



## (Un)bundling infrastructure procurement: Evidence from water supply and sewage projects

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### ABSTRACT

Public infrastructure has long been faced with difficulty in financing. Available public resources are often limited in many countries. Competitive bidding in public procurement systems is an important instrument to contain the public investment costs. But competition is often limited in the infrastructure sector. In such circumstances, better public procurement design can save a lot of public resources. There is a general tradeoff between the competition effect and economies of scale and scope; large contracts can benefit from the scale and scope effects but have to compromise competition. The unbundling approach can foster competition but may suffer from diseconomies of scale and scope. Using procurement data from water supply and sewage projects in developing countries, the paper analyzes the effects of the (un) bundling strategy on bidders' entry and bidding behavior. It shows that the bidder cost structure exhibits significant diseconomies of scope between two main public works in this sector, i.e., treatment plant construction and distribution network installation. There is no clear evidence of the competition effect. Therefore, there is no rationale of bundling these two works into a single contract. Unbundling can help governments to contain public infrastructure costs.

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### 1. Introduction

Public infrastructure has long faced difficulty financing in many countries, in particular in the developing world. About 884 million people are estimated to live without safe water, 2.6 billion people without sanitation (WHO and UNICEF, 2010). How to use the limited public resources wisely remains an important challenge for governments or public entities, especially under the fiscal pressure. The current paper examines the effects of public procurement design on infrastructure projects. It focuses on a particular procurement case with data collected from public procurement of water supply and sewage facilities. In principle, the current procurement systems largely rely on competitive bidding for the efficiency. But there is a tradeoff between economies of scope and the competition effect. Few studies have cast light on this. The current procurement practices seem to keep following the past

experiences with little evidence. This paper shows that the bundling (or turnkey) procurement observed in some cases may not be optimal because of its scope diseconomies. Better procurement planning could deliver a less costly outcome.

Competitive bidding is certainly one of the important policy instruments to contain public procurement costs and reduce the risks of collusive bidding behavior and corrupt practices. However, competition may not be the only factor that determines the efficiency in public financing, particularly for infrastructure projects. Public infrastructure works are normally significant in size and exhibit economies of scale and scope in procurement. Therefore, how to design procurement packages would likely affect the bidder's costs and entry strategy. In fact, competition has long been limited in public infrastructure procurement. In the U.S. highway construction auctions in Florida, the average number of bidders is about five, though with a wide range from 2 to 19 per auction (Gupta, 2002). In the case of Oklahoma road construction, the average number of bidding firms is only 3.3 (De Silva et al., 2003). In developing countries, large-scale infrastructure projects attracted about six bidders on average (Iimi, 2006; Estache and Iimi, 2008).

The current paper relies on data from public water supply and sewage projects in developing countries. In this sector, active, potential market players have been particularly limited. Foster (2005) points out that there are less than five multinational water

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enterprises that dominate the global market of water public–private partnership (PPP).<sup>3</sup> Even in the traditional public procurement context, the degree of competition is generally low (Estache and Iimi, 2008). This is not only because infrastructure projects are technically complex and highly customized but also because of possible design flaws in procurement systems. There is room to improve efficiency by designing procurement packages differently.

There is an important tradeoff between the size of contracts and the intensity of competition. On one hand, not many firms can apply for a highly complex and consolidated public work, because of financial, experiential and technical constraints. Of course, bidding requirements are important to secure the quality of large-scale public works. But large packages may severely limit the bidder participation. On the other hand, infrastructure projects normally exhibit significant economies of scale and scope in procurement. Therefore, substantial public resources could be saved by consolidating several small public contracts into a larger package. This would result in relatively low unit costs. Procurers can also minimize the administrative costs of tendering and supervising by reducing the number of contracts. By contrast, small contracts could contribute to fostering the market competition but will have to sacrifice potential economies of scale and scope.

In theory, whether to bundle or unbundle a set of relevant objects is an important choice for procurers or auctioneers. As per Palfrey (1983), if there are only two bidders for an arbitrary number of objects, the auctioneer should bundle all the objects to facilitate their competition against one another. Conversely, given a relatively large number of bidders, the auctioneer has a tendency to prefer to unbundle its objects. Chakraborty (2006) also shows that if the costs for entry are sufficiently large, separate competitive biddings become more preferable for the auctioneer, as the entry costs increase. Moreover, if the auctioneer can choose the level of entry costs at the optimal level, separate competitive biddings are always superior to a bundled one, regardless of the entry costs.<sup>4</sup>

In practice, whether the (un)bundling promotes or hinders competition is dependent on the market structure and firms' underlying costs. In the infrastructure sector, there is a wide range of public works that are closely related and can be integrated. Some companies may be able to undertake several different tasks simultaneously, even though they could potentially be contracted out separately. Other firms may specialize in certain areas of works. If potential bidders are highly heterogeneous, the unbundling strategy may be better, because it would encourage relatively small but specialized firms to participate in competitive bidding. One can expect the strong competition effect (Grimm et al., 2006). Governments may also prefer this strategy for political reasons, because it can promote local procurement and employment. But the potential scale and scope effects have to be discarded. The literature indicates that political interventions in public procurement often turn out particularly costly (e.g., Hyytinen et al., 2006; Marion, 2007).

Under the bundling approach, potential economies of scale and scope are supposed to be internalized in the bidders' bid strategy. If two tasks are complementary, the equilibrium bid on a bundled

contract would be more competitive than those on separated contracts. In Africa, for instance, the median costs of road construction and rehabilitation involving more than 50 km of road are 15–25 percent lower than smaller road contracts (Africon, 2008). Similarly, the predicted construction cost of a water treatment plant with a capacity of 500,000 m<sup>3</sup> per day is about 60 U.S. dollars per m<sup>3</sup>. However, it would cost 200 U.S. dollars per m<sup>3</sup> if the procured capacity is only 100,000 m<sup>3</sup> per day. Thus, the decentralized procurement would cost more than three times as much (Estache and Iimi, 2008).<sup>5</sup> However, the bundling may deter potential contractors from entering the market, if contracts are too large or require too heterogeneous inputs from firms. Limited competition might add to the public procurement costs, as suggested in auction theory.

From both theoretical and empirical points of view, an important issue is the endogeneity of bidder participation. In theory, the bidder participation would be endogenous in the presence of a positive entry cost required from bidders (McAfee and McMillan, 1987; Levin and Smith, 1994; Menezes and Monteiro, 2000).<sup>6</sup> Econometrically, how to control for this endogeneity is also an important problem (e.g., Porter and Zona, 1993; Bajari et al., 2009). Presumably, potential bidders would decide whether or not to enter the market, depending on characteristics of public works to be contracted out, their own constraints and rivals' bidding strategies. In the following analysis, the endogeneity is controlled by considering a potential set of prospective bidders.

With data from official development assistance (ODA) projects in the water supply and sewage sector, the paper casts light on the impacts of procurement design on the bidder participation and costs of public infrastructure projects. Specifically, it aims at estimating economies of scope between two types of public works: treatment plant development and distribution network installation. They may require different expertise and skills, but it is still possible to contract out them together as a single package. To estimate the effects of (un)bundling these two components, we employ a conventional instrumental variable (IV) estimator with the endogeneity of bidder participation taken into account, rather than assuming the fixed-*n* approach. The zero truncated negative binomial regression is also performed to obtain the predicted number of bidders. To check for robustness, the Kwoka's (2002) composite specification for economies of scope is applied, and the two-stage quantile regression (2SQR) is also estimated.

The remaining paper is organized as follows: Section 2 provides an overview of the ODA-related infrastructure procurement market and our used data in the water and sewage sector. Section 3 develops our empirical model to estimate the equilibrium bid function with endogenous bidder participation. Section 4 presents our main empirical results and policy implications. Section 5 discusses some robustness issues of the estimation results. And Section 6 concludes.

## 2. Competition and (un)bundling in water and sewage project procurement

The market of infrastructure development is significant in developing countries. Every year the OECD Development Assistance Committee (DAC) member countries are spending more than

<sup>3</sup> According to the Private Participation in Infrastructure (PPI) database, the top 10 percent largest firms—defined by the number of transactions that each company obtained—were awarded about half of total infrastructure PPP contracts. In the water industry, especially, a multinational French water service operator, Veolia Environnement (former Vivendi Environnement, or Compagnie Générale des Eaux), was alone awarded 51 contracts, and another French company, SUEZ (former Lyonnaise des Eaux), won 50 transactions in the developing world.

<sup>4</sup> It is worth noting that these propositions cannot be overemphasized, because they hold under the circumstances with only two symmetric bidders. No general model has yet been developed with more than two players. In addition, these models may not be dynamic in the sense that the fixed-*n* setting is still presumed.

<sup>5</sup> The comparison does ignore the indivisibility of the infrastructure assets, which may determine the feasible size of procurement in reality.

<sup>6</sup> Bidders are assumed to enter until their expected profits are driven to the entry cost. At this level no more firms can expect nonnegative profits from new entry. The optimal number of bidders would be increased by reducing entry costs and raising the profit guaranteed for a bidder with the highest possible procurement cost.

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