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REVIEW ESSAY

What more can we learn from R&D alliances? A review and research agenda

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Abstract R&D cooperation has become a core aspect of the innovation strategy of R&D-performing organisations over the last three decades. Globalization has increased the imperative to organise these cross-border, inter-firm agreements efficiently, and this has led to a cross-fertilisation of ideas from a variety of fields, including international business, management, geography and, more recently, psychology. The aim of this paper is to review and synthesise this literature to identify new directions for research. The breadth of the academic discussion has evolved towards a general consensus on governance choice decisions, motives for collaboration, partner selection decisions and performance implications. Despite having achieved some degree of clarity on these issues, the growing complexity and international nature of these alliances requires a multidisciplinary approach, both in relation to the theories to apply, as well as in the type of data needed.

Introduction

Greater cross-border competition means that nowadays there is no firm capable of staying competitive by relying on entirely on its internal resources and capabilities (Contractor et al., 2010; Das and Teng, 2000; Suarez and García-Canal, 2003). While this need of accessing external resources is common to firms in all sectors, the need to collaborate with external agents—i.e. suppliers, customers, competitors, universities or institutions—is even more evident in technological sectors (Kedia and Mooty, 2013; Quintana García and Benavides Velasco, 2007). More must be done with limited R&D budgets, as products and services are increasingly multi-technology, and this growing breadth of competences raises the costs and the associated risks (Leiponen and Helfat, 2010). Firms are forced to innovate at a faster rate so as to maintain their competitiveness in the market and, as a result, they see technological or R&D alliances not as an option, but as a strategic need (Cassiman and Veugelers, 2006). Previous literature has shown that accessing external technological knowledge through R&D alliances may help firms to reduce time-to-market, develop innovations that otherwise could not be done internally,

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improve the quality and efficiency of the innovations developed, as well as facilitate the access to new markets (Narula, 2001). This reflects a broader phenomenon, as cooperation at all aspects of the value chain is an essential part of economic activity, as seen by the growth in global value chains (Hernández and Pedersen, 2017) and innovation networks. In addition, universities, research institutes (not to mention governments, and supra-national organisations) all seek to create greater efficiencies. R&D cooperation is a complex activity, as given its strategic role and usually tacit and firm-specific nature, is an activity that, if poorly planned and managed, has long-term consequences that can threaten firm's survival.

Despite the benefits, R&D alliances are risky (Monteiro et al., 2017). They require partners to transfer and communicate technological knowledge that is usually difficult to codify and protect, thus generating important hazards for the partners (Cantwell and Santangelo, 1999; Oxley, 1997). This means that firms have to try to maximise coordination and communication so as to fully benefit from the partner's external knowledge, while at the same time protecting their knowledge from undesired technological leakages (Grimpe and Kaiser, 2010; Martínez-Noya et al., 2013). In other words, firms face an inter-organisational learning dilemma (Larsson et al., 1998). This tension between knowledge sharing and knowledge protection may lead to other paradoxes when selecting alliance partners, such as a higher preference for familiar and nearby partners especially for more radical projects (Li et al., 2008) which may bias partner selection decisions and lead to the paradox of embeddedness (Uzzi, 1996, 1997).

For this reason, the aim of this paper is to review the literature on R&D alliances to summarise what we know and identify the main challenges for future research. We believe that, despite the vast literature analysing R&D cooperation, there are many dimensions of R&D alliances that require a better understanding. Given their strategic nature, R&D alliances provide important insights into other types of alliances as they require greater diligence and planning. Therefore, the literature on R&D alliances has consistently foreshadowed (and even predicted) our understanding of cooperation in other value-adding activities. In general, although analysed from different disciplines—such as management, international business, and innovation—, the themes of this research have been consistent around the same questions, although the degree of analysis and precision has become increasingly more sophisticated. Given the multidisciplinary nature of the research on R&D alliances, this paper tries to identify future research opportunities from the current streams of enquiry in R&D alliances that can still be framed within these questions:

- *Why* do firms engage in R&D alliances? What are the *motivations* for undertaking these partnerships?
- *What* kinds of activities are undertaken? How and why has the *scope* of activities within R&D alliances changed?
- With *whom* and *where* do firms partner? How do firms select *partners*? Does *location* matter?
- *How* do firms undertake alliances? How does *contract design* influence alliance development and performance?
- *How* do R&D alliances impact innovation and/or financial *performance*? What factors moderate this alliance-performance relationship?

Our impression from our literature review is that the most interesting research opportunities emerge from the interlinkages between these questions, and require us to take a multidisciplinary approach that encompasses both the management and international business (IB) literatures. These questions are obviously hard to clearly delineate because in designing an alliance, they are interdependent. For instance, it is important to get a better understanding on how different motivations to form these technological agreements, and how discrete governance mechanisms (such as equity versus non-equity modes), or partner selection, may affect alliance outcomes (Diestre and Rajagopalan, 2012). Alliances also involve location decisions, which shape governance and partner selection decisions as well (Narula and Santangelo, 2012). Therefore, because firms increasingly utilise a global R&D portfolio (as also illustrated by the growing interest in open innovation), understanding how to ''orquestrate'' the effective governance of these agreements is crucial (Bogers et al., 2017). Conceptually, they require a wide-ranging set of concepts from sociology, game theory, industrial organisation, economic geography and international business, to name a few. More recently attention has been drawn to contract design (Contractor and Reuer, 2014) or behavioural theories as a means to analyse how more microfoundational aspects influence R&D alliance decisions (Das and Kumar, 2011; Martínez-Noya and García-Canal, 2015). We believe that this will allow a better understanding of how managers' perceptions or cognitive frameworks shape their alliance decisions in terms of their formation and development (Weber and Mayer, 2011).

The rest of the paper is structured as follows. First, we explain what we understand by R&D alliances and review their different typologies. Secondly, we focus on reviewing the literature according to the different key five questions that have been addressed on this theme (why, what, with whom, how and performance effects), to identify future research opportunities. Finally, we present the main conclusions that can be drawn from the study and highlight the main research opportunities that we identified.

The nature and typologies of R&D alliances

It is important to begin with a definition of what we understand to be R&D alliances. For our purposes, R&D alliances are innovation-based relationships formed by two or more partners who pool their resources and coordinate their activities to reach a common goal. These are relationships in which R&D activities constitute a significant part of the collaborative effort, and represent a particular subset of cooperative agreements (Hagedoorn, 2002; Oxley, 1997). They are also referred to as cooperative R&D, technological alliances, strategic technology partnering, or technological cooperative agreements (Narula and Martinez-Noya, 2015). Indeed, the lack of uniformity in their definition across the literature reflects the multidisciplinarity of the subject.

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