Does choice of contract matter for cost and quality of public goods

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Public Private Partnerships for National Highways

Lectures 1 and 2

PPPs for Infrastructure: Common Features

PPPs :

- pooling of resources through joint investments, by public and private sectors

- for making of provisions of public goods - roads and other infrastructure

- negotiations among participants for risk sharing

- allocation of project risks and liabilities, b/w public and private sectors
    - Public Sector - Regulatory, land related risks
    - Funding and commercial

Why PPPs?

Traditional (non-PPP) Approach:

- Delays and Cost Overruns are too frequent and too large;
- More than 80 percent of projects experience delays/cost overruns (Singh, 2010);
- Quality of assets deliver is poor

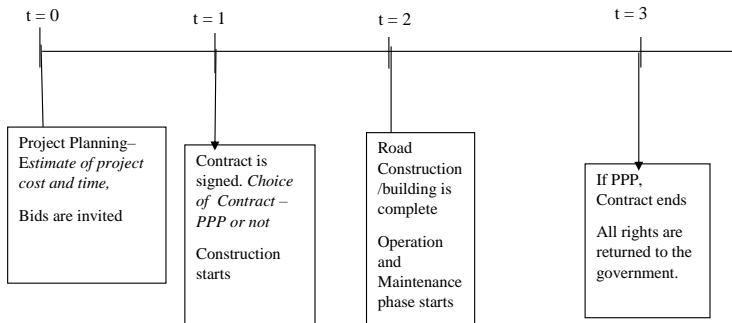**Belief in Superiority of PPPs**:

- will reduce project delays
- will bring down project costs
- will deliver better quality assets

  ... for ensuring provision of better road services, i. e., **higher quality of construction** *and maintenance of roads and* **completion of projects without cost and time overrun***, ... (Govt of India, May 2005)*

Expectations from PPPs

Project Phases

| t = 0 | t = 1 | t = 2 | t = 3 |

Project Planning–
E*stimate of project
cost and time,*

Bids are invited

Contract is
signed. *Choice
of Contract –
PPP or not*

Construction
starts

Road
Construction
/building is
complete

Operation
and
Maintenance
phase starts

If PPP,
Contract ends

All rights are
returned to the
government.

Project Timeline

Contracts, Obligations Decision Rights

Traditional Contracts:

- No Bundling

- Most engineering decisions are taking by Govt

- Construction Cost risk (mostly) borne by the contractor

- Contractor does not bear any Operation and Maintenance (O/M) cost and related risk

PPP:

- Bundling and Greater Delegation

- Most engineering decisions are taking by Contractor

- Entire Construction cost and O/M cost Risks borne by contractor

- Contractor may bear revenue related risks

    - Toll - commercial risk assigned to contractor
    - Annuity - retained by the government

PPPs Contracts and Risk Allocations

Figure 1. Different Levels of Private Sector Engagement in PPP Contracts

	Identify Infrastructure Need	Propose Solution	Project Design	Project Financing	Construction	Operation/ Maintenance	Ownership
Bid/Build	Public Sector				Private Sector	Public Sector	
Design/Build	Public Sector		Private Sector	Public Sector	Private Sector	Public Sector	
Design/Build/Finance	Public Sector		Private Sector			Public Sector	
Design/Build/Finance/ Operate/Maintain	Public Sector		Private Sector				Public Sector

Source: Brookings analysis and expert interviews

PPPs: Incomplete Contracts

Infrastructure Assets:

- Have output features
    - Number of traffic lanes, design of the road, over and under-passes
    - Engineering Designs
- Quality of the assets during Operational phase
    - quality of construction, quality and mix of inputs used, etc.

Problem:

- Output features are observable/verifiable/contractible
- But, Quality is not observable/verifiable
    - quality shows up after several years of construction,
    - corruption can make the quality 'non-verifiable'

Efforts, Cost and Quality

Cost reducing activities by contractor during Construction Phase:

- x denotes Observable cost reducing efforts
- y denotes Non-observable cost reducing but quality-reducing activities.

Let

- q denote quality of road during O/M phase
- effort y is quality-shading but x is not

$$q_y(.) < 0 \quad q_x(.) = 0$$

C^a denotes the **Actual Construction** costs, known at the end of Construction phase

$$C^a(x, y) = c_0^a - c_1(x) - c_2(y),$$

The First Best I

Let,

- M denote the operation and maintenance (repair) costs of the project, and

- B denote the Social Benefit from the road.

- M is incurred during the $O\&M$ phase, during dates $t = 2$ and $t = 3$.

- Similarly, B accrues in the $O\&M$ phase.

$$\frac{dB(y)}{dy} < 0 \ \& \ \frac{dM(y)}{dy} > 0.$$

Now, the net social benefit can be written as:

$$B(y) - M(y) - [c_0^a - c_1(x) - c_2(y)] - [x + y].$$

The First Best II

Therefore, the social optimization problem is:

$$\max_{x,y}\{B(y) - M(y) - c_0^a + c_1(x) + c_2(y) - x - y\} \quad (0.1)$$

Assume optimization problems are concave. The first order conditions are:

$$\frac{dc_1(x)}{dx} \leq 1 \quad (0.2)$$

$$\frac{dB(y)}{dy} + \frac{dc_2(y)}{dy} - \frac{dM(y)}{dy} \leq 1 \quad (0.3)$$

Let x^*, y^* solve these equations, respectively and simultaneously. We assume

$$x^* > 0 \;\; \text{However,} y^* = 0, i.e.,$$

the gains from quality reducing effort y are more than offset by the social costs in terms of increased maintenance costs and reduced benefits.

- Let q^* denote the socially optimum level of quality, i.e.,

$$q^* = q(y^*).$$

- $c_1(.)$, $c_2(.)$, $q(.)$, $M(.)$ and $B(.)$ are all non-contractible.

Traditional Contracts

- There is no bundling
- Contractor does not care about Maintenance costs
- Contractor focuses only on minimizing construction costs

Under TC, the contractor solves

$$\max_{x,y} \left\{ P^{TC} - [C_0^a - \alpha^{TC} c_1(x) - c_2(y) + x + y] \right\}, i.e.,$$

$$\min_{x,y} \left\{ \alpha^{TC} c_1(x) + c_2(y) - x - y] \right\}, i.e.,$$

$\alpha^{TC} < 1$

$$\left\{ \begin{array}{ll} x^{TC}(\alpha^{TC}) < x^* & . \\ y^{TC} > y^* = 0 & . \end{array} \right. \tag{0.4}$$

PPP: Contracts

- There is bundling
- Contractor cares about Maintenance costs
- Contractor focus on construction as well as Maintenance costs
- P^{PP} can be fixed or $P^{PP} = \gamma B(y)$

Under PPP, the contractor solves

$$\max_{x,y}\{P^{PP} - [M(y) + C_0^a - \alpha^{PP}c_1(x) - c_2(y) + x + y]$$

When P^{PP} does not depend on y,

$$\min_{x,y}\{M(y) + \alpha^{PP}c_1(x) + c_2(y) - x - y]$$

$$\alpha^{TP} < \alpha^{PP} \Rightarrow x^{TC} < x^{PP}$$
$$0 \leq y^{PP} < y^{TC}$$

Quality and Construction Costs

Proposition

Quality $q^{PP} > q^{TC}$

The Construction Cost Ratio:

$$CO = \frac{C^a}{C^e}$$

where C^a is the actual construction cost and C^e is the expected construction cost of the project.

Proposition

For any given project cost estimates, C^e:

$$x^{TC} = x^{PP} \Rightarrow [(\frac{C^a}{C^e})^{PP} > (\frac{C^a}{C^e})^{TC}$$

However, $x^{TC} < x^{PP}$ and $y^{TC} > y^{PP}$. Therefore, $(\frac{C^a}{C^e})^{PPP} >$ or $\leq (\frac{C^a}{C^e})^{TC}$ is possible

Bidding and Contract Choice

Let

- The government gets estimates of costs and revenue from toll
- Bids are invited with these estimates
- A project becomes PPP it investors find it commercially attractive.

Bid=Asking Price

- For non-PPP, it is the price asked for construction works
- For non-toll-PPP, it is the asked price for construction and maintenance tasks
- For toll-PPP, it is the asked price for construction and maintenance tasks **over and above toll receipts**

Note

- For toll-PPP, bid can be **positive or negative**
- Toll rates are uniform across the country
- No provision for contract renegotiation if cost are high