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Technological joint venture formation under the real options approach

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ABSTRACT

Technological joint ventures, as powerful mechanisms to attain innovation, have become commonplace. Firms form TJVs in an effort to access future technological opportunities without losing flexibility in uncertain contexts. The real options approach allows the essence of such managerial thinking to be captured, although research in this line remains scarce. Drawing on the real options approach and using an eight-year panel of 4050 Spanish manufacturing firms, we examine under which conditions firms form technological joint ventures. We find that a firm's propensity to form technological joint ventures is positively related to its absorptive capacity and to the degree of environmental technological uncertainty, and negatively related to the risk of pre-emption by rivals and the existence of opportunity costs. Our study contributes to bridging the gap between finance theory and strategic analysis. In addition, it shows practitioners the applicability of the real options approach for decision-making. Results suggest that public policies should particularly, although not exclusively, foster participation of young and small firms in technological joint ventures. We also suggest using managerial perceptions as a guide for channeling public grants.

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1. Introduction

Technological interfirm collaboration is an increasingly important phenomenon. Over 60% of innovative European firms resort to technological collaboration with other firms or institutions (such as universities or research centers),[1] a trend which does not seem to be confined to Europe (e.g. Link and Scott, 2005). This is basically due to the critical role technological innovation plays in firms' survival, together with the subsequent need to develop interorganizational links (Powell, 1998).

Within the area of research into technological collaboration, much attention has been devoted to the formation of technological joint ventures[2] (henceforth, TJVs), given their relevance and complexity (e.g. Garcia-Canal et al., 2008; Hagedoorn et al., 2000; Link et al., 2002; Link and Scott, 2005; Marín and Siotis, 2008; Oxley and Sampson, 2004). However, significant opportunities for further study of TJVs remain in both empirical and conceptual terms.

Empirical research into TJV formation has usually been hampered by the lack of microdata on key factors such as differences in absorptive capacity across firms (Marín and Siotis, 2008). Thus, further econometric analysis of the phenomenon using relevant microdata is soundly warranted.

Moreover, although they provide useful insights, the dominant theoretical frameworks in the field (i.e. transaction costs economics and the resource-based view) adopt a static approach and fail to explicitly recognize the managerial perception of TJVs as investment platforms in uncertain contexts. From the standpoint of transaction cost economics, TJVs are high-commitment governance structures formed in the face of opportunism hazards associated to technology transfer and development (e.g. Garcia-Canal et al., 2008). From the resource-based view, TJVs are formed in an attempt to seek innovation-based advantages from the synergies which are likely to emerge as partners' complementary technological resources are allowed to interact closely (e.g. Oxley and Sampson, 2004).

By contrast, the real options approach (henceforth, ROA) highlights the value of TJVs as flexible sequential investment strategies in uncertain contexts (Chi and McGuire, 1996). According to the ROA, TJVs are analogous to financial call options in the sense that they provide their partners the right (not the obligation) to internalize the technology involved in the alliance (underlying asset) at a specific price (exercise price) at or before a specific date (expira-

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[1] Source: *Fourth Community Innovation Survey*, http://epp.eurostat.ec.europa.eu. Data for firms active in innovation in the EU27 area, Iceland and Norway in the 2002–2004 period.

[2] TJVs are formalized long-term agreements (involving the creation of a new jointly-owned firm) between two or more organizations, which usually engage in interdependent value chain activities, such as R&D, to transfer existing technological capabilities from one partner to another and/or to generate new ones jointly (Khanna et al., 1998; Kogut, 1988).

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tion date). As call options, TJVs enable partners to reduce downside risk, while maintaining access to upside opportunities by expanding sequentially. According to this perspective, TJVs are used in uncertain contexts as platforms to profit from future technological opportunities whilst avoiding full-scale commitment of resources, thereby maintaining flexibility.

Since the analogy between joint ventures and options to expand was first proposed (Kogut, 1991), a number of papers have enriched this stream of research, also focusing on TJVs (e.g. Folta, 1998). ROA offers a dynamic perspective which is useful for explaining all the stages of the joint venture's lifecycle (Cuypers and Martin, 2007). However, the bulk of the attention has centered on its ending stage (Chi, 2000; Kumar, 2005; Li et al., 2007; Vassolo et al., 2004).[3] Hence, the ROA-based study of TJV formation as a strategic decision taken under uncertainty remains underexplored.

The above-mentioned challenges in research provide the spur for the current work. Our specific objective is to examine under which conditions firms form TJVs. In addition to further clarify TJV formation, this study seeks to bridge the gap between finance theory and strategic analysis. Simultaneously, our analysis could be viewed as proof of the potential of ROA for real managerial decision-making. We use the basic analogy between TJVs and financial call options to derive testable hypotheses about the likelihood of a TJV being formed. The analysis is conducted using a panel of 4050 Spanish manufacturing firms from 1998 to 2005. Results indicate that the decision to form a TJV has much to do with its option-like characteristics. In particular, we find that the likelihood of a TJV being formed depends positively on absorptive capacity and technological uncertainty, and negatively on risk of pre-emption by rivals and opportunity costs.

The rest of the paper is organized as follows. First, we review relevant ROA literature and describe TJVs as real options chains. In Section 3, we focus on TJV formation, and present the model and hypotheses. Section 4 shows the methodological issues, and the main empirical findings are discussed in Section 5. Finally, Section 6 provides concluding remarks.

2. ROA and TJVs

The ROA exploits the analogy between financial options and real options to translate valuation models and insights from the option pricing theory (henceforth, OPT) to corporate investments and strategies.[4] As widely recognized in both finance and management literatures, specific investments may be conceptualized as real options, on the condition that they possess option-like properties. In this regard, a real option is "the investment in physical assets, human competence, and organizational capabilities that provide the opportunity to respond to future contingent events" (Kogut and Kulatilaka, 2001: 745). To be deemed as having these option-like properties, a specific investment should meet two conditions: it must generate future choices and must allow preferential access to future opportunities (McGrath et al., 2004; Bowman and Hurry, 1993). As a result, ROA may be a powerful tool for explaining many managerial decisions, such as R&D investments (e.g. McGrath and Nerkar, 2004), information technology investments (e.g. Kulatilaka and Venkatraman, 2001), industry entry decisions (e.g. Folta and O'Brein, 2004), technology licensing (e.g. Ziedonis, 2007), or TJVs (McGrath et al., 2004; Reuer and Tong, 2005).

TJVs represent real options in the sense that they generate future choices, allow preferential access to future opportunities, and involve sequential investment strategies (McGrath et al., 2004).[5] In his pioneering work, Kogut (1991) considers that joint ventures "are created as real options to expand in response to future technological and market developments" (Kogut, 1991: 19) and suggests that investments in joint ventures "serve as platforms for possible future development" (Kogut, 1991: 32). In line with this, Kogut and Kulatilaka (1994) establish that joint ventures, as platforms, represent opportunity investments and should therefore be recognized as options. Accordingly, several ROA inspired papers (e.g. Folta, 1998; Folta and Miller, 2002; Pape and Schmidt-Tank, 2004; Savva and Scholtes, 2005; Vassolo et al., 2004) have drawn the analogy between joint ventures and call options.

A call option conveys on the holder the right, but not the obligation, to buy an underlying asset (e.g., a stock, an index, or another derivative) at a given price (strike price) and at some point in the future (time to expiration). Similarly, a joint venture provides its partners with the opportunity, but not the obligation, to invest in the acquisition of the bundle of assets developed or gained through the collaboration process, at or before the agreement expiration[6]. In the specific case of TJVs, the underlying asset is represented by a portfolio of previously unavailable technological capabilities (underlying technology) which endow its owners (TJV partners) with the right to invest in their full acquisition.[7]

Forming a TJV allows its partners to defer full commitment to the underlying technology while preserving the growth option to profit from future technological opportunities. When a firm forms a TJV, it accesses a growth option for future technological expansion, while retaining the option to defer full commitment to this technology (Fisch, 2006; Vassolo et al., 2004). Put differently, the formation of a TJV involves the allocation of a minimal amount of resources, thereby gaining the right to decide in the future over the full development or acquisition of the underlying technology. The ROA thus enables firms to consider the trade-off between commitment and flexibility when evaluating the convenience of forming a TJV.

Delaying the decision to full commitment represents a source of flexibility for firms, which has value insofar as technology investments are irreversible and risky (Dixit and Pindyck, 1995; McDonald and Siegel, 1986). This source of flexibility derives from the incremental nature of the TJV investment process. In the words of Tong and Reuer (2007), TJVs are transitional investments by design. They enable firms to reduce downside risk while accessing upside opportunities. The firm may preserve flexibility by waiting for more information from the environment about whether it is convenient to effectively capture future opportunities by making a larger commitment or not. As long as the firm maintains the right to exercise the option (by terminating the alliance and investing on its own in acquiring the whole underlying technology), it preserves all the potential upside profits, while limiting downside losses to the initial investment. This asymmetry in potential outcomes of TJVs is particularly valuable as the level of uncertainty increases.

[3] Valuable exceptions are Chi and McGuire (1996) and Folta (1998), who analyze how the downside risk limiting feature of postponing the outright acquisition affects the decision to undertake a joint venture.

[4] For a more detailed introduction to the analysis of ROA, see Dixit and Pindyck (1994), Trigeorgis (1996), or Copeland and Antikarov (2001).

[5] McGrath et al. (2004) identify four different but interrelated ways to conceptualize real options: first, options as growth opportunities, thus, as sources of firm's value; second, options as managerial choices; third, options as specific investments with option-like properties and, finally, options as a heuristic for strategy.

[6] Note that we consider the analogy between American-type call options and joint ventures, which implies that the right can be exercised at or before the expiration date (and not only at the expiration date, as occurs with European-type call options).

[7] One particular termination form of joint ventures which has been extensively studied is the buyout of the partner stake (e.g., Chi, 2000; Chi and McGuire, 1996; Kogut, 1991; Reuer and Tong, 2005). However, this is not the only possible ending of a fruitful TJV. This paper analyses the more general case of acquiring the underlying technology, however it may be obtained.

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