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Does complexity and prior interactions affect project procurement? Evidence from mining mega-projects

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Abstract

We investigated mining mega-projects to analyze the effect of project complexity on (1) the "make vs. ally" choice for the implementation stage of a project and the "fixed-price vs. cost-plus" contractual choice when an "ally" was chosen; and (2) the extent to which prior interactions with a contractor at earlier stages of the same project impact the "fixed-price vs. cost-plus" decision. Contrary to expectations, we found that project complexity promoted allying with external contractors but that, as expected, it promoted the use of cost-plus contracts. In addition, we found that prior interactions promoted fixed-price contracts and that this effect was more pronounced for less complex projects in which learning and knowledge acquired during prior stages was more easily transferred into contractual detail. Given that fixed prices are contractually heavier than cost-plus agreements, this result suggests that complexity strongly moderates the relationship between formal and relational contracting.
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Keywords: Complexity; Project procurement; Contracts; Make or buy; Prior interactions

1. Introduction

The supply chain and project management literature has increasingly focused its attention on the management of complex projects (Svejvig and Andersen, 2015; Ulku and Schmidt, 2011; Brinkhoff et al., 2014; Lu et al., 2015). A relevant issue in this literature is the governance of the project procurement (Pitsis et al., 2014; Olsen et al., 2005; Caniëls et al., 2012). Research in the strategic management literature has dealt with issues regarding the optimal governance of project procurement (Bajari and Tadelis, 2001; Bajari et al., 2009; Brahm and Tarziján, 2013; Castañer et al., 2014; Gil and Marion, 2013). In this paper, we draw from these two research streams to study the governance of projects delivering complex capital goods, in particular, mega-projects in the copper mining industry.

Capital goods projects have economic significance, and the governance of their design and construction is a fundamental determinant of their outcomes (Merrow, 2011; Winch, 2010). A major feature of project governance is how to address complexity. Large projects, such as those related to the delivery of buildings, airplanes, and plants, typically involve many tasks that interact to create a complex solution landscape (Simon, 1969; Caniëls et al., 2012; Peng et al., 2014). Moreover, the extended duration of these projects requires establishing and maintaining good relationships and trust among project participants to achieve project success (Winch, 2010; Brinkhoff et al., 2014; Ulku and Schmidt, 2011). In this setting, an informal contract based on relationships might complement or substitute for a formal contract (Cao and Lumineau, accepted for publication; Faems et al., 2008; Jayaraman et al., 2013; Poppo and Zenger, 2002; Schepker et al., 2013), and project complexity might serve as a key moderator of this relationship, just as it moderates project organization and outcome (e.g., Peng et al., 2014; Choo, 2014).

To further understand the interplay between project governance, complexity, and relationships, in this paper, we investigate the governance choices made by mining companies for 86 mega-projects in Latin America. Mining mega-projects include

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both a development and an implementation stage. In the development stage, the broad design of the project is outlined to estimate project costs, and major design choices are evaluated and preliminarily decided upon. In the implementation stage, the design is fully specified, and the project is executed and completed. Typical examples of mega-projects in mining are developing and constructing new mining sites, expanding current mining sites, and building or renovating related facilities such as processing plants or power plants. We focused on two fundamental and related governance choices that must occur during the implementation stage: (1) whether to "make" by managing project delivery internally or to "ally" by appointing a specialized engineering contractor (typically through a partnering agreement); and (2) whether to choose a fixed price (FP) or a cost-plus (C+) contract when an "ally" has been selected (Berends, 2000; Turner and Simister, 2001). We examined how these choices were influenced by project complexity and by interactions between the mining company and the engineering contractor during earlier stages of the project. To our knowledge, no prior empirical studies have analyzed how project complexity and prior relationships established during the same project affect the sequence of governance decisions identified above.

Following Bajari and Tadelis (2001), Tadelis (2002), Williamson (1985), and Nickerson and Zenger (2004), we hypothesized that project complexity, which was operationalized as the degree of interdependence between the project being implemented and current company mining sites, would be positively related to the choice of "internal governance" and to the choice of C+ contracts if an "ally" was chosen. Complex projects require more adaptation, coordination, and knowledge sharing, which would be optimally managed by an internal hierarchy. Moreover, complexity is expected to increase the likelihood of choosing a C+ contract that transferred most contractual risks to the mining company.

We also study how prior interactions affect the contractual choice of C+ vs. FP. In contrast to earlier studies, which typically operationalized prior interactions as interactions during other projects, we operationalized prior interactions as the presence of the contractor during an earlier stage of the same project. This measure more accurately evaluates the extent to which the parties improved contractibility through learning, which promotes the use of FP contracts (e.g., Vanneste and Puranam, 2010). Moreover, by examining the extent to which project complexity moderates the effect of prior interactions on the choice of FP and C+ contracts, the study also sheds light on the issue of the extent to which formal and informal contracts are substitutes or complementary, rather than seeking to find a unique relationship (Gulati and Nickerson, 2008; Lafontaine and Slade, 2013; Schepker et al., 2013).

This article is organized as follows: in the next section, we present the literature review and study hypotheses. We describe the context of the empirical research in the third section, and present the study data and variables in the fourth section. We present the empirical analysis and results in the fifth section, and finally, we discuss the study results and present our conclusions.

2. Literature review and hypotheses

A firm executing a project and choosing the governance structure for managing the implementation phase (i.e., the project's final design and construction) must decide whether to manage the implementation phase internally with its own project management unit or invite an external firm to serve this role. When an external firm is chosen, the firm must then decide whether to use a fixed price contract or a cost-plus contract.

2.1. Complexity and governance choices

Complexity has been considered to be an important driver of the "make or buy" and "FP or C+" choices. Simon (1969) defined complexity as the number of components that interact intensively within a system (pp. 183–184). In complex systems, the interactions between the different components or subsystems are typically non-trivial. In the literature on organizational boundaries, Baldwin (2008) and Zhou (2011) have adopted this view of complexity. Based on this definition of complexity, Nickerson and Zenger (2004) developed a theory of comparative governance and argued that the market does not optimally handle the search for solutions and the acquisition of problem-solving knowledge when elements exhibit extensive interdependencies because learning and knowledge sharing become difficult and hazardous. Instead, complex problems are more appropriately solved within a hierarchical organization by using an authority mechanism for moderately complex problems (Conner and Prahalad, 1996; Demsetz, 1988), and consensus and extensive knowledge sharing for highly complex problems (Grant, 1996; Kogut and Zander, 1996).

Based on transaction cost economics (Williamson, 1985), Bajari and Tadelis (2001), and Tadelis (2002) developed a theory of procurement contracts in construction projects, which uses the number of required project design choices as a measure of complexity. Although the number of design choices does not always increase interdependency, the theory proposed by Bajari and Tadelis (2001) readily incorporates interactions between design choices, which is consistent with Nickerson and Zenger's theory.

Tadelis (2002) argues that higher complexity is positively associated with contract incompleteness and thus with an increased number of unexpected project changes. Hierarchical governance is better able to manage unexpected changes because hierarchies economize on the ex post haggling and renegotiation costs these changes produce. In contrast, market governance is preferred when project complexity is low and ex post changes are infrequent because high-powered incentives are obtained at the expense of higher and less frequent haggling costs. Some empirical studies have found a positive relationship between complexity and the "make" choice (e.g., Brahm and Tarziján, 2012; Macher, 2006; Macher and Boerner, 2012; Masten, 1984; Levin and Tadelis, 2010; Monteverde and Teece, 1982; Novak and Eppinger, 2001).

Complexity might affect not only the "make or buy" choice but also the choice between C+ and FP contracts when the firm

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