



# Unravelling appropriability mechanisms and openness depth effects on firm performance across stages in the innovation process



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## ARTICLE INFO

### Article history:

Received 20 July 2016

Received in revised form 14 February 2017

Accepted 9 March 2017

Available online 19 April 2017

### Keywords:

External search

Openness

Types of partners

Depth of collaboration

Appropriability mechanisms

Intellectual property protection mechanisms

Paradox of disclosure

Innovation performance

Novelty

Efficiency

Exploration

Exploitation

Innovation phases

## ABSTRACT

There is to date abundant evidence about the way openness-performance liaisons are shaped, yet parallel streams of research point towards an intricate relationship between appropriability and openness. Accordingly, while openness may reveal ample opportunities, risks of e.g. misappropriation should also be accounted for in open innovation processes, as they might affect performance. Recent research highlights the scarcity of studies investigating openness, appropriability and performance, and suggests a further need to analyze this in different stages of the innovation process. This study therefore aims to investigate the effects of three groups of intellectual property protection mechanisms (formal, semi-formal and informal) and openness (in terms of collaboration depth with eight types of partners) on two types of innovation performance (efficiency and novelty) across innovation phases. The analysis is based on a sample of 340 manufacturing firms from three European countries. Findings show that in early stages of the innovation process, efficiency is positively linked to the use of semi-formal appropriability mechanisms, such as contracts, yet negatively related to the use of formal ones, such as patents. The latter potentially illustrates the high uncertainty and increased risks of imitation or misappropriation in early innovation phases. Informal appropriability mechanisms contribute to novelty in earlier as well as later stages. Results further indicate novelty is explained by university collaboration throughout the innovation process, while competitor collaboration positively associates with novelty in later innovation stages. Vertical collaborations with supplier and customers reveal contrasting effects, which could also have implications linked to imitation risks. Furthermore, the negative effects of formal appropriability mechanisms and supplier collaboration on innovation performance in distinct stages of the innovation process might have implications for the so-called paradox of disclosure.

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## 1. Introduction

A large body of literature emphasizes in recent years the utter importance of external knowledge search and efficient knowledge recombination in order to innovate (Chesbrough and Bogers, 2014; Mina et al., 2014; Martini et al., 2015). The openness to collaborate with external actors across the innovation process does however not come without challenges: recent studies also suggest that opening up for innovation significantly increases imitation risks and that such risks are present across all stages of the innovation process (Veer et al., 2016). This might further relate to the 'fundamental paradox' described by Arrow (1962: 615), as pointed out by Laursen and Salter (2014).

Indeed, innovation management literature provides ample evidence of how external search may influence firm performance (Chiang and Hung, 2010; Laursen and Salter, 2006; Spithoven, 2013; Tsai and Wang, 2009; Un et al., 2010). However, there are still unanswered

questions regarding firms' appropriability strategies across organizational boundaries and concerning the way companies manage to innovate in external collaborations while also capturing benefits from their innovations. For instance, Zobel et al. (2017) specifically call for further research investigating the use of formal and informal appropriation mechanisms in various phases of the innovation process. Cooperation with different types of partners and appropriability strategies has also been suggested as avenue for further research by recent studies (see Veer et al., 2016). Furthermore, while the intricate and often tense relationship between openness and appropriability is studied by scholars (see e.g. Laursen and Salter, 2014; Veer et al., 2016; Zobel et al., 2017) there is to date scarce evidence about openness and appropriability in relation with performance, as pointed out by Laursen and Salter (2014).

The previously suggested imitation risks that are more acute for companies that collaborate in R&D (Veer et al., 2016) may give rise to the so-called paradox of disclosure (see Arrow, 1962; Laursen and Salter, 2014). This study thus aims to address the above-signalled gaps in research (Laursen and Salter, 2014; Zobel et al., 2017) and investigate the effects of three groups of intellectual property protection mechanisms (IPPMs), i.e. formal (patents, trademarks, designs and

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copyrights), semi-formal (contracts and trade-secrets), informal (lead times and products complexity), and openness (in terms of collaboration depth with eight types of partners) on two different types of innovation performance, i.e. efficiency and novelty, across the phases of the innovation process. Analysis draws on a sample of 340 manufacturing firms from three European countries. Findings show that in early stages of the innovation process, efficiency is positively linked to the use of contracts (non-disclosure agreements, as well as other types of contractual agreements) and trade secrets, yet negatively related to the use of formal IPPMs, such as patents. Novelty is positively associated with the use of informal IPPMs and openness towards universities and firms in other industries. During later phases involving engineering and manufacturing, the efficiency side of performance is explained by collaboration with innovation intermediaries and consulting firms, and novelty is positively associated with informal IPPMs and openness towards universities, firms in other industries and customers; novelty is further negatively linked to the collaboration with suppliers. In the commercialization phase efficiency is explained by openness to customers, while novelty is positively influenced by the collaboration with both competitors and firms in other industries. The findings have relevant theoretical and managerial implications regarding the importance and strategic use of appropriability mechanisms in various phases of the innovation process, as well as concerning the potential benefits or risks of collaboration with various types of partners across the value chain.

## 2. Theoretical background and hypotheses development

The search for new knowledge is an essential element of innovation endeavors and investing in search generates capabilities to produce, apply and mix new knowledge, which in turn increases innovation performance (Laursen and Salter, 2006). In recent years, a growing body of literature massively investigates linkages between openness and performance (Chiang and Hung, 2010; Faems et al., 2010; Kang and Kang, 2009; Laursen and Salter, 2006; Santamaria and Surroca, 2011; Spithoven, 2013; Tsai and Wang, 2009; Un et al., 2010). Many uncover the effects of openness on innovative performance of firms (see Hwang and Lee, 2010; Inauen and Schenker-Wicki, 2011; Li and Tang, 2010; Nieto and Rodriguez, 2011; Wang et al., 2012), while some focus particularly on radical innovation performance (e.g. Chang et al., 2012). Furthermore, scholars explore the interplay between internal practices and external knowledge sourcing and their effects on performance (see Berchicci et al., 2015; Cassiman and Veugelers, 2006; Cheng and Huizingh, 2014; George et al., 2001; Grimpe and Kaiser, 2010; Hung and Chiang, 2010; Martini et al., 2015; Salge et al., 2012; Svetina and Prodan, 2008; Tsai et al., 2011). Many studies remain focused on manufacturing industries (e.g. Vega-Jurado et al., 2009; Wadhwa and Kotha, 2006) but several also investigate the linkages between open innovation and performance in services (Love and Mansury, 2007; Mention and Asikainen, 2012). Further areas of interest that stem from the investigation of open innovation practices and firm performance notably include investigation of SMEs (e.g. Gronum et al., 2012; Huang and Rice, 2009; Kim and Park, 2010; Lasagni, 2012; Parida et al., 2012) and several longitudinal studies (see Tsai and Wang, 2007a, 2007b). Various types of boundaries or proximity may be linked to different external search modes. Previous literature points out that when engaging in external search and collaboration firms cross spatial (geographical), as well as organizational and technological boundaries (Knoben and Oerlemans, 2006). However, it remains unclear how firms effectively bridge multiple boundaries (represented by e.g. distinct types of partners, providing different types of technological contributions to the innovation process) and how this affects the outcomes of the external search, in terms of value creation and appropriation.

Inter-organizational knowledge flows specifically require management in order to avoid either excessive disclosure (leading to unwanted

spillovers) or extreme concealment (possibly leading to missed collaboration opportunities with valuable partners). Still, literature concerned with search for external resources widely neglects the potential misappropriation risks, as pointed out by e.g. Katila et al. (2008). Thus, in parallel with the extensive investigations of the openness–performance relationship, a related literature stream pursues the intricate liaison between openness and appropriability (see Henttonen et al., 2016; Zobel et al., 2016, 2017). It is further emphasized that in some circumstances appropriability–openness tensions may lead to a paradox, as pointed out by Laursen and Salter (2014) paraphrasing Arrow (1962). This potential paradox manifests due to the need for openness when engaging in external search for knowledge or resources on one hand, and the challenge to protect internal knowledge in order to avoid misappropriation on the other hand (also see Arrow, 1962; Laursen and Salter, 2014). Hence the tense relationship between openness and appropriability may have severe impact on the performance outcomes of external search. Even though appropriability is a widely researched topic, the interconnections between appropriability, openness and performance are seldom investigated jointly in previous studies (Laursen and Salter, 2014). The few studies that investigate openness–performance linkages and also consider an appropriability component often restrict appropriability measures to, for instance, patents (see e.g. Faems et al., 2005). One notable exception is the study by Hurmelinna-Laukkanen et al. (2012) who analyze the effects of absorptive capacity, network stability and appropriability on firm innovative performance as well as on alliance outcome. Furthermore, recent studies signal the need for further investigation of appropriability and openness in regards to performance (Laursen and Salter, 2014), as well as specific inquiry into the use of different types of IPPMs in various stages of the innovation process (Zobel et al., 2017). The present study addresses these gaps by investigating effects of three groups of IPPMs and openness (in terms of depth of collaboration with eight types of partners) on efficiency and novelty performance in three different phases of the innovation process. In the following sections hypotheses concerning the associations between the use of IPPMs, openness and performance across different innovation stages are formulated. Since previous studies do not provide very conclusive evidence regarding the effects of use of different types of IPPMs or of the openness towards distinct types of partners on performance in specific stages across the innovation process, the hypotheses included in this study make the rather raw distinction between early, i.e. idea phases, and later, i.e. engineering, as well as commercialization phases, though in the analysis a clearer distinction is made between three stages: idea, engineering and commercialization.

### 2.1. Openness depth and firm performance across stages in the innovation process

As described in the previous section there are numerous studies that investigate linkages between openness and performance. The partly mixed results from previous studies, where some show clear positive results while others show partly negative outcomes (e.g. Laursen and Salter, 2006), imply that the fallout is contingent upon several factors. The need to investigate such contingencies has also been stressed in recent studies, for instance Bogers et al. (2016) or Cassiman and Valentini (2016). One factor of interest is how the involvement of different kinds of partners affects innovation performance. When searching for external knowledge, organizations make strategic choices concerning the type of partner they could source new knowledge and technologies from (see Katila et al., 2008). This choice in turn might affect the innovation performance of the firm (Fabrizio, 2009; Savino et al., 2015). Laursen and Salter (2006) propose various search channels and, following Scott and Brown (1999) and Brown and Duguid (2000), they suggest that every search channel is an individual search arena, which consequently requires distinct norms, rules and practices in order for the search efforts to become productive. According to Ebersberger et al. (2012), “firms search among customers, clients and competitors to

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