How to Achieve Efficiency in Government Procurement Auctions?: Analysis of Optimal Bidder Participation

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Introduction and Motivation

- In 2014, the value of procured goods, services and construction projects in Turkey was approximately US$34 billion. (4% of GDP)
- Government authorities such as the National Audit Office (NAO) promote effective and efficient GP auctions in order to achieve “value for money” (NAO 2007).
- Limited competition is one of the important reasons for lacking efficiency in GP auctions as stated by Lewis-Faupel et al. (2014).

Research Question

- Identify the optimal number of bidders to achieve the lowest procurement prices in public procurement auctions.
- Use a unique data set provided by the Public Procurement Authority of Turkey.
- The data set covers all government procurement auctions comprising more than half a million observations for the years 2005-2012.

Main Results

- On average, an increase in the number of bidders significantly lowers the difference between procurement prices and the estimated cost, our measure of efficiency.
- The lowest procurement price is achieved with seven bidders when all the auctions are considered.
- Optimal number is five for services, ten for both goods and construction auctions.
- Optimal number of bidders are significantly distinct when endogeneity is not controlled for.

Related Literature

- Levin and Smith (1994) show that under the optimal auction mechanism, the expected winning bid decreases when the number of potential bidders grows beyond a cut-off point.

- In common value settings, the total effect depends on the magnitudes of two opposing effects: the positive “competition effect” and the negative “winner's curse effect” (Bulow and Klemperer, 2002).

Related Literature

- Paarsch (1992) shows that the winning bid declines until the number of bidders reaches 5 to 10 for the tree planting contract auctions held in British Columbia.
- Gupta (2002) shows that the winning bid amount significantly decreases as the number of bidders rises to the level of about 6 to 8 firms in Oklohama state highway construction auctions.
- Iimi (2006) also investigates the competition effect in the Japanese Official Development Assistance (ODA) projects.

Data

- All government procurement auctions from 2005 to 2012.
- Detailed information about 565,298 auctions.
- Only winning bids.
- Estimated cost.
- Number of bidders.
- EKAP became operational in 2010.

Variables

- Three sets of explanatory variables
- Competitive environment: number of bidders
- Auction specific variables: “Above Threshold” dummy, sector dummies.
- Control variables:
  - Macroeconomic condition: Inflation, industrial production, central bank policy rate.
  - Stimulus Region dummies: The first region is the most developed and the sixth region is the least developed one.

Summary Statistics of the Variables

	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Winning Bid (WINBID)	565,298	454091.3	8063788	1.95	4.30e+09
Estimated Cost (ESTIMATE)	565,298	560406.4	9294096	1.97	4.30e+09
Dependent Variable[1]	565,298	-0.18	0.22	-1.44	0.37
Number of Bidders (N)	565,298	3	2.47	1	20
AUCTYPE: Services	197808 (34.99%) among 565298 auctions				
AUCTYPE: Goods	236238 (41.79%) among 565298 auctions				
AUCTYPE: Construction	131252 (23.22%) among 565298 auctions				
Stimulus Region	Dummy variables representing six stimulus regions of Turkey identified by the Ministry of Development. The first region is the most developed.				
YEAR1-8	Dummy variables for each year for 2005-2012.				

Empirical Methodology

$$ln\left(\frac{wb_i}{ecost_i}\right) = X_i\beta + N_i\lambda + \varepsilon_i$$

Empirical Methodology

- We take into account the possible endogeneity of number of bidders.
- Unobserved characteristics of potential bidders are likely to influence their decision to participate in the auction and these same characteristics are likely to simultaneously influence the winning bid.
- Woolridge (2010) control function instrumental variables approach.
- The inclusion of the error term controls for the endogeneity of the number of bidders in the outcome equation.

$$N_i = X_i\theta + IV_i\alpha + v_i$$

Empirical Methodology

- We choose the following variables to instrument for the endogenous regressor: the EKAP dummy and the BIGCITY dummy variable.
  - Gurakar and Tas (2015): significant effect of EKAP on number of bidders.

$$ln\left(\frac{wb_i}{ecost_i}\right) = X_i\theta + N_i\lambda_1 + \lambda_2 v_i + \varepsilon_i$$

Empirical Results

Table II
Determinants of Auction Prices: OLS vs IV (2SLS, GMM and CF)
Validity Check for Instruments and Comparison of OLS and IV

Variable	OLS	2SLS	GMM	CF
Number of Bidders	-0.037	-0.043	-0.043	-0.04
	(255.75)**	(27.68)**	(27.71)**	(26.51)**
Stimulus Region 2	0.01	0.01	0.01	0.01
	(13.42)**	(11.84)**	(11.84)**	(7.65)**
Stimulus Region 3	0.01	0.01	0.01	0.00
	(10.46)**	(7.57)**	(7.57)**	(4.00)**
Stimulus Region 4	0.02	0.02	0.02	0.01
	(16.44)**	(17.63)**	(17.62)**	(13.15)**
Stimulus Region 5	0.03	0.03	0.03	0.03
	(27.48)**	(29.07)**	(29.07)**	(24.62)**
Stimulus Region 6	0.04	0.05	0.05	0.04
	(36.57)**	(39.41)**	(39.41)**	(32.39)**

Empirical Results

Instrumental Variables	EKAP BIGCITY	EKAP BIGCITY	EKAP BIGCITY
Overidentification test of all instruments Ho: Instruments are valid			
Hansen J statistic	0.13** (p=0.72)	0.13** (p=0.72)	
Kleibergen-Paap rk LM statistic	3145.91**	3145.91**	
GMM C statistic	17.24**	17.37**	

Identifying Optimal Number of Bidders

- We implement the methodology suggested by Rezende (2008).
- We construct a dummy variable for each number of bidders.

$$ln\left(\frac{wb_i}{ecost_i}\right) = X_i\theta + \sum_{k=2}^{20} D(N=k)_i\lambda_k + \lambda_{21}v_i + \delta_i$$

Table III
Optimal Number of Bidders

	All		Service		Goods		Construction	
	CF	F-test	CF	F-test	CF	F-test	CF	F-test
n2	-0.08		-0.10		-0.11		-0.05	
	(43.93)**		(35.35)**		(25.30)**		(20.32)**	
n3	-0.11	339.66*	-0.12	18.21**	-0.19	376.15**	-0.10	430.74**
	(34.69)**		(20.85)**		(23.11)**		(26.26)**	
n4	-0.14	259**	-0.14	51.47**	-0.26	274.94**	-0.14	336.32**
	(30.78)**		(17.68)**		(21.58)**		(26.73)**	
n5	-0.16	85.04**	-0.15	7.9**	-0.31	129.39**	-0.19	365.13**
	(26.46)**		(14.21)**		(19.34)**		(29.14)**	
n6	-0.17	24.07**	-0.16	0.53	-0.36	51.63**	-0.22	127.11**
	(22.84)**		(11.72)**		(17.11)**		(28.18)**	
n7	-0.18	22.14**	-0.17	2.62	-0.40	47.28**	-0.25	83.88**
	(21.43)**		(10.60)**		(16.33)**		(25.60)**	
n8	-0.18	0.53	-0.15	9.49**	-0.43	9.68**	-0.27	40.21**
	(18.18)**		(7.94)**		(15.06)**		(26.31)**	
n9	-0.18	0.04	-0.14	0.43	-0.45	4.11*	-0.29	13.61**
	(15.14)**		(6.37)**		(13.43)**		(22.60)**	
n10	-0.18	0.01	-0.13	1.27	-0.49	18.02**	-0.30	5.22*
	(13.34)**		(5.14)**		(13.39)**		(20.79)**	
n11	-0.17	11.48**	-0.10	6.39**	-0.49	0.1	-0.30	1.26
	(10.95)**		(3.43)**		(12.12)**		(18.61)**	

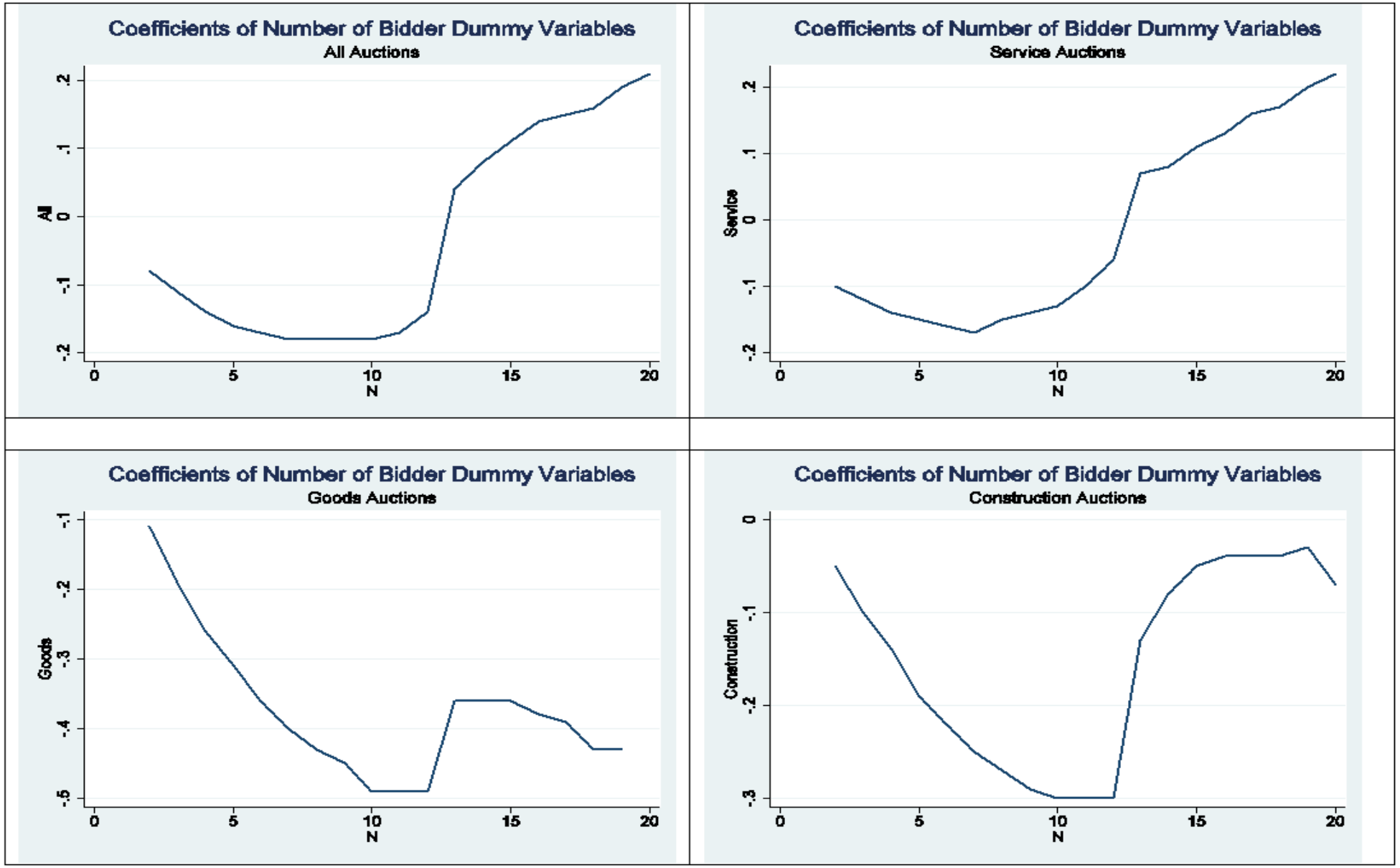

Figure 1: Control Function Coefficients of Number of Bidder Dummies

Effect of Endogeneity

Table IV
Optimal Number of Bidders Assuming Exogeneity

	All		Service		Goods		Construction	
	CF	F-test	CF	F-test	CF	F-test	CF	F-test
ı2	-0.09 (133.21)**		-0.12 (94.13)**		-0.09 (91.40)**		-0.04 (29.45)**	
ı3	-0.14 (160.96)**	2310.82**	-0.15 (89.88)**	268.69**	-0.15 (115.96)**	1753.83**	-0.09 (57.62)**	782.17**
ı4	-0.19 (168.70)**	1359.51**	-0.20 (85.69)**	258.81**	-0.20 (115.42)**	689.87**	-0.14 (78.77)**	625.53**
ı5	-0.22 (161.79)**	519.15**	-0.22 (74.78)**	64.34**	-0.24 (99.93)**	161.05**	-0.19 (93.96)**	457.1**
ı6	-0.25 (154.48)**	195.55**	-0.25 (66.90)**	21.26**	-0.26 (84.54)**	36.89**	-0.23 (103.61)**	207.99**
ı7	-0.28 (140.37)**	139.55**	-0.27 (57.19)**	23.33**	-0.28 (67.43)**	24.06**	-0.26 (105.04)**	109.33**
ı8	-0.29 (133.82)**	23**	-0.27 (52.88)**	0.41	-0.29 (54.17)**	1.05	-0.28 (108.64)**	53.74**
ı9	-0.31 (124.02)**	23.18**	-0.28 (44.24)**	2.29	-0.29 (46.20)**	0.09	-0.30 (105.19)**	28.77**
.10	-0.33 (116.11)**	18.5**	-0.29 (39.60)**	0.42	-0.32 (36.05)**	6.35*	-0.31 (101.75)**	9.34**
.11	-0.33 (109.81)**	0.23	-0.28 (35.70)**	1.27	-0.29 (29.23)**	3.27	-0.32 (98.00)**	3.36
.12	-0.32 (109.29)**	2.3	-0.25 (34.04)**	5.06*	-0.27 (22.87)**	2.3	-0.31 (97.92)**	1.82

Conclusion

- The number of bidders significantly and negatively affects the difference between the procurement price and the estimated cost,
- More competition considerably improves efficiency of government procurement auctions in Turkey.
- The lowest procurement price is achieved with seven bidders when all the auctions are considered.
- However, this number is five for services, ten for both goods and construction auctions.
- The optimal number of bidders is significantly distinct when endogeneity is not controlled for.

Policy Implications

- Governments can devise policies to achieve the optimal number of bidders which may lead to considerable savings due to lower winning bids.
- Counter-factual analysis shows that if the number of bidders were at the optimal level for all of the auctions, the average savings per auction would be
  - US$8,421 for service,
  - US$259,062 for goods
  - US$5,894 for construction auctions.