



# The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms

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## ARTICLE INFO

Available online 11 May 2011

### Keywords:

Open innovation  
DUI and STI innovation modes  
Scope  
Depth and orientation of openness  
Innovative performance

## ABSTRACT

It is commonly accepted nowadays that external knowledge sources are important for firms' innovative performance. However, it is still not clear, what dimensions of firms' external knowledge search strategy are crucial in determining their innovation success and whether these search strategies are contingent on different innovation modes. In this study, we analyse how the innovative performance is affected by the scope, depth, and orientation of firms' external search strategies. We apply this analysis to firms using STI (science, technology and innovation) and DUI (doing, using and interacting) innovation modes. Based on a survey among firms in China, we find that greater scope and depth of openness for both innovation modes improves innovative performance indicating that open innovation is also relevant beyond science and technology based innovation. Furthermore, we find that decreasing returns in external search strategies, suggested by Laursen and Salter (2006), are not always present and are contingent on the innovation modes. Next, we find that the type of external partners (we label it "orientation of openness") is crucial in explaining innovative performance and that firms using DUI or STI innovation modes have different sets of relevant innovation partners. This shows that the orientation of openness is an important dimension—in addition to the scope and depth of openness. As respondents are located in China, this study provides evidence that open innovation is also relevant in developing countries.

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## 1. Introduction

Technological innovation is a risky activity and only a fraction of the innovations that start as promising ideas make it to the market as successful new products and services. Increasing globalisation, shorter time-to-market windows, intensified competition, and the increased threat of a war for talent are trends that firms can only cope with if they innovate. Companies however increasingly realise that internal R&D may be prohibitively expensive and too slow to be first movers in the market. Co-operation with external technology partners has proven to be one solution (Bamford et al., 2003). Similarly, open innovation offers a new way of framing and managing external sources of innovation (Chesbrough, 2003, 2006).

Recent studies have emphasised the importance of external knowledge sources and the use of networks in the innovation

process (Cohen and Levinthal, 1990; von Hippel, 1988; Nonaka, 1994; George et al., 2002; Caloghirou et al., 2004). Firms rarely innovate alone and increasingly look to users, suppliers, universities, technology agencies, and even competitors for new ideas. Open innovation may show the advantage of free flows of new ideas, but it does not always result in positive effects. Collaborating with other organisations can lead to a leakage of key technologies and high costs for information search and knowledge integration. Furthermore, moving from closed to open innovation requires changes in corporate culture and organisational structure (Chiaroni et al., 2009). Therefore, the influence of openness on a firm's innovative performance is an interesting research field to explore but until recently only a few empirical studies have analysed this topic in detail.

In this study, we contribute to literature about the impact of firm's openness on their innovation performance in three ways. First, we extend the analysis of external search strategies. Laursen and Salter (2006) link external search strategy to innovative performance and find that searching widely and deeply is in a curvilinear way (an inverted U-shape) related to performance. However, in this study we claim that the diversity of partners and

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the intensity of the relations with external partners cannot explain innovation performance in a satisfactory way. The type of innovation partners should also be introduced into the analysis since firms rely for different kinds of innovations on specific knowledge sources and links (Todtling et al., 2009). Firms introducing more advanced innovations are relying to a higher extent on R&D and patents, and they are cooperating more often with universities and research organisations. Firms that introduce incremental, not state of the art innovations rely more on knowledge links with business services (Todtling et al., 2009). Therefore, depending on their needs different firms may have different external knowledge links and a different search strategy for accelerating internal innovation. The literature is however relatively silent about with whom firms carry out different types of innovation. In analysing the impact of openness on the innovative performance of companies we use Laursen and Salter (2006) concepts of breadth (scope) and depth as two components of the openness of a firm's external search strategies. The *scope of openness* refers to the diversity of types of partners to which the innovating firm has a connection; while the *depth of openness* reflects the intensity of co-operation with these partners. In addition to depth and scope of openness, we also explore the *orientation* of a firm's external sourcing strategy. Firms may engage in a broad or narrow search for partners, but it is also important to find the right type of innovation partners – or the right orientation – depending on the technology they are looking for.

Second, we explore the effectiveness of search strategies for firms using two different modes of innovation (Jensen et al., 2007). One mode of innovation is the *science, technology and innovation* (STI) mode which is based on the production and use of codified scientific and technological knowledge. In contrast, the *doing, using and interacting* (DUI) mode relies on informal processes of learning and experience based know-how (Jensen et al., 2007). As the two innovation modes differ considerably with respect to the sources and size of the technological opportunities and the danger of knowledge leakage, we expect that firms' search strategies for the development of these two modes of innovation will also diverge to some extent. The arguments leading to the hypotheses are based on different insights to those used in Laursen and Salter (2006) because we are primarily interested in the difference between the DUI and STI modes of innovation.

Third, our study is based on a survey of innovating companies in China. To our knowledge this is one of the first surveys about open innovation in developing countries. We test the hypotheses using a survey of external search strategies used by a sample of 209 Chinese firms that have a national or regional R&D centre in China's Zhejiang province. The survey explores the interactions of firms with exterior sources of knowledge during innovation processes.

In the empirical part of the paper, we test the relationship between the scope, depth, and orientation of openness and the innovative performance of firms using STI and DUI innovation modes. We find that openness in a firm's innovation activities improves innovative performance, although the influence differs for both innovation modes. More specifically, and in contrast with Laursen and Salter (2006), we find only decreasing returns with respect to the scope of openness for firms using the STI-mode. We find that the scope of openness has a linear effect on innovative performance for firms using the DUI-mode and the depth of openness has a linear effect on firm's innovative performance for both innovation modes. The results of the empirical analysis furthermore show that choosing the right type of partner is as important as the scope and depth of the external search strategy. This is in line with prior research about technological alliances

and the orientation of an innovating firm when choosing the right type of partners is crucial to explain its innovative performance (Rothaermel, 2001; Rothaermel and Deeds, 2004; Faems et al., 2005).

In sum, this paper examines the influence of scope, depth, and orientation of openness on innovative performance when applied to the STI and DUI modes of innovation. By focusing on the differences between DUI and STI modes of innovation, we show how the seminal work of Laursen and Salter (2006) must be adapted to these two ways in which companies innovate. In addition, we find empirical evidence that the scope and depth of a firm's external search only offers a partial explanation for the benefits of open innovation; the orientation of openness is a crucial variable in explaining the success of open innovation. We find evidence that the STI and DUI innovation modes require different types of partners to develop commercially successful innovations. A successful orientation for STI-mode of innovation will not lead to success for DUI-mode of innovation and vice versa.

The paper is structured as follows: the following section develops a number of hypotheses based on a brief review of the role of the various external partner types and two modes of innovation. Section 3 analyses the survey data and variables, and Section 4 discusses the empirical results. In the final section we draw conclusions and focus on some managerial implications and policy recommendations.

## 2. Theory and hypotheses

Open innovation 'is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation respectively' (Chesbrough et al., 2006, p. 2). Compared to the traditional and closed innovation model, innovative firms are committed to open innovation that makes full use of external innovation resources, including technological and market-related resources. Moreover, internally developed ideas and technologies can be taken to the market through licensing and spin-offs if the business model of the new venture cannot be aligned with a firm's current business model.

### 2.1. The role of various innovation sources of open innovation

Open innovation is fuelled by different innovation sources. The management literature provides helpful insights to help pinpoint the contributions of both internal and external sources in determining the innovative performance of companies. We first describe some of these internal sources, and then describe the contribution of external sources of innovation.

Human capital is the first internal source of innovation. Traditionally, innovative performance has been related to the human capital found in R&D departments. However, the importance of knowledge originating from a firm's internal units outside the R&D lab, such as marketing and manufacturing is well understood (Tucker, 2002; Dundon, 2002). Several scholars maintain that innovation should be the responsibility of all employees, and not the task of a few specialists in the R&D department. Salesman, front-line employees, R&D personnel, managers, and service personnel can all be excellent innovators (Tucker, 2002; Shapiro, 2002; Christiansen, 2000; Dundon, 2002). Managers should try to embed innovation into each part of the organisation and make all employees feel responsible for producing new ideas. The GE 'Work-Out' creates an open collaborative workplace where everyone's opinion is welcome, and each employee is a participant in the innovation process (Ulrich et al., 2002). Wal-Mart considers front-line employees as its most precious

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