



Domestic R&D spillovers and absorptive capacity: Some evidence for US, Europe and Japan

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ABSTRACT

Absorptive capacity is one of the most influential concepts in the management and innovation literature. First introduced by Cohen and Levinthal (1989), it is typically defined as a set of organizational routines and processes that allow firms to assimilate, transform and exploit external knowledge. An aspect that has been ignored by the literature on absorptive capacity is the nature of the knowledge being absorbed. This paper suggests that the learning strategies underpinning absorptive capacity adapt to the type of external knowledge they are more likely to get exposure to and as a result, not all the firms appear to benefit from the same type of external knowledge for the same level of absorptive capacity. To this purpose, we explore how firm-level absorptive capacity mediates the relationship between rent and pure R&D spillovers on the one hand and firm-level turnover on the other in three economic areas (Europe, Japan and US). The empirical analysis uses a dataset (sourced from the EU R&D investment scoreboards) made of 879 worldwide R&D-intensive manufacturing firms. Given the panel data structure of the sample, econometric techniques that deal with unobserved heterogeneity as well as weak exogeneity are employed. The empirical results suggest for the same level of absorptive capacity, firms in economic areas that are closer to the world technology frontier tend to benefit more from pure (knowledge) spillovers than from rent spillovers. Vice versa, firms located in areas that are not on the technology frontier appear to benefit mostly from rent spillovers that travel along the supply chain. These results suggest that absorptive capacity changes with the type of knowledge they may get exposed to.

1. Introduction

Absorptive capacity is one of the most influential concepts in the management literature. First introduced by Cohen and Levinthal (1989) and then developed by Zahra and George (2002) in the context of a firm's learning and innovation, it is now a by-word for a variety of learning strategies, routines and processes that influence the firm's ability to exploit the external knowledge necessary to build other organizational capabilities (Todorova and Durisin, 2007; Zahra and George, 2002). Over the last thirty years, substantial research effort has been devoted to the analysis of the absorptive capacity and its drivers (D'Souza and Kulkarni, 2015). Research on absorptive capacity has mostly focused on two main areas: a) the impact of absorptive capacity on firm-level performance and its ability to sustain competitive advantage (Kancs and Siliverstovs, 2016) and b) the internal factors that influence the development of the

absorptive capacity itself (see Jansen et al., 2005).

Still much remains to be explored. For instance the literature has largely ignored the role that knowledge attributes play in conditioning the firm's absorptive capacity even if their importance has been highlighted on several occasions by the literature on knowledge transfer (see Cohen and Levinthal, 1989; Mangematin and Nesta, 1999).¹ This paper aims at filling this gap by exploring the relationship among firm-level performance, absorptive capacity and types of knowledge; more specifically it suggests that firms adjust their learning strategies to fine-tune their capability to process and exploit external knowledge from the characteristics of the knowledge itself. According to this view, R&D intensive firms may develop learning strategies that allow them to process highly specialized technological knowledge sourced from firms that operate in a similar technological field while medium-tech industries may be specialized in sourcing knowledge from intermediate inputs or

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¹ Cohen and Levinthal (1989) suggested that the applicability and the complexity of the knowledge may influence the ability of a firm to absorb it. Equally, Mangematin and Nesta (1999) found more theoretical knowledge requires higher levels of absorptive capacity for the firm to be able to exploit it.

from their main competitors. If this is true, then the first group of firms will appear to benefit mostly from specialized knowledge while the opposite holds for the second group of firms. These considerations offer a straightforward way to test the hypothesis that firm-level absorptive capacity is shaped by the knowledge firms are more likely to get exposure to. Indeed, the empirical literature on R&D spillovers suggests that absorptive capacity mediates the relationship between firm-level performance and R&D spillovers. In addition, R&D spillovers differ according to the types of knowledge they carry: pure (knowledge) spillovers tend to be carriers of technological knowledge contributing to innovation while rent spillovers are pecuniary externalities that travel along the supply chain (Griliches, 1979). This implies that if our hypothesis holds, then for the same level of *observed* absorptive capacity, firms located in areas (or economic environments) where pure knowledge spillovers are more important than rent spillovers may benefit more from the former type of spillovers than from the latter.

Our empirical strategy hinges on the notion that we can distinguish among different economic environments and prevailing types of knowledge flows in each area. Given the difficulty of doing so, we decide to operationalize this notion by focusing on economic areas that differ in their position with respect to the world technology frontier (Griffith et al., 2003, 2004). The assumption is that the distance from the frontier may capture different characteristics of the knowledge flows in an area. For instance, economic areas (or countries) that are closer to the frontier are characterized by sophisticated innovation ecosystems where research institutes and high-tech firms play a key role in producing the type of technological knowledge that is the building block of the pure R&D spillovers. The implication is that in this type of environment pure spillovers matter for firm-level performance more than rent spillovers.

Empirically, we study how firm-level absorptive capacity mediates the relationship between rent and pure R&D spillovers on the one hand and firm-level turnover on the other in three economic areas - Europe, Japan and US - which differ in their position with respect to the world technology frontier (Griffith et al., 2004). The analysis is conducted on a new dataset (sourced from the EU R&D investment scoreboards) made of 879 R&D-intensive manufacturing firms observed between 2002 and 2010. Empirically, we test our hypotheses by estimating a variety of augmented production functions for sub-set of firms located in each economic area covered by our dataset while controlling for the firm's absorptive capacity and for the different type of R&D spillovers.

In line with the current literature, our R&D spillovers have been computed as the amount of R&D conducted elsewhere weighted by a proxy for the intensity of knowledge flows between two firms. We use two measures of R&D spillovers. The first measure is based on the methodology suggested by Jaffe (1986) and assumes that the closer two firms are in the technological space, the more the research activity of one firm is supposed to be affected by the technological spillovers generated by the research activities of the second firm. The second measure relies on the methodology of Terleckyj (1974) who suggested that the supply chain is the main transmission mechanism of R&D spillovers. In both cases, we divide the potential stock of spillovers into two distinct components: intra-industry stock which corresponds to the sum of R&D stocks of firms belonging to the same cluster of technological activities and an inter-industry stock which is computed from the R&D conducted by firms belonging to other industries.² The results suggest that for the same level of absorptive capacity, firms in economic areas that are closer to the world technology frontier tend to benefit more from pure (knowledge) spillovers than from rent spillovers. Vice versa, firms located in areas that are not on the technology frontier appear to benefit mostly from rent spillovers. These results suggest that firms tend to

update and adapt their learning strategies so to better take advantage of the prevailing type of knowledge in the external environment.

This paper contributes to the existing literature on absorptive capacity in several ways: first, it shows that the nature of absorbed knowledge matters and that firms specialise in acquiring and processing specific types of knowledge. In general terms, we argue that the competencies needed by a firm in order to absorb external knowledge vary, depending on the nature of the knowledge consistently with what has been suggested in the field of organizational learning (see for instance Jansen et al., 2005). Second, it provides a potential explanation of why some firms appear to benefit from some types of spillovers more than from others and relates these differences to the characteristics of the absorbed knowledge. In itself, this is an interesting result as this is a gap in the literature on R&D spillovers as this has never engaged with such a research question. Finally, it provides some suggestive evidence on how the distance from the technology frontier influences firm-level absorptive capacity. There is a large literature that focuses on the distance from the technology frontier and its influence on firms' performance but very little is known about how it may potentially affect firm's internal strategies (see Griffith et al., 2004). This is one of the few papers that shows that country-level factors (like the distance from the frontier) may do exactly so in the context of the absorptive capacity.

The remainder of the paper is organized as follows. The next section briefly reviews the main literature on R&D spillovers and develops the main hypotheses. The data and empirical methodology are described in Section 3 while the results are discussed in Section 4. Finally, Section 5 offers some concluding remarks.

2. Literature review and hypothesis development

As mentioned in the Introduction, the literature on R&D externalities is rather voluminous as knowledge accumulation has been for a long time recognized as a key driver of economic growth (Jones, 2002). The starting point of this literature is that knowledge generated by the investment in R&D can be considered equivalent to a public good as non-innovating firms can only be partially stopped from appropriating some of the benefits generated by the investment in R&D. This knowledge will then benefit the recipient firm as long as it helps to strengthen its competitive advantage in line with the Resource based view of a firm that considers knowledge a key resource contributing to the creation of its competitive advantage (Teece, 1992; Grant, 1996).

This literature has identified a variety of externalities that can be generated by the investment in R&D. Griliches (1979) distinguishes between rent spillovers and pure knowledge spillovers. Rent spillovers arise when the prices of intermediate inputs purchased from other firms or countries are not fully adjusted for quality improvements resulting from the suppliers' R&D investment with the result that some of the rents are appropriated by the users of the innovation (Terleckyj, 1974; Goto and Suzuki, 1989; Verspagen, 1997; Crespi et al., 2007). By contrast, pure knowledge spillovers arise because of the imperfect appropriability of ideas: the benefits of new knowledge accrue not only to the innovator, but "spill over" to other firms, thus enriching the pool of ideas subsequent innovations are based upon. In addition, the empirical literature on R&D spillovers has identified a variety of mechanisms that allow knowledge spillovers to travel across industries, regions and even countries with some authors highlighting the importance of intra-industry R&D spillovers versus the inter-industry R&D spillovers (see Kancs and Siliverstovs, 2016).

There are many channels through which knowledge produced by the investment in R&D may leak out of a firm's boundaries. For instance, Grandstrand et al. (1992) point out that technical knowledge may leak thanks to the scanning efforts of the competitors. In addition, the literature on agglomeration economies suggests that knowledge may circulate among firms that share the same location thanks to the mobility of workers in the area (Fernandes and Ferreira, 2013; Hoetker and Agarwal, 2007). Several studies have quantified the contribution of the R&D

² Intra-industry spillovers can be also be considered as specialized or Marshall-Arrow-Romer (MAR) spillovers (Marshall, 1890; Arrow, 1962; Romer, 1986), while inter-industry spillovers can be considered as diversified or Jacob spillovers (Jacobs, 1969).

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