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Valuation of innovation projects with high uncertainty: Reasons behind the search for real options

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ABSTRACT

Real Options (RO) has been indicated to valuate projects with high uncertainty. However, literature points to challenges and asks for an organizational understanding of its use. So: Why do managers search for the RO approach to valuate radical innovation projects? Based on five in-depth case studies, we discuss hidden organizational and managerial issues related to the search for RO to valuate radical innovation. We argue that managers search for RO to cope with the "paradox of organizational fit", and later, to deal with the "newness prison", employing RO Structuring and RO Integration to allow exposure to radical innovation.

1. Introduction

A critical challenge for firms is to define a proper approach to evaluate radical innovation (RI) projects, characterized by high uncertainty. Decades of scholarship have shown that inadequate managerial approaches are able to extinguish radical initiatives (e.g., Christensen et al., 2008), leading to incrementalism in the portfolios (Cooper, 2013). Indeed, the financial *valuation* of RI is a complex task (Paulson et al., 2007). While incremental innovation relies on historical data related to well-known technologies and the market, radical innovation deals with uncertainties from different sources (Rice et al., 2008), including "unknowns-unknowns" (Meyer et al., 2002) and a lack of, or poor, data.

A number of studies have indicated that traditional financial tools, such as Net Present Value (NPV), Return of Investments (ROI) and the like, are not suitable to valuate RI projects, since they are not capable of dealing with the lack of past data, uncertainty, the investment reversibility in innovation. Additionally, they do not take into account managerial flexibility – the possibility of changing the project path during its execution (Huchzermeier and Loch, 2001; Santiago and Vakili, 2005; O'Connor et al., 2008; Kester et al., 2009; Goffin and Mitchell, 2010; Wang et al., 2015). Some authors consider Real Options (RO) as a more suitable approach to the context of RI (e.g., Huchzermeier and Loch, 2001; Santiago and Vakili, 2005). RO would support the technical valuation of radical

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projects, making them easier to justify and manage and would also quantify managerial flexibility, allowing these projects to appear financially more attractive (Perlitz et al., 1999; McGrath and Nerkar, 2004).

Even though there has been a technical development of RO methods, there is still an ongoing concern expressed in innovation literature (Huchzermeier and Loch, 2001; Santiago and Bifano, 2005; Wang et al., 2015): that firms struggle to implement RO effectively (Reuer and Tong, 2007). Studies have found important challenges and barriers to RO: its intrinsic mathematical complexity, the non-intuitive results it produces, the lack of awareness of its mechanisms by most of the decision-makers, and the difficulties that still exist in modeling really disruptive projects, containing "unknowns-unknowns" (e.g., Fredberg, 2007). Nevertheless, some scholars have indicated that firms continue to search for RO in order to valuate innovation projects (Wang et al., 2015). This leads us to the following research question: *Why do managers search for RO to valuate radical innovation projects?*

Indeed, there is a lack of empirical and theoretical development regarding the organizational – broadly speaking – side of the search for the RO approach (Barnett, 2005; Coff and Laverty, 2007; Tong and Reuer, 2007; Barnett, 2008). To shed light on this search is critical to theory and practice. Uncovering these organizational aspects might illuminate the hidden reasons why managers search for RO to valuate RI and, therefore, increase the understanding of the dilemmas and bottlenecks of RI management. Such awareness is fundamental for a more comprehensive development of a theory of RI management. The investigation of the hidden issues behind the search for RO in the context of radical innovation advances the academic knowledge in several ways. For instance, it adds to the understanding of the organizational aspects influencing the implementation and use of the RO valuation approach. Additionally, it frames the role of legitimacy in introducing "management innovations" (Birkinshaw et al., 2008), since RO is an attempt to manage RI within a firm's current legitimated organizational and managerial system. This key point is often neglected by RO literature, which tends to be focused on the technical, and less on the legitimation, side of managers' decisions. Moreover, it extends the scholarly elaboration on the challenges of performing RI continuously, considering the difficulties in managing radical and incremental projects in the same portfolio (Chao and Kavadias, 2008; O'Connor et al., 2008; Kelley et al., 2011).

To address these questions, we draw on the literature concerned with the valuation of projects with high uncertainty and on the literature of RI management, notably those dedicated to organizational aspects. Based on this body of knowledge, we build a conceptual framework, which compiles the main aspects related to RO in innovation management and carry out five rich, longitudinal, inductive, in-depth case studies in firms searching for the RO approach to valuate RI projects.

Based on the interaction between the conceptual framework and the empirical data, we contribute to theory in several ways. First, we identified that managers search for RO to deal with the "paradox of organizational fit". We found that this paradox emerges when: i. Firms start to perform radical innovations, ii. Managers are assigned to fulfill a portfolio of radical innovations, iii. Managers consider that their firm's board would consider decisions more legitimate if current systems are used, iii. But, as current systems are not adequate to RI, managers lose legitimacy when facing failures and setbacks common to RI. Second, after deciding to use RO, managers face another challenge we call the "newness prison": when they decide to perform something new by using a new way, they also lose legitimacy. Third, we found that managers search for ways to structure the decisions required for a project, using RO trees – we term this RO Structuring. Fourth, managers look for a communication and a mindset bridge across different levels: project, portfolio, and strategy – we term this RO Integration. Based on these findings, we developed illustrative propositions and a research agenda.

Our work has the following structure: Section 2 focuses on the theoretical background to support the field study; Section 3 describes the methodological design of the research; Section 4 presents the results and the evidences from the case studies; Section 5 discusses the main findings, their relationships with the literature and with the research question; Section 6 provides the conclusion and final considerations.

2. Theoretical background

We draw on the relevant literature to support the empirical study. First, we discuss the important literature to interface innovation management and valuation, focusing on organizational and managerial aspects. Second, we discuss RO and its application in innovation management. Finally, we present a conceptual framework to guide our fieldwork.

2.1. Project valuation and the innovation management system

The development of a radically new product, process or technology innovation is surrounded by uncertainties from different sources – technical, organizational, market, and resources (Rice et al., 2008), carrying "unknowns-unknowns" that increase project complexity and ambiguity (De Meyer et al., 2002; Pich et al., 2002; Sommer et al., 2009). This creates challenges for project valuation, and it may become inviable to use the traditional financial tools (NPV, ROI, IRR) as the data is unreliable (Schneider et al., 2007). However, project valuation is a critical task for innovation portfolio management (Cooper et al., 1999), because it relates to the judgment of the viability of a single project – the "valuation problem" (Goffin and Mitchell, 2010), and to the relative viability, where resources need to be divided between projects in the portfolio.

The incapacity of traditional financial methods to work in cases of data unpredictability is one of the reasons pointed to by the literature for making them non-adherent for innovation projects (McGrath and Nerkar, 2004). It is not possible to have market data for a radically new product that creates a new market. When the product is completely new, that is, when it does not substitute an existing one, it is virtually impossible to have an accurate market evaluation (O'Connor et al., 2008). When the project relies on a radically new technology, or on a new integration of different technologies, it is very difficult to predict future production costs (Salerno et al., 2015). Therefore, the use of financial metrics, as the main metrics in managing RI portfolios has received criticism