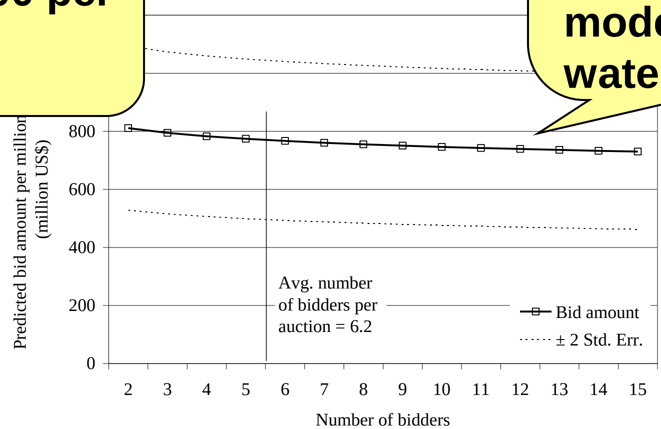
Declining; but the competition effect looks moderate for water.

But if competition is limited at 2, cost will be over $600,000 per km.

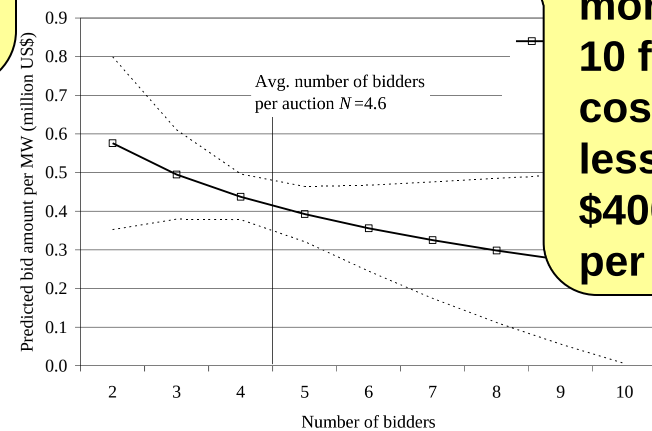
If competition includes more than 10 firms, cost will be less than $400,000 per km.



ter supply and sanit

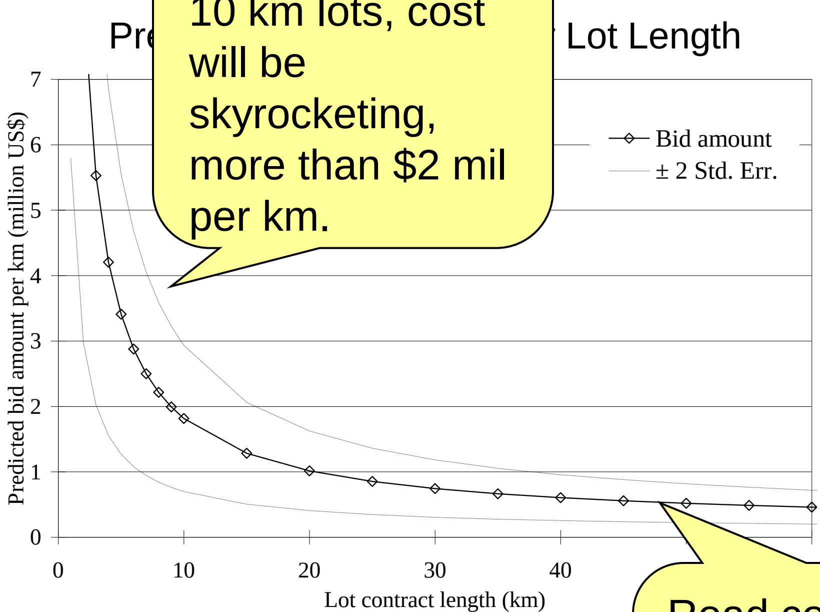


Electricity

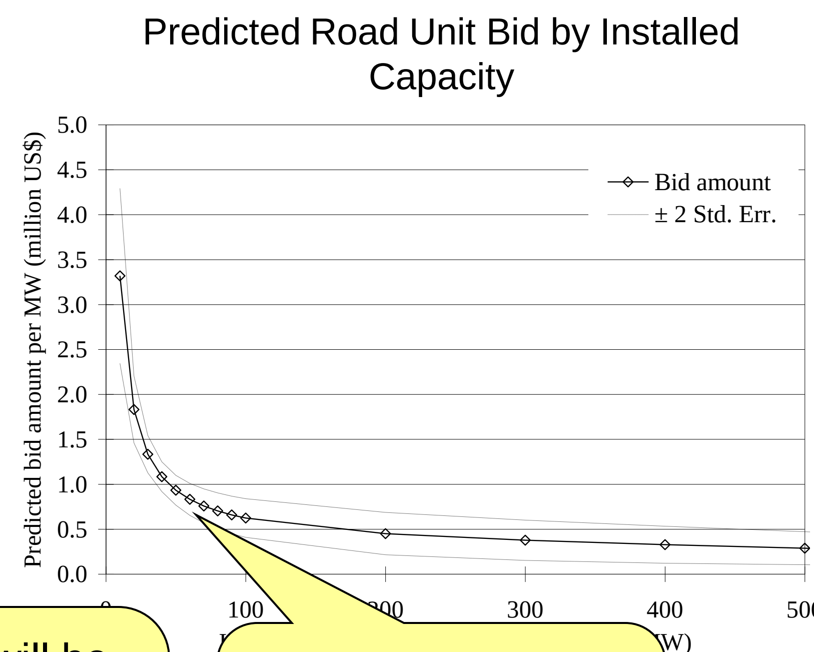


Procurement design, i.e., project/contract size, is very, very important to contain procurement costs and improve efficiency….

"Xmas-tree-type" projects with a number of procurement subcomponents may not be a good idea!



But for less than 10 km lots, cost will be skyrocketing, more than $2 mil per km.

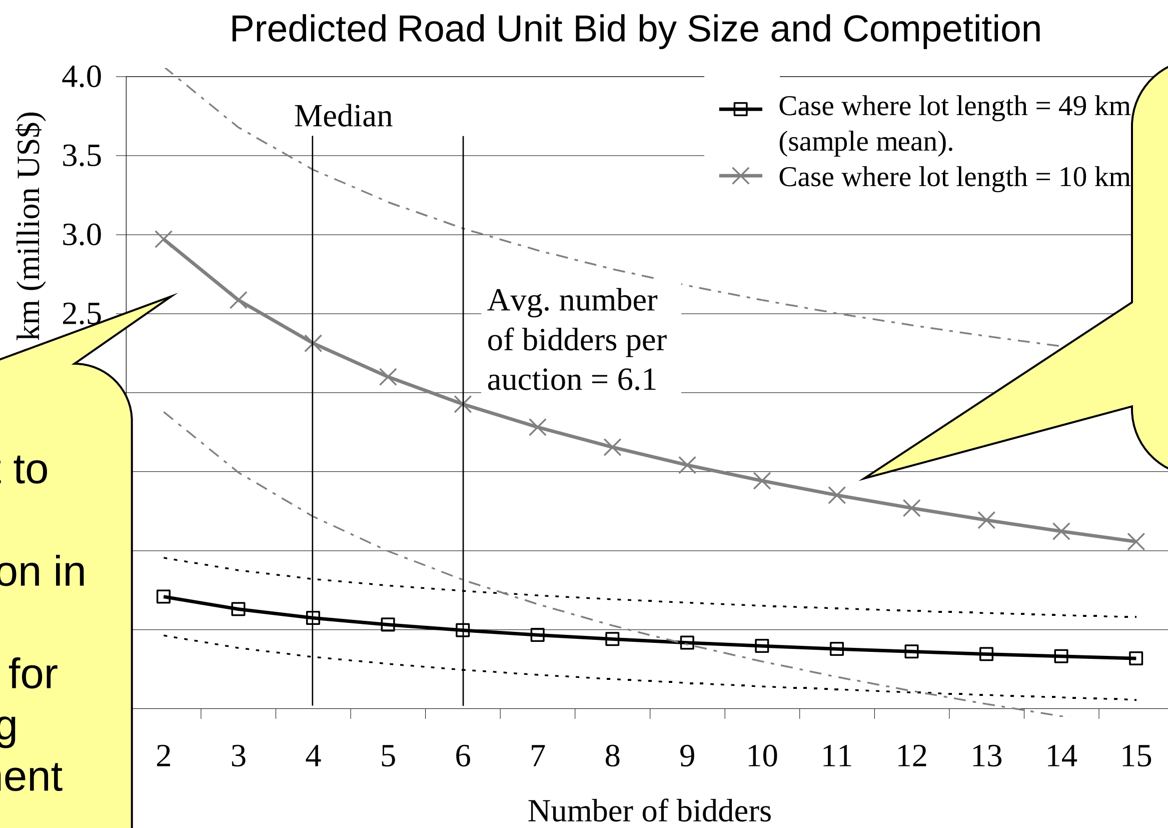


Road cost will be $500,000 per km, when procuring a 49 km (sample avg) package.

Power project cost will also be high for less than 50MW procurements.

Design is crucial in particular when competition is limited….

Small size with little competition leads to extremely high costs!



Very important to increase competition in small contracts for containing procurement costs!

The decreasing effect on the bids is more considerable for small-size procurement lots (e.g., 10km)

How much scope for gains from more competition?

- **Gains from improved procurement efficiency are HUGE:**
  - In the book, we explain how we estimated a savings of **at least 8 % of total infrastructure procurement costs.**
    - Larger than the observed corruption costs (i.e., 3.5% of contract amount for SSA).
    - Not minor from a fiscal viewpoint (8% of 1.5-4% of GDP is a lot!)
- **Competition is the keys to these efficiency gains**
  - ...SO HOW CAN WE GET MORE BIDDERS???

Should we try to attract more fringe (maybe weaker) bidders?

A bit more of auction theory

- **<u>Theoretical prediction:</u> If a weak bidder faces a strong bidder rather than another weak bidder, s/he bids more aggressively (Maskin and Riley, 2002).**
  - **In theory, a weak bidder is defined to have a different distribution of underlying valuations (costs) from a strong bidder...roughly speaking $F_w(c)$ first-order stochastically dominates $F_s(c)$.**
- **<u>Empirics:</u> In state road procurements, new entrants (i.e., weak bidders) have been found to be more aggressive (De Silva, et al., 2002).**
- **<u>Empirical questions</u>: who is the weak bidder? How to define? Market concentration?**
  - **In our analysis, divide the sample into two groups: auctioned before 2002 (about 20% of total sample) and after 2002 (80%).**
  - **Define a bidder as *incumbent* if s/he includes a firm who was awarded in the first sub-sample period at least once.**
  - **Define the rest as entrant.**

Market concentration was not as high as we were expecting…even if some were too often winners

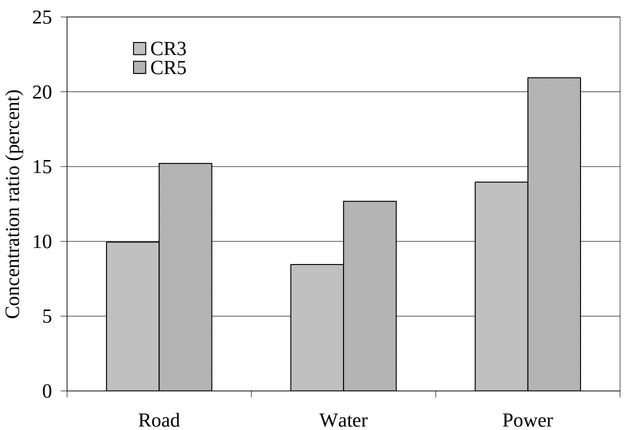
Concentration of Contract Awards

No. of wins	Number of firms: Road	Water	Power
1	74	79	43
2	17	21	11
3	11	5	4
4	2		1
5	3		1
6		1	
7	1		

Working Classification of Incumbent and Fringe Bidders: 2003-2007

	Roads	Water	Electricity
Number of auctions	45	60	33
Number of bidders	188	236	99
Of which, incumbent bidders	62	39	36
Of which, fringe bidders	126	197	63
Of which, bidders facing incumbents	71	66	38

Concentration Ratio



Some of “incumbents”

Sector	Company
Roads	China Road & Bridge Corporation
	Civil Engineering Construction Corporation No. 1
	Grinaker
	Plant Pool Limited
	Sable Transport Limited
	Shimizu
	Thang Long
Water and sewage	Constructora Cadena S.A. de C.V.
	Summit Grade Limited, Part
	Tianjin Machinery & Electric Equipment Import & Export Co. Ltd.
	Urbanizacion y Riego de Baja California S.A. de C.V.
Electricity	Mitsui & Co., Ltd
	Alstom
	China National Electric Wire & Cable Import & Export Corporation
	EnegroInvest D.D.
	Itochu
	Nissho Iwai Corporation

Empirical model

- **Based on our basic model.**

$$b_{it} = \alpha_1 D_{Fringe_i} + \alpha_2 D_{FringeFacedIncumbent_{it}} + \alpha_3 ShrInc_i + \alpha_4 PastWin_i + X'_t \beta + \delta \ln N_t + \varepsilon_{it}$$

  - **But we add a few variables:**
    - **Dummy for fringe (entrant, weak) bidders to capture their general unobserved characteristics**
    - **Dummy for fringe bidders who faced with incumbents to test Maskin and Riley's hypothesis**
    - **Share of incumbents in that auction to capture an alleged notion of less competitiveness among a set of common players in infrastructure auctions.**
    - **No. of wins in the pre-period (1997-2002): a proxy of firm's efficiency (low cost nature)**

Main estimation results

1. **Competition from new entrants has helped**
2. **Fringe bidders were aggressive as expected.**
3. **Share of incumbents is strongly positive …indicating an anticompetitive effect as expected in basic theory.**

4. **<u>Policy implications: </u>…quite expected**
   - **scope to increase role for fringe/entrant bidders for procurement efficiency.**
     - **…yet quite difficult to implement in practice under current procurement rules in ODA**

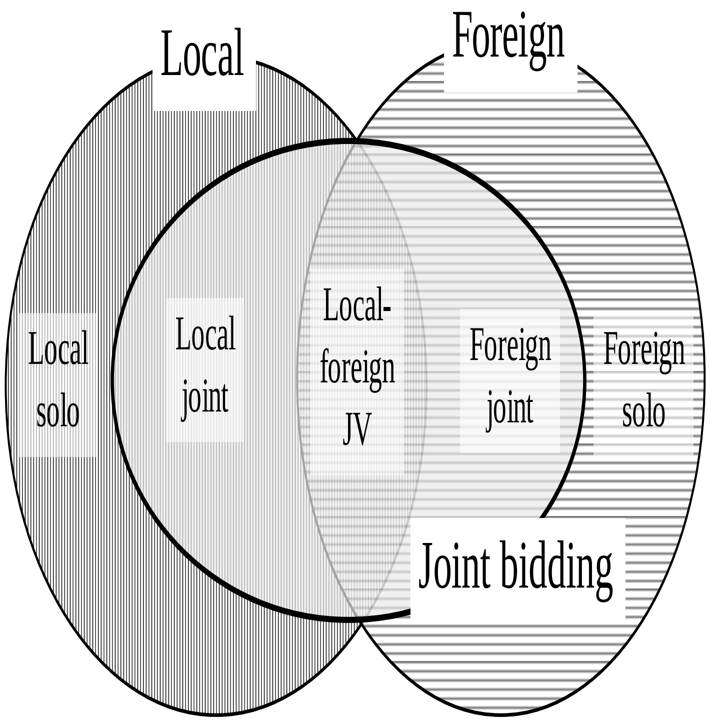
Is Joint bidding in infrastructure procurement good or bad for competition?

Auction theory on joint bidding ?

- **Theoretical prediction: Mixed story**
  - **Resource restriction view: Pooling resources reduces the barrier to entry (Hendricks and Porter, 1992). +**
  - **Information aggregation reduces competition (Krishna and Morgan, 1997). -**
  - **The two effects work and the former is dominated by the latter (Mares and Shor, 2008), but it all adds to a net anti-competitive effect. -**
  - **However: Free coalition intensifies competition (Cho et al., 2002) +**
- **Empirics:**
  - **Joint bidding is pro-competitive in oil lease auctions (Moody and Kruvant, 1988; Hendricks and Porter, 1992).**
  - **But … only for local bidders in ODA projects (Iimi, 2004).**

Common coalition forms in infrastructure procurements? more local JV in road and water and more foreign JV for electricity.

Classification of Joint Bidding



Joint Bidding Practices at Bidder Level

	Roads		Water		Electricity	
	Obs.	Share	Obs.	Share	Obs.	Share
Including local firm(s)	394	70.3	329	79.6	139	35.3
Including foreign firm(s)	394	37.6	329	29.2	139	71.2
Joint bidding	394	23.4	329	25.8	139	31.7
Including local firm(s)	394	19.5	329	21.9	139	9.4
Including foreign firm(s)	394	11.7	329	12.8	139	28.8
All local firms	394	11.7	329	13.1	139	2.9
All foreign firms	394	3.8	329	4.0	139	22.3
Both local and foreign firms	394	7.9	329	8.8	139	6.5

The model we test

- **Based again on a adaptation of our basic model.**
- **Additional concern about endogeneity of joint bidding decision.**
  - **Particular firms might form a bidding coalition.**
    - **E.g., resource restraint view**
    - **Lemon market (those who are looking for partners are weak bidders, failing to make a coalition).**
  - **Treatment effect model**

$$b_{it} = \alpha JBID_{it} + X'_t \beta + Z'_i \gamma + \delta \ln N_t + \varepsilon_{it}$$

$$JBID_{it} = \begin{cases} 1 & \text{if } JBID^*_{it} = W'_t \theta + u_{it} \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

Main estimation results

- **Endogeneity:**
  - **Statistically not severe for road and electricity.**
  - **For water, OLS is downward biased….possibly implying that truly efficient firms are more likely to depend on joint bidding and at the same time to make lower bids.**

- **We find that joint bidding is broadly anti-competitive… BUT this varies across sectors and depending on the nature of the joint venture.**
  - **Road: Foreign-only joint bidding is anti-competitive; foreign and local coalition is pro-competitive.**
  - **Water: Joint bidding is clearly anti-competitive, especially if foreign firm(s) are included.**
  - **Electricity: Far from conclusive.**

- **Policy implication: Encourage joint bidding involving local firms.**

Conclusion

- **Scope to cut costs exists**
  - **Increased competition could reduce procurement costs and save aid resources considerably…some 8% of total costs.**
- **Too much of a one size fits all in design of auctions given the heterogeneity of the sector**
- **A few more general conclusions:**
  - **Avoid small contracts!**
  - **Encourage new entrant participation.**
  - **Encourage joint bidding practices, but focus on JV with local firms….**
  - **Do not rely too much on foreign joint bidding only.**
  - **Don’t underestimate governance...it may matter**

LAST POINT...

IF WE HAVE THE TIME

How much would improved governance help cut procurement costs?

A few new PRELIMINARY results on how much governance explains unit costs (not in the book…ongoing research)

- **Two questions:**
  - **Did governance contribute to reduce competition in this market?**
    - **With or without a regulators to supervise the sector**
    - **With or without financial rigor**
  - **Did poor governance contribute to stimulate opportunistic practices such as strategic low-balling?**

A model to test the impact of governance on corruption

- $Num_{ist} = f\,(gov_{ist}\;, X_{ist}\;, c_s\,, c_l)$

- With
  - Num_{ist} is the number of bidders affected by the level of governance, gov, in each sector s (i.e. Pooled data from water, electricity and roads)
  - X is the vector of other contract (auction) specific characteristics (to control for heterogeneity across auctions)
    - include the engineering cost estimates, project duration, whether or not a regulatory agency is in place, a financial sustainability proxy (i.e. Unaccounted for water and electricity and local gaz price/Luxembourg price)
  - c_s are sector specific fixed effects (to deal with omitted or unobserved variables)
  - c_l are country specific fixed effects

Is low-balling a problem in this sample?

- **Estimate the following model**
  - **Simple OLS**
  - **As well as a zero truncated negative binomial model**
- $\mathbf{Low_{ist} = g\,(gov_{ist}\ ,\, X_{ist}\, ,\, c_s\, ,\, c_l\,)}$
- **With low is the difference btw the winning bid and the average bid in the tender**
- **If low is negatively affected by *gov*, then it validates our concern**

Results so far

- **Financial sustainability matters positively to the number of bids for all sectors**
  - **Wald test suggests it matters a lot more to the water sector than to roads and electricity**
- **Regulatory accountability also, but it is not statistically significant**
- **On low balling**
  - **No strong results**
  - **bids are lower when governance is weaker but not strong statistical significance (just above 10%)**
  - **Stronger governance leads to bid convergence, suggesting that it leads to more competition**