



Contents lists available at ScienceDirect

## Technological Forecasting &amp; Social Change



## R&D partnerships: An exploratory approach to the role of structural variables in joint project performance

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## ARTICLE INFO

## Article history:

Received 10 October 2012

Received in revised form 8 January 2014

Accepted 21 January 2014

Available online xxxxx

## Keywords:

Density

Intensity

Structure

Joint R&D projects

Partnerships

## ABSTRACT

Traditionally the literature on partnership has focused on understanding why firms choose to cooperate and with whom, however, our understanding of the impact of the resulting network structure on the performance of the project is limited. This study builds on joint R&D projects developed in Europe in order to analyse certain structural variables – number and typology of partners, and intensity and density of interactions in the network – which may result in a greater performance of exploration and exploitation R&D projects. Findings show that these structural variables are good predictors of project performance; in particular, the joint performance function in exploration projects is positively dependent on the number of partners; however, in exploitation projects this function depends positively on the density and intensity of interactions, and negatively on the number of partners. Our results complement previous research while adding empirical evidence on the nonlinear and contingent character of structural variables and the performance of joint projects.

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### 1. Introduction

Technological collaboration for R&D development is being increasingly adopted between organisations to combine resources for common goals [1–3]. Firms join other institutions in organising networks, not only at a local but also at a national and international level, in order to develop technological projects that may positively influence competitiveness [3–7]. The effect of network structure in technological project performance has been a topic of considerable interest and study in recent years [5–8]. According to Hagedoorn et al. [3] and Pek-Hooi and Roberts [9] there are two elements which integrate the network structure of a joint R&D project: The network nodes comprising the partners that take part in the project, and the interactions

established among partners. Characterised by these two main elements, the study of network structures has been approached from two distinct points of view: The resource-based perspective where the analysis focuses on the partner whose role is to contribute and share resources in the network [10–16]; and the social capital theory, where the key variable is the interaction between partners, analysing those resources inherent in social relationships which facilitate the collective action [17–25,6].

When studying joint R&D projects, as March [26] points out, exploitation projects use existing information to improve efficiency and returns from present strategies, competencies and procedures, while exploration entails searching and experimenting to find emerging innovations which will produce future profits. Koza and Lewin [76, p. 147] subsequently argued that a partner's decision to enter in a joint project 'can be distinguished in terms of its motivation, to exploit an existing capability or to explore new opportunities'. From a structural point of view, previous studies have documented that cohesion, strong ties, and small sizes are the central characteristics of exploitation joint R&D projects [27,28,16]. On the other side,

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Gilsing et al. [29] have pointed out that the main characteristics of exploration joint R&D projects devoted to the search and exploration of technological information are their sparseness, weak ties, and large size.

Beyond the broad consensus of the importance of network structure in managerial performance [30,31], there is a debate on several issues regarding structural attributes and the mechanisms through which they impact on project performance. Thus, in the case of exploration projects, scholars suggest that the large size and weak ties of networks tend to create small groups (clustering) within the network, and that this has a negative impact on the performance of the joint project [29,6,32]. Regarding exploitation projects, other studies argue that strong cohesion in networks produces redundant information and small size increases the conflicts between partners [3].

In this paper we seek to further the debate on size and cohesion issues using survey data collected from a representative sample of joint R&D projects carried out within European Framework Programmes. Using both exploration and exploitation projects from these Programmes we address three questions: (1) Is there an optimal structure for networks in joint R&D projects for the two types of projects considered?; if this is true, (2) what typology and number of partners must be involved in exploration and exploitation joint R&D projects to maximise network performance?; and (3) what class of interactions must be established in exploration and exploitation R&D projects to maximise network performance? In this article we develop a combined methodology – structural equation modelling and artificial neural networks (ANN) – to test causal relationships and approximate the joint performance function of exploration and exploitation R&D projects.

The purpose of our study is to contribute to the extant research on project literature in two ways. First, we aim to extend our understanding of the effects and influence of structural variables on the performance of project networks. Second, we aim to contribute to project management literature by analysing the structural variables which are central in explaining efficient performance in exploitation and exploration joint R&D projects.

In the sections that follow, we present a concise overview of relevant literature on the structure of joint R&D projects in order to generate research questions. Subsequently, we present the findings obtained from the empirical analysis carried out using a sample of joint R&D projects developed in the European biotechnology industry. We conclude with a discussion of our findings, implications, limitations, and suggestions for further research.

## 2. Theoretical background

### 2.1. Joint R&D projects: objectives and structure

Joint projects are the union of two or more partners through a cooperative agreement with the purpose of sharing capabilities and resources to reach a joint objective [33,8]. The set of activities developed in the joint R&D project create multiple interactions among the partners in the dynamic process which lead to the accomplishment of project objectives. Pek-Hooi and Roberts [9] pointed out that technological processes are those processes which are distributed among all

agents involved in the network, while Scott-Young and Samson [34] indicated that an organisational structure is necessary for the development of the joint project. The objective of this structure is to infuse order in a relationship where potential conflict may arise, and where opportunities for common gain exist [35,36]. The structure, therefore, is the framework within which the R&D process is developed and the partnership is organised. This structure, generally a network structure, is made up of the nodes (the partners), and the interrelated links or ties among them [25]. In both the determination of the partners as well as in the ties, the objective is that the resulting design shall be efficient and achieve the expected joint performance [24,36,31]. Therefore, it can be argued that different combinations of partners and ties may result in different levels of performance within networks which share the same objectives.

### 2.2. Resource-based perspective: typology of partners and size of network

From the resource-based perspective, collaboration to develop a joint R&D project is a way to access technological resources or to improve competitive positioning without the need to acquire or possess them through traditional paths [11,15,16]. The strategic advantage of partnership derives from specific assets that firms dedicate to cooperation relationships, and from complementarities between their own resources and the resources of their partners. Thus, one of the main aspects of the structural design of the network, from the firm viewpoint, is the definition and search for a suitable partner profile to achieve the results sought through the cooperation. Questions such as why to cooperate and with whom, have been key variables for scholars in those analyses [3,15]. However, less attention has been paid, from the project perspective, to the definition of the project structure and its impact on project results. One view is that advanced by Dyer and Nobeoka [27] who identified two kinds of networks in the case of Toyota's suppliers. The first type was made up of a large number of partners whose objective was to explore technological information. In this case, the large number of partners increased the sources of knowledge. The second comprised a smaller number of partners whose objective was to use technological information to generate innovative products, that is, to exploit knowledge and information. Their results confirm the hypothesis that each type of project has distinctive structural characteristics. From the viewpoint of project results, Gilsing et al. [29] pointed out that the objective of exploration projects is to create technological knowledge through a constant search for new opportunities. According to these authors, the search for new opportunities implies that exploration projects normally include universities and research centres from different countries, as well as a high number of participants. Exploitation projects on the other hand, involve companies, universities or consultants with a high heterogeneity of partners, but fewer in number than in the case of research exploration projects, and seek to engage both sources of innovation (universities) as well as users (firms) [9]. In general, exploitation projects are characterised by their smaller size structure and greater diversity of partners than in exploration projects,

Efficiency in the structure, however, has not been specified in the literature in terms of number of partners and their types,

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