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Bundling decisions in procurement auctions with sequential tasks☆

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ABSTRACT

This paper investigates the principal's bundling decision during a procurement auction for a project consisting of two sequential tasks, in which task externality exists and information arrives sequentially. We show that, although increasing the number of bidders in the market for the second task always tilts the principal's choice toward unbundling, increasing the number of consortiums that can perform both tasks tilts the principal's preference toward bundling if the externality is negative.

1. Introduction

For a typical project with multiple related phases, the owner's decisions about whether to contract with single or separate entities for the different phases represent a critical component of the procurement strategy. For example, recent project delivery methods have witnessed a shift away from design–bid–build (D–B–B) and toward design–build (D–B).[1] The Design-Build Institute of America (DBIA) has reported that D–B projects accounted for more than 30% of the total number of construction in the US in 2001, as compared to just 5% in 1985 (Beard et al., 2001; Tulacz, 2002). In the provision of infrastructure services also, a movement away from conventional short-term contracts has been documented.[2] PPPs are now used extensively across Europe, Canada, the US, and a number of developing countries. Estimates show that 82% of all water projects and 92% of all transport projects undertaken between 1984 and 2002 were PPPs (Oppenheimer and MacGregor, 2004). Furthermore, 30% of all services provided by the larger European Union (EU) governments are delivered through PPPs (Torres and Pina, 2001). Traditionally employed for transportation, energy, and water systems, PPPs have recently penetrated into IT services,

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[1] In D–B–B, separate entities are responsible for the design and construction of a project. However, in D–B, design and construction aspects are contracted with a single entity known as the *design-builder*.

[2] PPP is characterized by long-term contracts between a public sector authority and a private party, in which the tasks of designing, building, and operating are bundled together to form a special purpose vehicle.

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accommodation, leisure facilities, prisons, military purchase,[3] waste management, schools, and hospitals.[4]

The literature on task separation and integration tends to overlook one important dimension: competition among bidders. Competition is a very important factor that determines the principal's bundling decision. Practitioners repeatedly express concerns that public authorities deal with only a small number of large consortia, those which are able to organize bids for the large scale projects involved in PPP contracting. In fact, PPPs are often adopted in public procurement, such as procurement of infrastructure development projects, where competition is limited (Gupta, 2002; Foster, 2005; NAO, 2007). Indeed, Estache and Iimi (2009) found a significant negative relation between the use of bundling and the number of bidders. Concurrent with the move from unbundling to bundling methods in the construction industry during the late twentieth century, there has also been a merger and acquisition (M&A) wave, which indicates that there may be a negative relation between competition and the adoption of the D–B method. In the sample of construction M&A transactions in the US during 1980–2002 analyzed by Choi and Russell (2004), only 5.3% took place in the first four years (1980–1984), while 41.9% occurred during the four-year period between 1995 and 1999. By way of a specific example, while investigating the Los Angeles Unified School District's Belmont project, a D–B project with excessive cost and environmental issues, district attorney Steve Cooley concluded that one problem of the D–B process is that it does not make use of competitive bidding where the prospective builders bid on the same design.[5] As a theoretical guideline, Grimm et al. (2006) presented four main factors that may influence a procurer's bundling-versus-unbundling decision: synergies in production, number of bidders, the degree of heterogeneity of participants and aftermarket trade, and higher cost uncertainty of advanced buying. This paper aims to investigate the effect of competition on the optimal choice between the bundling and unbundling of sequential tasks, and how the effect varies with other factors such as the sign of externality along the sequence.

We begin with some common features shared by these contracting methods. First, auctioning is the primary method used for selection (see e.g., McAfee and McMillan, 1986; Laffont and Tirole, 1987). This suggests that there is information asymmetry between the project principal and its agents. In the absence of asymmetric information, the principal can always do better by selecting the most efficient contractor and using take-it-or-leave-it (TIOLI) offers, without incurring the cost of organizing an auction. Second, activities in the preceding task impact the project quality or operating cost of the succeeding task. Third, bidders can obtain further information, such as the exact size of the project, quality attributes of the infrastructure, quantity and prices of different inputs and available technology. This sequential arrival of information leads to a different information structure under task bundling and unbundling. Costings in the D–B framework are much less accurate than those in the D–B–B framework, while operators in a conventional approach have more accurate estimates of the operating costs that may be incurred with PPPs. For example, Ernzen and Schexnayder (2000) presented an analysis of a company's labor cost risk based on a case study of two similar projects. One project was a typical D–B–B job and the other was a D–B job. They found that there were consistently greater fluctuations in the labor cost in the D–B project. Oztas and Okmen (2004) found that risks, including cost risk, are generally higher in the D–B method than in the D–B–B method. The evidence above suggests that the estimate of labor cost in D–B would be less accurate. Furthermore, Iossa and Martimort (2012) compared PPP and the traditional procurement method. They argued that the mapping between the effort at the design stage and final performance is ex ante uncertain, but new information may come along during operations, thereby suggesting that bidders may hold more information after the planning stage than before it.

For the purpose of illustration, we consider a project as comprising two sequential tasks. Tasks 1 and 2 are, respectively, designing and building (as in the case of the project delivery methods debate), or building and operating (as in the scenario for PPPs). Any cost-reducing activity is non-observable and non-contractible, which typically raises the moral hazard problem. We assume that task externality exists – that is, the activity in task 1 has an impact on the operation cost of task 2. Furthermore, information regarding agents' cost type for task 2 arrives only in period 2; agents only know their cost type for task 1 during period 1.

To minimize the expected total payment to agents, the principal can choose between two regimes – the bundling or unbundling of tasks. Under the bundling regime, a single prospective consortium is selected to perform both tasks through competitive bidding for an incentive contract, as opposed to the unbundling regime, where the contractors for the two tasks are selected through two sequential auctions. In this paper, we consider the first-price, sealed-bid auction. For the sake of simplicity, we only examine linear contracts as in McAfee and McMillan (1986). The linearity assumption leads to a moral hazard problem, and the winner's effort increases with the slope of the linear contract, which we term “the power of incentives” in the paper.[6]

In procurement, some tasks can only be performed by a few firms, while other tasks could be performed by many firms. We assume that N_1 firms can perform task 1 and N_2 firms can perform task 2, with $N_1 < N_2$. For example, for the construction industry, building firms outnumber designing firms. In the bundled auction, a designer and a builder have to form a consortium before participating in the auction. As a result, the number of consortiums is equal to N_1. We define N_2 as the competitiveness in the market for task 2 and N_1 as the competitiveness in the market of joint-tasks.

There are two crucial differences that determine the relative advantage and disadvantage of the two procurement regimes in our model. The first is the externality internalization. In the auction organized in period 1, agents have private information on the cost of task 1 under both regimes. Hence, the winner earns information rent, which increases with the share of the cost of task 1 borne by that firm. Consequently, there is a trade-off between providing incentives and reducing the winner's information rent in the auctions. In the presence of positive task externality, a higher cost-reduction effort in task 1 leads to a lower operation cost for task 2. Hence, bundling serves as a device for internalizing task externality and mitigating the agency problem of task 1. For negative externality, the agent is more reluctant to exert cost-control measures due to internalization in period 1; this aggravates the agency problem. Consequently, whether externality internalization biases the principal's choice toward bundling or unbundling depends on whether the externality is positive or negative.

The second difference between the two regimes is the presence of sequential information. The assumption that agents can only observe their cost related to task 2 in period 2 has two effects. First, unlike in unbundling, in which the most efficient agent for task 2 is chosen, the consortium chosen in the bundled auction is only associated with the average cost of performing task 2, an efficiency loss with bundling for period 2. Second, unlike in bundling, agents have private information; therefore, information rent should be given to the winner while auctioning task 2 in the unbundled regime. As competition in task 2 increases, the efficiency loss of bundling increases and the information

[3] For example, Lyon (2000, 2006) conducted an empirical analysis on procurement for tactical missiles in American defense policy and compared the pricing of competition and bundling. See Grimm et al. (2006), “Division into lots and competition in procurement”, Chapter 7, *Handbook of Procurement*, edited by Dimitri et al.

[4] See Iossa and Martimort (2013) for more detailed examples of PPP.

[5] http://da.lacounty.gov/pdf/BLC_Final_Report.pdf, “Los Angeles DA, Steve Cooley final Investigate report on Belmont”.

[6] If we consider optimal contracting as in Laffont and Tirole (1987), then the model belongs to the category of “false moral hazard models”, since the possibility to contract on overall costs makes effort de facto contractible.