Contract enforcement and productive efficiency: Evidence from the bidding and renegotiation of power contracts in India.

Ryan, N. (2020), Econometrica.

Environmental Reading Group session 30

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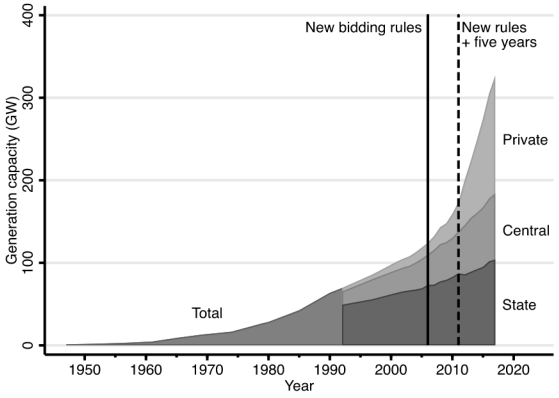
Research Question

By examining the bidding and renegotiation of power procurement auctions in India, the paper aims to understand the role of contract enforcement in shaping equilibrium rents and productive efficiency. It finds that the **weak contract enforcement leads to lower than cost bidding and larger markup in renegotiation.**

Context

National Tariff Policy in 2006 mandates that all power procurement must be done through competitive scoring auction.



number of Renegotiation

Widespread renegotiation of contracts is observed. out of 39 known winners, 20 renegotiated their contracts and 7 succeeded.

TABLE I

SUMMARY OF BIDS AND RENEGOTIATION[a]

			Petition Status			Mean	
Year	Bids	Winners	Known	Filed	Granted	Tariff (INR/kWh)	Capacity (MW)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2006	18	3	3	3	2	2.1	3465
2007	23	10	8	4	0	2.9	1043
2008	26	6	4	3	1	3.1	350
2009	34	11	8	7	3	3.5	913
2010	36	5	4	0	0	3.8	365
2011	22	7	3	1	1	4.7	259
2012	40	12	9	2	0	5.7	340
Total	199	54	39	20	7	3.9	836

Renegotiation Response to Cost Shocks

$$R_{it} = \gamma_0 + \gamma_1 CoalShock_t + \gamma_2 CoalShock_t \times CoalImported_i + \gamma_3 UMPP_i + \gamma_4 CoalImported_i + \gamma_5 CoalDomestic_i + \varepsilon_{it} \quad (1)$$

TABLE II

COST SHOCKS AND RENEGOTIATION[a]

	Dependent Var.: Dummy for Renegotiation			
	(1)	(2)	(3)	(4)
Coal price shock (Rs/kWh)	0.242	0.205		0.120
	(0.0991)	(0.109)		(0.124)
Coal imported (=1) × coal price shock (Rs/kWh)				0.452
				(0.159)
Ultra-mega power plant (=1)		0.335	0.526	0.197
		(0.142)	(0.177)	(0.215)
Coal imported (=1)			0.474	0.228
			(0.177)	(0.205)
Coal domestic (=1)			0.282	0.178
			(0.166)	(0.202)
Constant	0.513	0.487	0.158	0.278
	(0.0762)	(0.0839)	(0.129)	(0.175)
Observations	39	39	39	39

Firm Connectedness and Renegotiation

TABLE III

FIRM CONNECTEDNESS AND RENEGOTIATION[a]

	Dependent Variable: Dummy for Petition …			
	Filed (1)	Filed (2)	Granted (3)	Granted (4)
Connected firm (=1)	0.292	0.331	0.183	0.251
	(0.161)	(0.166)	(0.112)	(0.124)
Firm controls		Yes		Yes
Mean dependent variable:				
All firms	0.51	0.51	0.18	0.18
Unconnected firms	0.33	0.33	0.07	0.07
Observations	39	39	39	39

Firms that are more connected to the Government of India renegotiate more than other bidders.

Firm Connectedness and Bids Index

$$FractionIndexed_{ai} = \beta_0 + \beta_1 ConnectedFirm_i + \beta_2 BidPrice_{ai} + \beta_3' X_i + \beta_4' X_a + \varepsilon_{ai} \quad (2)$$

TABLE IV

FIRM CONNECTEDNESS AND BIDDING STRATEGIES[a]

	Dependent Var.: Fraction of Bid Indexed to Coal				
	(1)	(2)	(3)	(4)	(5)
Connected firm (=1)	−0.0694	−0.0775	−0.0789	−0.0750	−0.0776
	(0.0297)	(0.0297)	(0.0306)	(0.0347)	(0.0317)
Bid price (Rs/kWh)	0.0589	0.0268	0.0558	0.0543	0.0552
	(0.0108)	(0.0295)	(0.0258)	(0.0267)	(0.0259)
Connected firm (=1) × coal tied to auction (=1)				−0.0216	
				(0.0645)	
Connected firm (=1) × auction before coal awarded (=1)					−0.00854
					(0.0698)
Firm controls		Yes	Yes	Yes	Yes
Auction controls		Yes			
Auction fixed effects			Yes	Yes	Yes
Mean dep. var.	0.24	0.24	0.24	0.24	0.24
Observations	121	121	121	121	121

Connected bidders index less of their bids to the price of coal.

Setup

- N firms, each indexed by i; bid at $t = 0$ to supply one unit of power in $t = 1$.
- iid and **two-dimensional private** type $\theta_i = \{h_i, \Delta_i\}$, where h_i is the tech type (heat rate), and Δ_i is a return to renegotiation.
- two-part bid $\beta_i = (\beta_{Fi}, \beta_{hi})$. The firm/firms bidding the $Wgeq1$ lowest total scores $S(\beta_i)$ win the auction.
- Linear scoring rule: $S(\beta_i) = \beta_{Fi} + \beta_{hi}\mathbb{E}(p)$. β_{hi} **is indexed to the price of coal** p**,** which is uncertain at $t = 0$.
- Expected profit of firm i is $\pi_i = \beta_{Fi} + (\beta_{hi} - h_i)p$. $c_i = h_i p$ is the marginal cost of production.

Condition of Renegotiation

Winners would renegotiate if the expected profit from variable part is smaller than reservation value V_0.

$$\begin{aligned} R(\beta_i, \theta_i) &= 1\{(\beta_{hi} - h_i)p < V_0\} \\ &= 1\{p > V_0/-(h_i - \beta_{hi})\} = 1\{p > \bar{p}_i\} \end{aligned} \tag{3}$$

Assumption: $h_i > \beta_{hi}$, so **firms bid below their cost.** If renegotiation succeedes, the firm gets Δ_i.

$$\pi_R = \underbrace{\beta_{Fi} + (\beta_{hi} - h_i)p}_{\pi_i} + \Delta_i R_i \tag{4}$$

Δ_i is heterogeneous as some firms are more connected to the government.

equilibrium I

In a scoring auction, each **risk-averse** bidder chooses to bid components $\beta_i = (\beta_{Fi}, \beta_{hi})$ to maximize expected profit.

1. conditional on given score S_i. Assume mean-variance utility function.

$$\begin{aligned} &\max_{\beta_{Fi},\beta_{hi}} E[\pi_R] - \eta\, Var[\pi_i] \\ &s.t \quad S_i = \beta_{Fi} + \beta_{hi}\mathbb{E}(p) \end{aligned} \tag{5}$$

Substitute β_{Fi} by S_i, the maximization problem can be rewritten as:

$$\max_{\beta_{hi}} S_i \underbrace{-h_i E[p] + \Delta_i E[R] - \eta\, Var[\pi_i]}_{\text{pseudo-type} \quad k(\theta_i)} \tag{6}$$

equilibrium II

2. Now consider i's choice of an optimal score, the maximization problem is:

$$\max_{S_i} V(S_i|\theta_i)Pr(S_i < S_{j(W)}) = max_{Si}(Si + k(\theta_i))Pr(Si < S_{j(W)}) \quad (7)$$

Let $G(\cdot|X_a)$ give the cdf conditional on the observable characteristics X_a of an auction, the maximization problem becomes:

$$\max_{S_i}(S_i + k(\theta_i))(1 - G(S_i|X_a))^{N-W} \quad (8)$$

Take FOC w.r.t S_i and solving for $k(\theta_i)$, we get:

$$k(\theta_i) = \frac{1}{N-W}\frac{1 - G(S_i|X_a)}{g(S_i|X_a)} - S_i \quad (9)$$

Identification I

Lemma 1

The optimal indexation is increasing and pseudo-type decreasing in heat rate.

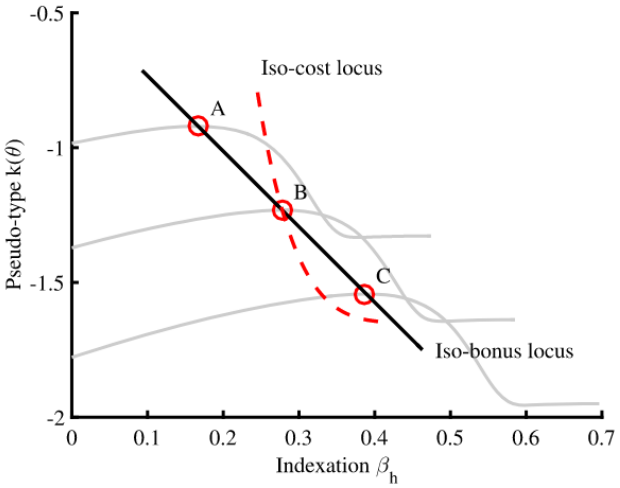
Lemma 2

The optimal indexation is decreasing and the pseudo-type increasing in the renegotiation bonus.

Proposition 1

Assume that the parameters (η, V_0) *are known and that the chosen indexation* β_{hi}^* *is interior. Then the bidder's type* θ_i *is nonparametrically identified from* X_i.

Identification II



Score distribution

Assume equilibrium score distribution $G(\cdot|X_a)$ is log-normal based on observation.

Type Identification

In theory:

$$k(\theta_i) = \max_{\beta_{hi}} \{-h_i E[p] + \Delta_i E[R(\beta_i, \theta_i)] - \eta\, Var[\pi_i(\beta_i, \theta_i)]\} \tag{10}$$

In estimation:

$$k(\theta_i) = \max_{\beta_{hi}} \{\beta_{hi}(E[\tilde{P}_t] - \tilde{P}_0) - h_i E[\tilde{P}_t] + \Delta_i E[\tilde{R}_t] - \eta(\beta_{hi} - h_i)^2 Var[\tilde{P}_t]\} \tag{11}$$

FOC:

$$\frac{dk(\theta_i)}{d\beta_h} = E[\tilde{P}_t] - \tilde{P}_0 + \Delta_i \frac{dE[\tilde{R}_t]}{d\beta_h} - 2\eta(\beta_{hi} - h_i) Var[\tilde{P}_t] = 0 \tag{12}$$

risk parameter $\eta = 1$ and reservation value $V_0 = 0.3 INR/kWh$ are calibrated from the data. And assume homogeneity across bidders.

Counterfactual

Higher index if strict enforcement.

TABLE V

EQUILIBRIUM AND COUNTERFACTUAL BIDS, COSTS AND MARK-UPS[a]

	Equilibrium				Counterfactual	
Sample:	With Bid		With Type		With Type	
Bids:	All	Winning	All	Winning	All	Winning
	(1)	(2)	(3)	(4)	(5)	(6)
Bid (INR/kWh)	3.68	3.41	3.62	3.39	4.20	3.70
	(0.05)	(0.05)	(0.05)	(0.05)	(0.10)	(0.09)
Pseudo-type (INR/kWh)	3.46	3.03	3.38	2.98	3.38	3.27
	(0.06)	(0.08)	(0.07)	(0.10)	(0.07)	(0.11)
Margin over pseudotype (%)	9.16	16.61	10.07	18.36	29.07	21.87
	(1.01)	(2.19)	(1.28)	(2.75)	(2.95)	(4.87)
Cost of supply (INR/kWh)			3.97	3.72	3.97	3.36
			(0.10)	(0.11)	(0.10)	(0.10)
Margin over cost (%)			−3.88	−2.81	7.73	12.81
			(1.76)	(2.94)	(0.95)	(1.91)
Bonus Δ (INR/kWh)			0.29	0.31	0.29	0.33
			(0.02)	(0.05)	(0.02)	(0.05)
Value of renegotiation (INR/kWh)			0.22	0.24		
			(0.02)	(0.04)		

Conclusion

- Weak contract enforcement leads to lower than cost bidding and larger markup in renegotiation.
- Connected firms index less of their bids to the price of coal.
- Strict enforcement would lead to bids rise to cover cost but lower markups. Hence higher efficiency.

References

Ryan, N. (2020). Contract enforcement and productive efficiency: Evidence from the bidding and renegotiation of power contracts in India. Econometrica, 88(2), 383-424.