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Journal of Business Research 144 (2022) 975–986

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

# The dynamic contribution of innovation ecosystems to schumpeterian firms: A multi-level analysis

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ARTICLE INFO

*Keywords:*
Innovation Ecosystems
Innovation
Schumpeterian Entrepreneurship
Knowledge Spillover Theory
United Kingdom

ABSTRACT

This study investigates how geographical proximity with innovation ecosystems' agents contribute to Schumpeterian firms' innovation performance. By adopting the knowledge spillover theory, we propose and test a conceptual model using a firm-level data that merged information from multiple sources resulting in 3,074 observations during the period of 2002–2014. Our results contribute to the literature by extending three academic discussions: (a) the achievement of Schumpeterian firms' innovation performance based on geographical proximity to innovation ecosystems' agents, (b) the role of firm size, and (c) discussion on mechanisms of knowledge spillover for firm performance. We develop theoretical insights and managerial implications for Schumpeterian firms.

## 1. Introduction

Innovation in firms is very different in terms of growth orientation (Autio, Kenney, Mustar, Siegel, & Wright, 2014), its impact on the national and regional economy (Ács, Autio, & Szerb, 2014; Ács, Stam, Audretsch, & O'Connor, 2017; Meissner, Polt, & Vonortas, 2017), as well as ability to create conducive innovation ecosystem context (Roper, Love, & Bonner, 2017; Bogers & Zobel, 2017). Only a small fraction of innovative firms follow a high-growth knowledge-intensive orientation (Frenz & Ietto-Gillies, 2009; Autio et al., 2014). This small fraction of firms is the only one that appropriates the Schumpeterian view of entrepreneurship (Malerba & Orsenigo, 1996) that refers to high-growth and knowledge-intensive innovative firms (Schumpeter, 1934). Despite all the impressive progress made in the recent entrepreneurship and innovation literature in explaining both what drives Schumpeterian firms as well as the impact on regional entrepreneurial ecosystems (Mthanti & Ojah, 2017; Colombelli, Krafft, & Quatraro, 2014), the case of Schumpeter's entrepreneurship and how best to achieve it remains noticeably absent.

A complementary academic debate has focused on the source of innovation and the role of innovation ecosystems in facilitating entrepreneurship and economic growth (Adner, 2017; Bogers & Zobel, 2017), with a focus on the regional and national levels, stressing the role played by interconnectedness, learning and interactions between firms (Fischer, Queiroz, & Vonortas, 2018; Alvedalen & Boschma, 2017).

Prior research has identified that it is the geography of collaboration that limits the extent that entrepreneurs are able to benefit from knowledge co-creation with external partners (Boschma, 2005; Audretsch & Belitski, 2020a), while Feldman (1999), Audretsch and Lehmann (2005) and Roper et al. (2017) explicitly pointed on the nature of knowledge, that changes the way entrepreneurs consider the geographical locus of collaboration.

Despite the theoretical underpinning and importance of knowledge collaboration between Schumpeterian type firms and innovation ecosystems' agents (Cappelli, Czarnitzki, & Kraft, 2014; Ács et al., 2017; Roper et al., 2017), there is a paucity of knowledge about the role of geographical proximity and co-location with innovation ecosystem agents play in innovation performance of Schumpeterian firms (Fischer et al., 2018).

Thus, the aim of this study is to develop a more comprehensive, theoretically grounded understanding of the role that knowledge collaboration with innovation ecosystem agents across different

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https://doi.org/10.1016/j.jbusres.2022.02.037
Received 14 October 2020; Received in revised form 2 February 2022; Accepted 12 February 2022
Available online 24 February 2022

geographical proximities may play in firm performance and innovation in Schumpeterian firms and to analyze whether such effects may be conditional on location of innovation ecosystem agents partners and firm size. For this, drawing upon Borgatti and Halgin (2011), Audretsch and Belitski (2017), Roper et al. (2017) and, we define innovation ecosystem agents as public and (or) private organizations (e.g. research institutes, universities, government, suppliers, customers, consultants competitors) who are embedded into knowledge collaboration with each other, they jointly capitalise on knowledge, co-operate on innovation and exploit ideas, resulting in greater knowledge spillovers and new economic value co-creation. This definition is consistent with a systemic understanding of innovation process, in which innovation is seen as the result of the cooperation and interaction of a multitude of various actors (Meissner, 2016; Meissner et al., 2017).

Our sample combines two distinctive datasets of UK Innovation survey and Business structure database resulting in 3,074 observations during the period of 2002–2014.

The contributions of our study can be considered from at least three perspectives. Firstly, this study contributes of the knowledge spillover literature by extending arguments of the knowledge spillover theory of entrepreneurship to explain the mechanisms which drive firm innovation and growth. Although past inquiries into this domain have considered the potential for knowledge spillovers flowing from investment in R&D by firms within the same industry and between industries (Audretsch & Belitski, 2020b), they have largely ignored the critical cross-pollination of knowledge between a focal firms and a variety of innovation ecosystem agents both private (e.g. suppliers, customers, consultants) and public (universities, research labs, government departments) that Schumpeterian firms can capture from other agents via direct form of collaboration on knowledge (Kobarg, Stumpf-Wollersheim, & Welpe, 2019) operating within their region, country or globally. Our empirical assessment of the knowledge spillovers from geographically proximal innovation ecosystem agents reveals that they cross-fertilize innovation and firm performance in Schumpeterian firms.

Secondly, this study also contributes to the knowledge management and innovation literature by drawing attention to the task of acquiring unintentional knowledge spillovers from a broad range of collaborations with different partner types as these innovation ecosystem agents represent potentially knowledge rich information sources (Kobarg et al., 2019; Roper et al., 2017). Prior studies frequently focus on knowledge transfer as an unintentional and passively involved knowledge transfer (Cassiman & Veugelers, 2002, 2006; Giovannetti & Piga, 2017). Our research considers whether and how firms learn and appropriate knowledge spillovers for innovation not only passively and indirectly through other firms investing in R&D and knowledge externalities (Griliches, 1991), but also actively and directly through partnerships and research collaborations with innovation ecosystem actors (Meissner et al., 2017) and due to the attributes of their location and co-location. The majority of studies of knowledge spillovers have focused on whether or not there is a flow to local knowledge between firms (Audretsch & Feldman, 1996; Cassiman & Veugelers, 2002; Miotti & Sachwald, 2003; Kobarg et al., 2019), rather than whether and how Schumpeterian firms use knowledge collaboration to jointly co-create new products and services. Therefore, we analyze how Schumpeterian firms may benefit from greater potential collaboration on knowledge with ecosystem agents across different geographical proximities.

Thirdly, this study provides insights into firm performance and innovation based upon knowledge availability by merging insights from the entrepreneurship, innovation and growth literatures. By scrutinizing the effects that an increased opportunity for knowledge spillover may have upon firm performance and innovation, we establish the varying effects that context, location and firm size may play for performance and innovation. Thus, we add to our knowledge on Schumpeterian firms and the emergent literature on the dynamics or innovation ecosystems and the regional locus of this literature (Fischer et al., 2018). Viewing knowledge spillovers from innovation ecosystem agents as a force which propels Schumpeterian firms to introduce new products to market and increase sales, we assess the potential role of knowledge collaboration in creating conducive environments for knowledge-based entrepreneurial activity. Methodologically, existing literature missing out on dynamic approaches to knowledge-based entrepreneurship, that looked into the dynamic characteristics of Schumpeterian firms over time which we address with merged data on six waves of innovation survey in the UK.

The remainder of this paper is as follows. Section 2 describes the conceptual background and develops the theoretical foundations of the knowledge spillover of innovation framework for Schumpeterian firms. Section 3 describes the methodological design, while the results are discussed in Section 4. Finally, Section 5 discusses and concludes with policy implications, limitations, and recommendations for future research.

## 2. Theoretical framework

### 2.1. *Schumpeterian firms and the knowledge spillover of innovation*

Innovation activity is characterized by the newness and complexity of knowledge. Fit is characterized as a means to create competitive advantage in a market or industry, and as a method to increase firm performance and create new products and services (Meissner & Kotsemir, 2016; Meissner, 2015). The ability of Schumpeterian and incumbent firms to access, adopt and commercialize knowledge is dependent on multiple interfaces and resources inside and outside the organization (Audretsch & Keilbach, 2007; Ács, Braunerhjelm, Audretsch, & Carlsson, 2009). Firm innovation and growth requires searching and absorbing diverse knowledge (Jaspers & Van den Ende, 2010) as well as recombining internal and external knowledge (West, Salter, Vanhaverbeke, & Chesbrough, 2014; Battke, Schmidt, Stollenwerk, & Hoffmann, 2016).

Schumpeterian firm employ two knowledge management strategies – first knowledge creation in-house by investing in internal R&D (Schamberger, Cleven, & Brettel, 2013; Roper & Hewitt-Dundas, 2015), while it they also engage in co-creating knowledge within innovation ecosystems with a variety of partners such as such as suppliers, customers, consultants, competitors, universities and regional and national government (Beers & Zand, 2014; Roper et al., 2017). Being able to observe and access external knowledge by Schumpeterian firms facilitates firm innovation and performance as the access to new external knowledge furthers the emergence of new ideas (Griliches, 1991) and increases the probability of the fusion ideas and resources already available for innovation in Schumpeterian firms. While knowledge spillover originates within incumbent organizations but not yet commercialized (Audretsch & Keilbach, 2007) by innovation ecosystem agents, Schumpeterian firms access this knowledge for innovation and growth. In order to do so they create social relationships and interact with external partners directly by collaboration and R&D agreements (Tsai & Ghoshal, 1998) and via spillovers (Audretsch & Belitski, 2020b).

The differences in the extent of use, adoption and commercialization of new knowledge between Schumpeterian firms and other innovation ecosystem agents can be explained by from a Knightian view of risk and uncertainty (Knight, 1933). Schumpeterian firms are better in dealing with uncertainty than other innovation ecosystem agents. Knowledge is associated with uncertainty, transaction costs and asymmetry and produced by innovation ecosystem agents, but not commercialized due to high uncertainty or low profit margins, can be used by Schumpeterian firms to broaden the knowledge pool, share, and mitigate the uncertainty associated with innovation activity (Eisenhardt & Schoonhoven, 1996). Due to the inherited uncertainty of innovation process, innovation ecosystem agents apply knowledge filtration mechanisms which can decline the adoption and commercialization of new knowledge by incumbent firms, however it therefore creates entrepreneurial opportunity to exploit this knowledge by Schumpeterian firms as a knowledge spillover of innovation.

 

The literature deals with the role of knowledge spillover in firm innovation and performance emphasizes the role of geographical proximity and context for access to knowledge spillovers from the co-location with innovation ecosystem agents along with their effects on firm growth. Mechanisms, including the following may facilitate the knowledge spillover within a close geographical proximity. Firstly, demonstration effects through product reverse engineering and imitation. Secondly, labor market effects through employee exchange and movement. Thirdly, local linkage effects through the selection of suppliers and distributors, and finally, competition effects through rivalry between innovation ecosystem agents. An underlying premise is that a substantial portion of knowledge spillover is geographically confined (Audretsch & Feldman, 1996). As such, a Schumpeterian firm collocated in close geographical proximity to incumbents and other partners may thus improve their learning from them (Darr, Argote, & Epple, 1995) though greater capacity of knowledge search and efficiency of resource and knowledge sharing.

For example, there is a strong geographical dimension to knowledge spillovers from universities, suppliers and customers with the impact of university R&D and customer relationship being confined largely to the region in which the research takes place (Audretsch & Feldman, 1996). To some extent, the geographical dimension of such effects is linked to the tacit nature of knowledge. Innovation ecosystem agents as universities may be more willing to share knowledge with geographically close firms as a result of shared norms, values, and other formal and informal institutions (Roper et al., 2017).

Knowledge spillovers generated as result of highly concentrated and localized global knowledge can be decomposed into distinct types of spillovers occurring based upon an increased in the number of the innovation ecosystem agents and their types (e.g., breadth) and an intensity of knowledge collaboration with them (e.g., depth). Knowledge collaboration with an increased number of innovation ecosystem agents and their different types (e.g. universities, suppliers, competitors, R&D labs, consultants, etc.) reveals that spillover effects to knowledge production and tend to be greater when partners are located within the same region or country due to institutional, cognitive, technological and spatial proximities (Boschma, 2005; Nooteboom, Van Haverbeke, Duysters, Gilsing, & Van den Oord, 2007). For example, codified knowledge may become valuable only if it is applied with tacit knowledge in a local context (Maskell, Bathelt, & Malmberg, 2004) and the exchange of tacit knowledge is limited when the distance between partners increases (Feldman, 1999). This also brings us to shared culture of innovation, cognition and regulation, including enforcing contracts, registering intellectual property rights, dealing with insolvency, R&D legal agreements and other (Nooteboom et al., 2007; Audretsch, Belitski, & Desai, 2019).

Finally, in the developed economies such as the United Kingdom or United States Schumpeterian firms should be able to access global knowledge locally by co-locating with multinational firms (Rugman & Verbeke, 2001; De Clercq, Hessels, & van Stel, 2008), industrial clusters (Asheim & Coenen, 2005) and regional innovation systems (Asheim, Smith, & Oughton, 2011). Based on these arguments, we hypothesize:

**H1:** Knowledge spillover of innovation is higher for Schumpeterian firms who collaborate on knowledge with innovation ecosystems' agents in close geographical proximity.

### 2.2. *Schumpeterian firms' size and greater innovation returns*

Firm size plays an important role in the knowledge spillover of innovation (Kelley & Helper, 1999; Rogers, 2004) as it affects the level of absorptive capacity of external knowledge (Cohen & Levinthal, 1989). Small-sized Schumpeterian firms operate under higher resource constraints than their larger counterparts. Therefore, small-sized Schumpeterian firms are more likely to exploit collaboration within closer geographical proximity innovation ecosystems' agents because of the lower cost of external knowledge sources (Ács & Audretsch, 1990; Bughin & Jacques, 1994; Cohen & Klepper, 1996; Chesbrough, Vanhaverbeke & West, 2006).

The way knowledge spillover is appropriated and commercialized by Schumpeterian firms depends on the absorptive capacity (Ghio, Guerini, Lehmann, & Rossi-Lamastra, 2015) as a critical factor that affects the process of transmitting knowledge spillover by Schumpeterian firms. The absorptive capacity theory of knowledge spillover entrepreneurship (Qian & Ács, 2013) clarifies how firms may vary. The absorptive capacity theory of knowledge spillover entrepreneurship argues that, the level of knowledge spillover depends not only on the speed of knowledge creation, but also on entrepreneurial absorptive capacity. Cohen and Levinthal (1990: 128), define absorptive capacity as "an ability to recognize the value of new information, assimilate it, and apply it to commercial ends" with Qian and Ács (2013: 191) extending this definition to "entrepreneur to understand new knowledge, recognize its value, and subsequently commercialize it by creating a firm". Smaller firms lack time and financial resources to support acquisition, assimilation, transformation and exploitation of new knowledge, therefore small Schumpeterian firms will be more likely to rely on local knowledge collaborations to compensate for the lack of absorptive capacity and will use spatial and cognitive proximity to innovate new products (Boschma, 2005; Balland, Boschma, & Frenken, 2015; Ács et al., 2017; Guerrero, Liñán, & Cáceres-Carrasco, 2020). Small size firms will build their innovation process relying on external knowledge they absorb naturally from the local markets, local suppliers, customers and universities.

Close geographical proximity to innovation ecosystems' agents becomes an efficient mechanism to leverage the lack of absorptive capacity and further diffuse knowledge at a low cost (Audretsch & Feldman, 1996). On the one hand, absorptive capacity involves the scientific knowledge the firm should have in order to understand what's new and recognize its market value. On the other hand, a firm may rely on the market or accessible business knowledge with which the firm can use to innovate.

Typically, small-sized firms will rely on local knowledge sourcing, such as industrial clusters generating considerable knowledge spillovers to smaller firms (Audretsch & Belitski, 2017).

For a small-sized Schumpeterian firm, knowledge spillovers are local where a firm would have a cognitive understanding and which can start from research laboratories, government programmes, universities, local customers, and suppliers (Audretsch & Vivarelli, 1996; Feldman, 2006; De Massis, Audretsch, Uhlaner, & Kammerlander, 2018). Unlike medium and large-sized firms, with a higher absorptive capacity to recognize and assimilate knowledge spillovers (Cohen & Levinthal, 1990), small-sized Schumpeterian firms rely on technology and knowledge sourcing from local innovation ecosystems' agents (Cassiman & Veugelers, 2002) and within their regional ecosystems (O'Connor, Stam, Sussan, & Audretsch, 2018). Based on these arguments, we hypothesize:

**H2:** Small-size Schumpeterian firms benefit more from collaboration on knowledge with innovation ecosystems' agents in close geographical proximity.

## 3. Methodology

### 3.1. *Sample*

We build a panel dataset merging the Business Structure Database (BSD), the Business Enterprise Research and Development survey (BERD), and the UK Innovation Survey (UKIS) from 2002 to 2014. First, we collected and matched six consecutive UKIS waves to BSD data. Each wave was conducted every second year by the Office of National Statistics (ONS) in the UK on behalf of the Department of Business Innovation and Skills (BIS).

The UKIS offers the most comprehensive data in terms of the range of enterprises surveyed. This dataset covers all manufacturing sectors and most private services, ICT, the creative sector (UK Standard Industrial Classification of Economic Activities), and micro, small, medium, and large-sized firms. It includes direct measures of innovation performance, such as a share of new to market sales and a wide variety of factors influencing innovation.

The BSD also offers information on the year of establishment, ownership, employment, and industry. Likewise, the BERD offers additional information on R&D expenditure in-house and buying R&D from innovation ecosystems' agents. We matched each correspondent UKIS survey wave with the BSD data for each UKIS period's initial year. Our match resulted in 3,074 observations, which complies with Schumpeterian selection criteria (Schumpeter, 1934; Colombelli, Krafft, & Vivarelli, 2016) such as up to seven years since establishment, filing a patent, introducing a new product or process, investing in any form of R&D, collaborate on knowledge with external innovation ecosystems' agents, introducing new products to market. The criteria are characterized by 'creative destruction' with technological ease of entry and new firms' major role in innovative activities (Malerba & Orsenigo, 1996). All missing values and non-applicable answers were labelled as missing and not included in our sample. Table 1 illustrates the sample distribution by industry and the UK region where the firm is located.

### 3.2. Dependent and explanatory variables

Our dependent variable (innovation performance) is sales of new-to-market products, the percentage of a firm's total sales serves as a proxy for radical product innovation taken from UKIS. This proxy of product innovation was used in previous studies on innovation in firms (Kleinknecht, Van Montfort, & Brouwer, 2002; Santamaria, Nieto, & Barge-Gil, 2009; Cervantes & Meissner, 2014). and within the UK context (Laursen & Salter, 2006, 2014) and macroeconomic indicators of innovation (Meissner, 2015). The use of this variable comes from Schumpeter's use of language (i.e., his identification of this activity as disruptive, while Kirzner (1973, 1999) has maintained that this entrepreneurial activity is the possibility of winning pure profit. The average firm's sales of new-to-market products in our sample is 4.03%, with a standard deviation of 14.5 percent.

The role of geographical proximity is captured through collaboration as a proxy for knowledge spillover for innovation. We created four new explanatory variables from the UKIS named collaboration proximity: "UK regional," "UK national," "Europe," and "other countries" (Cappelli et al., 2014; Balland et al., 2015). These binary variables take value one if the firm collaborates on innovation with at least three interdependent

**Table 1**
Sector divisions (by SIC 2007) and geographical regions.

| Sector divisions | Total | % | Region | Total | % |
|---|---|---|---|---|---|
| Mining & Quarrying | 22 | 0.72 | North East | 169 | 5.50 |
| Manufacturing basic | 106 | 3.45 | North West | 310 | 10.08 |
| High-tech manufacturing | 355 | 11.55 | Yorkshire and Humber | 237 | 7.71 |
| Electricity, gas, and water supply | 42 | 1.37 | East Midlands | 250 | 8.13 |
| Construction | 358 | 11.65 | West Midlands | 257 | 8.36 |
| Wholesale, retail trade | 350 | 11.39 | Eastern England | 279 | 9.08 |
| Transport, storage | 170 | 5.53 | London | 298 | 9.69 |
| Hotels & restaurants | 310 | 10.08 | South East | 344 | 11.19 |
| ICT | 268 | 8.72 | South West | 273 | 8.88 |
| Financial intermediation | 132 | 4.29 | Wales | 217 | 7.06 |
| Real estate & other business activities | 386 | 12.56 | Scotland | 222 | 7.22 |
| Public admin, defense | 514 | 16.72 | Northern Ireland | 218 | 7.09 |
| Education | 12 | 0.39 | | | |
| Other community, social active | 49 | 1.59 | | | |

Source: Office of National Statistics: BSD, BERD, and UKIS (2002–2014).

actors within innovation ecosystems (e.g., businesses within enterprise groups, suppliers, clients or customers, competitors, consultants, commercial labs, universities, governments), and zero otherwise (Adner, 2017; Bogers & Zobel, 2017). Most importantly, these variables capture external exposure to knowledge collaboration (Cassiman & Veugelers, 2006; Laursen & Salter, 2014). Each collaboration is viewed across four geographical dimensions: regional, national, Europe, and other countries. A similar indicator was also used in earlier studies related to the measurement of collaboration proximity (Boschma & Frenken, 2010). The full list of explanatory and control variables used in this study is in Table 2.

### 3.3. Control variables

We have included several control variables related to firm characteristics, year, industry (2 SIC digits), the survey wave, and the UK region fixed effects. We use a binary variable, which indicates whether or not a firm's innovation activity faces the following *"constraints on innovation"*: the perceived direct innovation costs and risks are high, there is a lack of qualified personnel and a lack of information on markets and market domination by established firms. Firms that report greater constraints are exposed to a higher level of competition, which may affect both the propensity to innovate and the innovation performance (Miotti & Sachwald, 2003; Nooteboom et al., 2007; Schamberger et al., 2013; Beers & Zand, 2014). A Schumpeterian firm will remain entrepreneurial to the extent that individuals can engage in entrepreneurial behaviour and decision-making (Hornsby, Kuratko, Holt, & Wales, 2013). Operationalized with the Corporate Entrepreneurship strategy, *"entrepreneurial climate"* is measured as new methods of organising work responsibilities and decision-making.

A firm that aims to improve innovation performance is also likely to experiment with new collaboration models. Evidence that was creating new collaboration methods with external innovation ecosystems' agents plays a role in transmitting knowledge and innovation (Colombelli & Quatraro, 2018). We use a binary variable *"Process innovation external"* as new methods of organising external relationships with other firms or public institutions and another binary variable for "*exploration activity*" of a firm (March, 1991; Schamberger et al., 2013). Additionally, we use a binary variable, which indicates whether or not a firm introduces process innovation in-house *"Process innovation internal."* Process innovation relates to all-new or significantly improved methods, although new to the firm, does not need to be new to the industry.

We control for a *"firm size"* measured as the number of employees (small, medium, and large), firm age measured as a log of firm age, thereby capturing potential decreasing marginal returns to firm age (Kelley & Helper, 1999). We control for the firm's absorptive capacity by controlling for *"scientists"* – a share of employees with the BS degree and above, which is also used as a proxy for general human capital (Zahra & George, 2002). General human capital refers to employees' knowledge and skills obtained through formal education and professional experience (Ghio et al., 2015), which is applicable to various innovation activities. We add a firm's "*Legal status"* as a binary variable for sole-proprietorship, on-for-profit, and partnership (including family businesses) with limited company liability as a reference category. We also control for sales abroad as a measure of internationalisation with a binary variable for *"Exporter"* (Rugman & Verbeke, 2001; Narula, 2004) and firm foreign ownership with a binary variable for *"Foreign firm."*

We included *"in-house R&D expenditure"* in logarithms to capture the firm's absorptive capacity as well as "*design intensity"* measured as all forms of design expenditure (£) to the total sales (£) and "*training intensity"* measured as all forms of training activities to create new knowledge and innovate (£) to the total sales (£). Also, we included external R&D expenditure in logarithms as a control for buying external creative knowledge. It is important to distinguish between buying knowledge and knowledge externalities (knowledge spillovers, collaboration, flows) where no financial compensation is involved (Battke

**Table 2**
Descriptive Statistics.

| Label | | Description of variables | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| | | | Product innovation 3,074 obs. | | | |
| Innovation performance **(DV)** | | % of the firm's total turnover from goods and services, new to the market (%) | 4.122 | 13.50 | 0.00 | 100.00 |
| Geographical proximity to innovation ecosystems' agents | UK Regional | Binary variable = 1 if the firm co-operates on innovation with at least three out of seven external partners partner regionally (enterprise group, suppliers, customers, consultants, competitors, university, government) | 0.085 | 0.268 | 0.00 | 1.00 |
| | UK National | Binary variable = 1 if the firm co-operates on innovation with at least three out of seven external partners partner nationally (enterprise group, suppliers, customers, consultants, competitors, university, government) | 0.088 | 0.281 | 0.00 | 1.00 |
| | European Countries | Binary variable = 1 if the firm co-operates on innovation with at least three out of seven external partners partner in Europe (enterprise group, suppliers, customers, consultants, competitors, university, government) | 0.030 | 0.165 | 0.00 | 1.00 |
| | Other Countries | Binary variable = 1 if the firm co-operates on innovation with at least three out of seven external partners partner in another world (enterprise group, suppliers, customers, consultants, competitors, university, government) | 0.029 | 0.153 | 0.00 | 1.00 |
| In-house R&D expenditure | | Internal Research and Development expenditure (£), log | 0.829 | 1.641 | 0.00 | 10.72 |
| External R&D expenditure | | External Research and Development expenditure (£), log | 0.277 | 0.912 | 0.00 | 8.51 |
| Design intensity | | All forms of design expenditure (£) to total sales (£) ratio | 0.024 | 0.332 | 0.00 | 0.33 |
| Training intensity | | Training for innovative activities expenditure (£) to total sales (£) ratio | 0.037 | 0.685 | 0.00 | 0.30 |
| Entrepreneurial climate | | New methods of organising work responsibilities and decision making (a new system of employee responsibilities, teamwork, decentralisation, integration or de-integration education/ training) | 0.209 | 0.444 | 0.00 | 1.00 |
| Process innovation external | | New methods of organising external relationships with other firms or public institutions | 0.223 | 0.420 | 0.00 | 1.00 |
| Process innovation internal | | Binary variable = 1 if the firm introduced any new or significantly improved processes for producing or supplying goods or services, zero otherwise. | 0.209 | 0.469 | 0.00 | 1.0.00 |
| Firm size | *Small* | Binary variable equal one if the number of FTEs is <50, zero otherwise | 0.705 | 0.421 | 0.00 | 1.00 |
| | *medium* | Binary variable equal one if the number of FTEs is between 50 and 249, zero otherwise | 0.214 | 0.469 | 0.00 | 1.00 |
| | *large* | Binary variable equal one if the number of FTEs is >=250, zero otherwise | 0.079 | 0.258 | 0.00 | 1.00 |
| Industry | *High-tech Manufacturing* | Binary variable equal one if firms belong to one of the following SIC 2007 (2 digits): 21, 26, 30, zero otherwise | 0.002 | 0.049 | 0.00 | 1.00 |
| | *Medium-tech Manufacturing* | Binary variable equal one if firms belong to one of the SIC 2007 (2 digits): 20, 22–27, 28, 29, 32, zero otherwise | 0.047 | 0.258 | 0.00 | 1.00 |
| | *Low-tech Manufacturing* | Binary variable equal one if firms belong to one of the SIC2007 (2 digits): 10–19, 31, zero otherwise | 0.052 | 0.241 | 0.00 | 1.00 |
| | *High-tech Services* | Binary variable equal one if firms belong to one of the SIC2007 (2 digits): 59, 60, 61, 62, 72 zero otherwise | 0.089 | 0.252 | 0.00 | 1.00 |
| Legal status | *Sole proprietor* | Binary variable = 1 if the firm's legal status is Sole-proprietor, 0 otherwise | 0.074 | 0.267 | 0.00 | 1.00 |
| | *Partnership* | Binary variable = 1 if the firm's legal status is a partnership, 0 otherwise | 0.081 | 0.263 | 0.00 | 1.00 |
| | *Non-for-profit body* | Binary variable = 1 if the firm's legal status is *Non for profit*, 0 otherwise | 0.011 | 0.089 | 0.00 | 1.00 |
| Exploration | | How important were the Increasing range of goods or services and Increasing market share in your decision to innovate in goods or services, processes? | 0.803 | 0.397 | 0.00 | 1.00 |
| Constraints on innovation | *Cost* | Binary variable equals one if the firm states excessive perceived economic risks, direct innovation costs too high, cost and availability of finance, zero otherwise | 0.322 | 0.479 | 0.00 | 1.00 |
| | *Knowledge* | Binary variable equals one if the firm state's lack of qualified personnel, lack of information on markets, lack of information on techs markets, zero otherwise | 0.163 | 0.366 | 0.00 | 1.00 |
| | *Incumbents* | Binary variable equals one if the firm state's market dominated by established firms, uncertain demand for goods or services, zero otherwise | 0.189 | 0.325 | 0.00 | 1.00 |
| Age of firm | | Age of a firm (years since the establishment), log | 1.277 | 0.606 | 0.00 | 1.96 |
| Scientist, % of FTE | | The proportion of employees that hold a degree or higher qualification in science and engineering | 7.431 | 18.21 | 0.00 | 100.00 |
| Exporter | | Binary variable = 1 if a firm sells its products in foreign markets, 0 otherwise | 0.249 | 0.463 | 0.00 | 1.00 |
| Foreign ownership | | Binary variable = 1 if a firm has headquarters abroad, 0 otherwise | 0.147 | 0.241 | 0.00 | 1.00 |

Source Office of National Statistics: BSD, BERD, and UKIS (2002–2014). The number of observations 3,074.

et al., 2016). Finally, we include 70 industry fixed effects (SIC code 2 digits) (mining and quarrying as the reference category) and 12 regional fixed effects (North-East region of the UK as the reference category) in the regression.

### 3.4. Model specification

We estimate innovation production function (Pakes & Griliches, 1984) in which external knowledge collaboration, investment in knowledge, and other firm-level characteristics become inputs, and product innovation is an output using a mixed-effects generalised linear model (Luke, 2004; Goldstein, 2011). The regression is multi-level and includes firm-level characteristics, survey wave, and one of 128 city-regions in the United Kingdom (UK), where a firm is located. The model contains both fixed and random effects. Fixed effects are directly estimated, in addition to being indirectly estimated by covariances of random intercepts and slopes (Rabe-Hesketh, Pickles, & Taylor, 2000). Innovation production function was estimated using a generalised linear mixed-effect model with the dependent variable $y_{ijk}$ and the independent variable $x_{ijk}$ such that:

$$y_{ijk} = \beta_0 + \beta_1 x_{ijk} + \beta_2 \tau_{ijk} + \varepsilon_{ijk} \quad (1)$$

where i is the firm level-1, j is the region level-2, and k serves to index the wave survey level-3. The dependent variable $y_{ijk}$ represent product innovation for firm i in region j and taken from the wave k. The explanatory variables, which were previously described, are presented by $x_{ijk}$. Other control variables which represent firm-specific characteristics described in Table 1 are presented by $\tau_{ijk}$, this also includes industry 2 digit SIC fixed-effects. Finally, $\varepsilon_{ijk}$ is an error term that consists of three components in the hierarchical model:

$$\varepsilon_{ijk} = \gamma_i + \mu_j + t_k + \nu_{ijk} \quad (2)$$

where $\gamma_i$ represents the omitted variables that vary across firms but not over regions and waves, $\mu_{ij\bullet}$ denotes the omitted variables that vary over regions but are constant across firms and waves, $t_{k\bullet}$ represents omitted variables which vary across waves but not across firms and regions, while finally $\nu_{ijk}$ is the error term. The presence of more than one residual term makes the standard multivariate model, such as a fixed-effects specification, inapplicable. A generalised maximum likelihood (GML) procedure should therefore be used, which is estimated using maximum likelihood with the truncated distribution of $y_{ijk}$. The covariation between firm innovation performance sharing the same regional and time externalities can be expressed by the intra-class correlation in this model (Goldstein, 2011). With this, the between-regions variance contributes to firm innovation performance in addition to the variance between firms.

## 4. Empirical results

Table 3 reports the estimated mixed effect (multi-level) generalised linear model (GLM), which measures firm, time, industry, and regional characteristics, which may affect innovation performance. We use four binary explanatory variables (specification 5, Table 3) to measure the joint effect of all collaboration innovation ecosystems' agents and geographical dimensions on firm innovation. The coefficient of interest is positive and statistically significant with regional ($\beta_r = 0.48$, $p < 0.05$) and national innovation ecosystems' agents ($\beta_n = 0.52$, $p < 0.05$). This result is supporting H1. Our finding confirms that Schumpeterian firms, when engaging in external knowledge exchange with regional and national innovation ecosystems' agents have higher innovation performance.

The size of the beta coefficients for the UK regional and UK national collaborators is within the same confidence interval. It means no significant difference between the returns to knowledge collaboration for national and regional innovation ecosystems' agents. There is no evidence of the relationship between international innovation ecosystems' agents and firm innovation.

The results reported in specifications 1–4, Table 3 illustrate positive and significant moderation coefficient of firm size and European innovation ecosystems' agents ($\beta_E = 0.83$, $p < 0.05$), which is different from H2. H2 is not supported as small-sized Schumpeterian firms; when engaging in external knowledge, collaboration with regional and national innovation ecosystems' agents will not experience higher innovation performance than firms of other sizes. Although knowledge collaboration with European and international innovation ecosystems'

**Table 3**
Mixed-effects GLM.

| Specification Geographical proximity | (1) Regional | (2) National | (3) Europe | (4) World | (5) Overall |
|---|---|---|---|---|---|
| Small firm (1–49 FTEs) **(H2)** | 0.61* (0.26) | 0.66* (0.26) | 0.63* (0.26) | 0.67** (0.26) | 0.66** (0.26) |
| small firm × UK Regional **(H2)** | 0.49 (0.30) | | | | |
| small firm × UK National **(H2)** | | −0.01 (0.36) | | | |
| small firm × European countries | | | 0.83* (0.49) | | |
| small firm × other countries | | | | −0.35 (0.67) | |
| Collaboration UK Regional **(H1)** | 0.13 (0.35) | 0.48** (0.2) | 0.50** (0.2) | 0.48** (0.2) | 0.48** (0.2) |
| Collaboration UK National **(H1)** | 0.52* (0.21) | 0.52* (0.32) | 0.51** (0.21) | 0.52** (0.21) | 0.52** (0.21) |
| Collaboration European countries | −0.27 (0.36) | −0.33 (0.36) | −0.88 (0.54) | −0.34 (0.36) | −0.33 (0.36) |
| Collaboration Other World | 0.28 (0.37) | 0.32 (0.37) | 0.28 (0.37) | 0.59 (0.64) | 0.32 (0.36) |
| In-house R&D expenditure, log | 0.25*** (0.037) | 0.25*** (0.037) | 0.25*** (0.037) | 0.25*** (0.037) | 0.25*** (0.037) |
| External R&D expenditure, log | 0.04 (0.05) | 0.04 (0.05) | 0.04 (0.05) | 0.04 (0.05) | 0.04 (0.05) |
| Design intensity | 0.46 (0.32) | 0.47 (0.32) | 0.45 (0.31) | 0.47 (0.32) | 0.47 (0.32) |
| Training intensity | −0.09 (0.18) | −0.09 (0.17) | −0.09 (0.18) | −0.09 (0.17) | −0.09 (0.17) |
| Entrepreneurial climate | 0.22* (0.14) | 0.22* (0.14) | 0.22* (0.14) | 0.22* (0.14) | 0.22* (0.14) |
| Process innovation external | 0.24 (0.14) | 0.23* (0.14) | 0.23* (0.14) | 0.23* (0.14) | 0.23* (0.14) |
| Process innovation internal | 0.88*** (0.13) | 0.88*** (0.13) | 0.89*** (0.13) | 0.88*** (0.13) | 0.88*** (0.13) |
| Medium firm (50–249 FTEs) | 0.50* (0.27) | 0.49* (0.27) | 0.51* (0.27) | 0.48* (0.27) | 0.49* (0.27) |
| High tech sector | 2.64** (0.97) | 2.60** (0.97) | 2.59** (0.97) | 2.62** (0.96) | 2.60** (0.97) |
| Medium-tech sector | 0.50 (0.41) | 0.49 (0.41) | 0.48 (0.41) | 0.49 (0.41) | 0.49 (0.41) |
| Low-tech sector | 0.87 (0.78) | 0.90 (0.78) | 0.82 (0.79) | 0.91 (0.78) | 0.90 (0.78) |
| High tech services | 0.10 (0.25) | 0.09 (0.25) | 0.09 (0.25) | 0.10 (0.25) | 0.09 (0.25) |
| Sole proprietor | −0.11 (0.29) | −0.12 (0.29) | −0.11 (0.29) | −0.12 (0.29) | −0.12 (0.29) |
| Partnership | −0.48* (0.29) | −0.49* (0.29) | −0.48* (0.29) | −0.49* (0.29) | −0.49 (0.29) |
| Non-profit making body | −0.69 (0.73) | −0.73 (0.73) | −0.74 (0.73) | −0.73 (0.73) | −0.73 (0.73) |
| Exploration | 2.52*** (0.39) | 2.52*** (0.39) | 2.53*** (0.39) | 2.52*** (0.39) | 2.52*** (0.39) |
| Constrain innovation: cost | 0.43*** (0.13) | 0.43*** (0.13) | 0.43*** (0.13) | 0.43*** (0.13) | 0.43*** (0.13) |
| Constrain innovation: knowledge | 0.02 (0.17) | 0.01 (0.17) | 0.02 (0.17) | 0.01 (0.17) | 0.01 (0.17) |
| Constrain innovation: incumbents | −0.02 (0.16) | −0.02 (0.16) | −0.03 (0.16) | −0.02 (0.16) | −0.02 (0.16) |
| Age of firm, logs | −0.01 (0.09) | −0.01 (0.09) | −0.01 (0.09) | −0.01 (0.09) | −0.01 (0.09) |
| Scientists | 0.01 (0.00) | 0.01 (0.00) | 0.01 (0.00) | 0.01 (0.00) | 0.01 (0.00) |

(continued on next page)

**Table 3** (*continued*)

| Specification Geographical proximity | (1) Regional | (2) National | (3) Europe | (4) World | (5) Overall |
|---|---|---|---|---|---|
| Exporter | 0.33** (0.13) | 0.33** (0.13) | 0.32** (0.13) | 0.33** (0.13) | 0.30** (0.13) |
| Foreign | 0.14** (0.04) | 0.14** (0.04) | 0.14** (0.04) | 0.12** (0.04) | 0.15** (0.04) |
| Mills ratio: innovation active bias | 1.13*** (0.29) | 1.13*** (0.29) | 1.12*** (0.29) | 1.14*** (0.29) | 1.13*** (0.29) |
| Mills ratio: protection bias | 0.35*** (0.11) | 0.36*** (0.11) | 0.35*** (0.11) | 0.36*** (0.11) | 0.36** (0.11) |
| Constant | −6.90*** (1.22) | −7.00*** (1.12) | −6.90*** (1.20) | −7.00*** (1.10) | −7.00*** (1.10) |
| variance (year) | 0.19 (0.21) | 0.20 (0.22) | 0.20 (0.23) | 0.19 (0.21) | 0.20 (0.22) |
| variance (year/region) | 0.01 (0.03) | 0.01 (0.03) | 0.01 (0.03) | 0.01 (0.03) | 0.01 (0.03) |
| number of fixed effect parameters | 30 | 30 | 30 | 30 | 28 |
| number of random effect parameters | 2 | 2 | 2 | 2 | 2 |
| Overall model chi2 | 411.1393 | 410.12 | 409.34 | 410.87 | 410.12 |
| LR test vs. logistic model: chi2 | 17.80 | 17.96 | 18.09 | 17.75 | 18.01 |
| log-likelihood | −988.67 | −989.48 | −988.54 | −989.23 | −989.50 |

Note: standard errors are in parenthesis. Reference category for firm size = large firm (250 + FTEs); The reference category for firm ownership status: public corporation. Industry (1 digit SIC) and year fixed effects are suppressed to save space. LR test vs. logistic model supports the use of a multi-level mixed-effects model. Significance level: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$″.
Source: The Office of National Statistics: BSD, BERD, and UKIS (2002–2014). The number of observations 3,074.

agents is important for Schumpeterian firms, the statistical effect is weaker than knowledge collaboration on firm innovation with regional and national innovation ecosystems' agents (spec. 5, Table 3). Other interesting results are related to the positive effect of in-house R&D investment on firm innovation ($\beta_{R\&D} = 0.25$, $p < 0.001$), while buying R&D and investment in design and training was not found to affect innovation directly (Table 3). Improvement in the external forms of collaboration ($\beta_{ext} = 0.23$, $p < 0.05$) as well as process innovation ($\beta_{int} = 0.88$, $p < 0.001$) are positively associated with product innovation. The entrepreneurial climate within a firm ($\beta_{climate} = 0.22$, $p < 0.01$) supports product innovation (Hornsby et al., 2013).

Schumpeterian firms in high tech sectors have higher innovative performance ($\beta_{Hightech} = 2.59–2.64$, $p < 0.01$) compared to medium and low-tech firms. Once we controlled for additional characteristics, Firm age and scientists were not associated with firm innovation, which means that Schumpeterian firms during the establishment stage are likely to produce as much innovation as firms 6–7 years after establishment. Changes in a share of employees with a college degree were not associated with innovation. Firms which perceive the cost of innovation as a significant obstacle have higher innovation performance ($\beta_{cost} = 0.43$, $p < 0.001$) (Table 4). Exporters and foreign-owned firms have higher innovation performance than non-exporters ($\beta_e = 0.33$, $p < 0.001$) and firms which are not foreign-owned ($\beta_e = 0.14$, $p < 0.01$) (Frenz & Ietto-Gillies, 2009).

### 4.1. Post hoc analysis

Post hoc analysis aims to check the robustness of the results. Using multi-level GLM estimation results in Eq. (1), we calculate product innovation's predictive values for small, medium, and large-sized Schumpeterian firms (Table 4). These firms are divided into two groups: those who do not collaborate on knowledge with external innovation ecosystems' agents and across regional, national, European, and international geographical dimensions. The predictive margins shown in Fig. 1 demonstrate that Schumpeterian firms of all sizes benefit from knowledge collaboration with external innovation ecosystems' agents across all geographical dimensions, with the highest levels of product innovation achieved in collaboration with regional/national innovation ecosystems' agents, thereby supporting H1.

**Table 4**
Differences in product innovation between small and large Schumpeterian firms conditional on their collaboration partner (mixed-effect GLM).

| Firm size | 3,074 observations | | | |
|---|---|---|---|---|
| Regional-level | | | Total effect | Diff-in-diff |
| | No-collaboration | Collaboration | | |
| Medium & large | 0.175 | 0.424 | 0.249 | 0.045 |
| Small | 0.144 | 0.440 | 0.297 | |
| National-level | | | Total effect | Diff-in-diff |
| | No-collaboration | Collaboration | | |
| Medium & large | 0.145 | 0.490 | 0.344 | 0.004 |
| Small | 0.135 | 0.484 | 0.348 | |
| European-level | | | Total effect | Diff-in-diff |
| | No-collaboration | Collaboration | | |
| Medium & large | 0.174 | 0.453 | 0.278 | 0.142* |
| Small | 0.157 | 0.577 | 0.420 | |
| World-level | | | Total effect | Diff-in-diff |
| | No-collaboration | Collaboration | | |
| Medium & large | 0.176 | 0.631 | 0.455 | −0.043 |
| Small | 0.160 | 0.572 | 0.413 | |

Source: Authors based on the Office of National Statistics: BSD, BERD, and UKIS (2002–2014).

Table 4 illustrates the interaction coefficient between a collaboration innovation ecosystems' agents and firm size calculated from the estimation (1). Small firms compared to medium and large-sized Schumpeterian firms are likely to benefit more by collaboration with European innovation ecosystems' agents than with other agents. For example, by engaging in collaboration with knowledge innovation ecosystems' agents in Europe, small Schumpeterian firms in the UK are likely to increase their new-to-market sales from 15.5 percent to 57.7 percent, which is by 42 percent. Medium and large Schumpeterian firms in the UK will increase their innovation sales from 17.4 to 45.3 percent, which is 14.4 percent less than the small firms' effect.

An ability of Schumpeterian firms to exploit external knowledge that is sufficiently diverse (European innovation ecosystems' agents) but is located within a similar institutional context (European Union) resolves the "proximity paradox" of innovation (Boschma & Frenken, 2010). Knowledge inflows from European innovation ecosystems' agents for small firms are likely to bring new ideas while providing a secure institutional environment for firms to resolve insolvency and protect co-created knowledge (Love, Roper, & Vahter, 2014). Both the UK and European collaborators are subject to European regulation and are more likely to disclose their know-how and collaborate on innovation as part of their market development (safe internationalization) strategy (Rugman & Verbeke, 2001).

As a robustness check for H2, we also estimated model (2) using logistic panel data estimation. We used the same dependent,

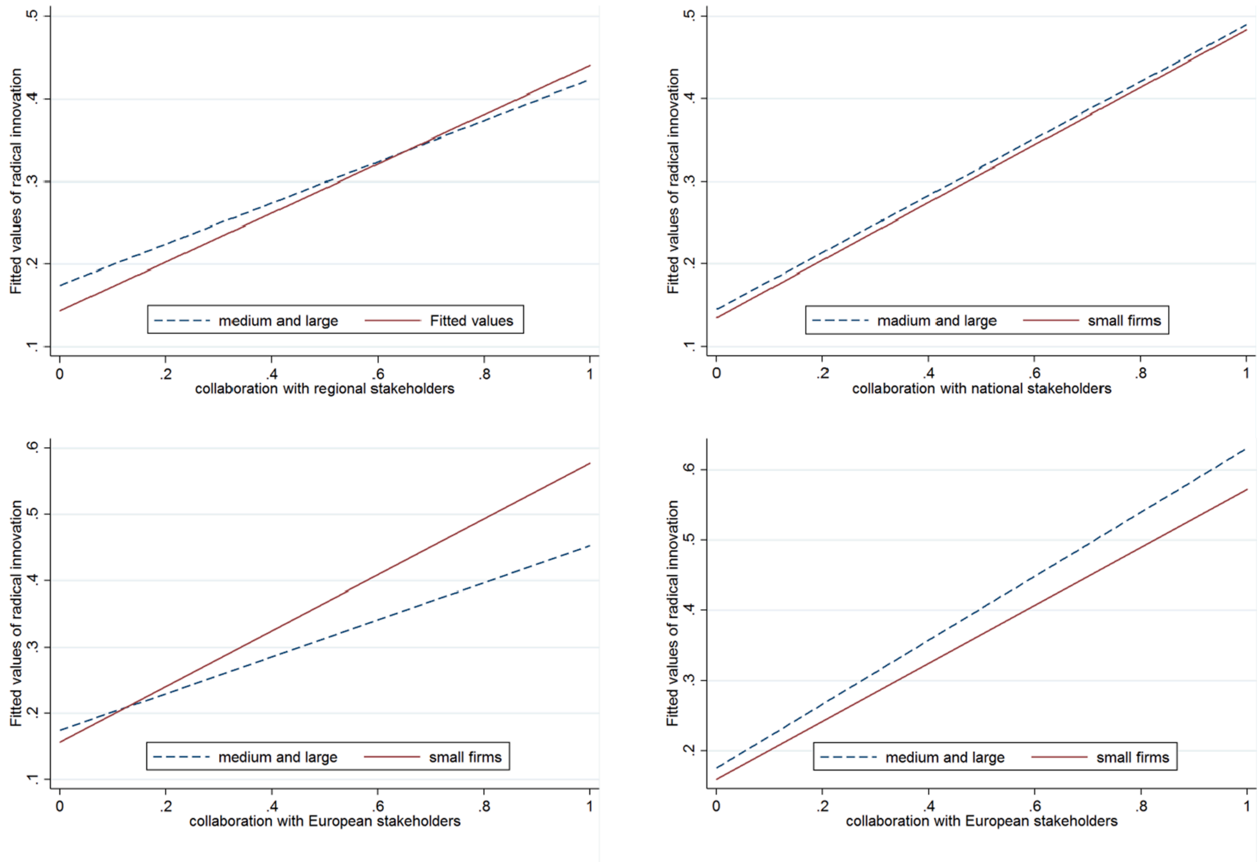


**Fig. 1.** Differences in product innovation conditional on knowledge conditional on their collaboration partner (mixed-effect GLM). Source: Authors based on the Office of National Statistics: BSD, BERD, and UKIS (2002–2014).

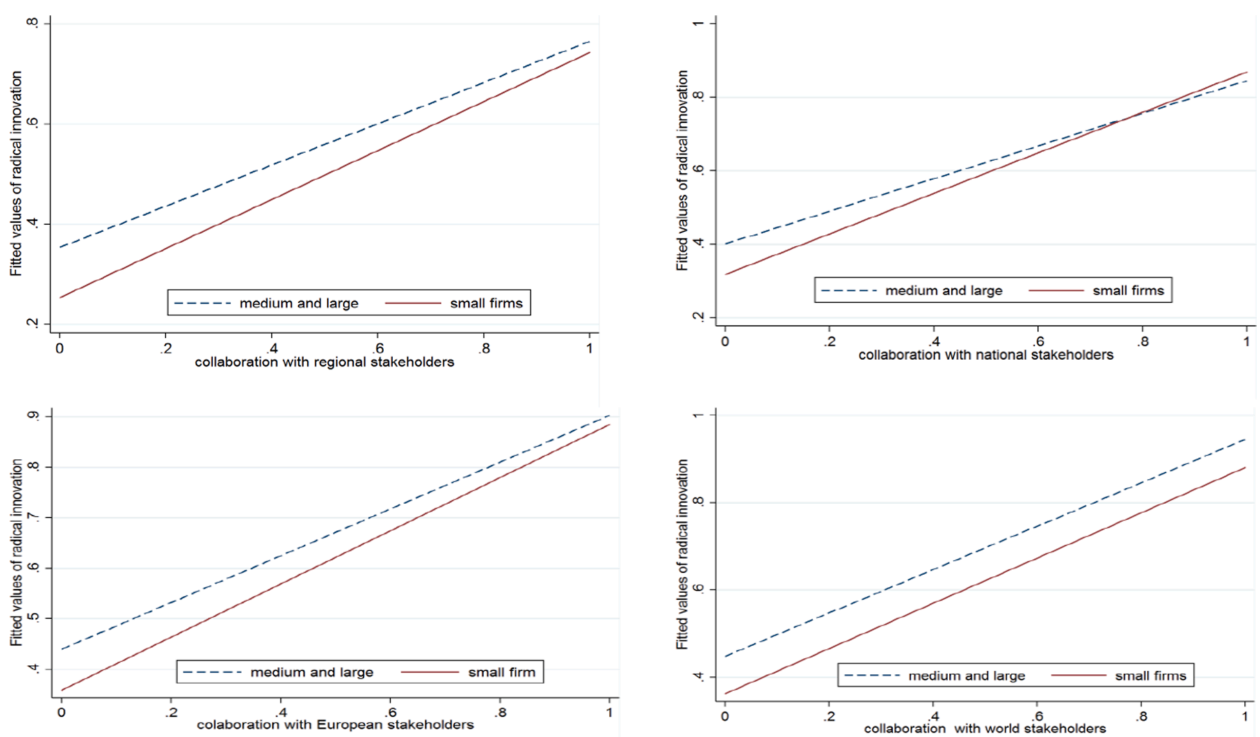


**Fig. 2.** Differences in product innovation conditional on knowledge conditional on their collaboration partner (logistic estimation). Source: Authors based on the Office of National Statistics: BSD, BERD, and UKIS (2002–2014).

independent, and control variables, but did not account for multi-level effects. The logistic regression results support mixed-effect GLM results with the predictive margins for product innovation, which are illustrated in Fig. 2. It confirms the positive effect of knowledge collaboration for product innovation in Schumpeterian firms across all geographical dimensions. One may observe that the change in predicted innovation levels is the highest for small firms that collaborate with European innovation ecosystems' agents.

## 5. Discussion and conclusion

This study makes three contribution to knowledge spillover of innovation and entrepreneurship literature.

First, controlling for multiple firm-level characteristics we examine the role that the knowledge collaboration with innovation ecosystem agents across different geographical proximities play in innovation and growth in Schumpeterian firms. Prior studies have explored the effects of unintentional knowledge transfer mainly via passive networks (Giovannetti & Piga, 2017), via spillovers from investment in R&D and technology (Audretsch & Belitski, 2020b) and other stakeholders (Feldman, 1999; Meissner, 2016; Kobarg et al., 2019), with little research on knowledge spillover of innovation drawing on active and direct forms of knowledge collaboration with ecosystem agents. In this respect, this study extends the recent stream of knowledge spillover research (Jaffe, 1986; Griliches, 1991; Audretsch & Feldman, 1996) of the factors that facilitate the knowledge-driven innovation (Roper et al., 2017).

Second, this study demonstrates the role of geographical proximity affect of innovation in Schumpeterian firms as a form of intentional knowledge transfer (Cassiman & Veugelers, 2002; Colombo, Laursen, Magnusson, & Rossi-Lamastra, 2011; West et al., 2014; Colombelli et al., 2014, 2016; Fischer et al., 2018), and thereby contribute to the knowledge collaboration literature on the role that global and local dimensions of knowledge in a form of spillovers may predict the innovation outcome – sales and innovation (Audretsch & Belitski, 2020a) and between Schumpeterian firms of different size (Audretsch & Vivarelli, 1996; Rogers, 2004; Ghio et al., 2015).

Third, unlike prior research that focused on the role of external knowledge sourcing and open innovation in inter-firm networks (Alvedalen & Boschma, 2017; Fischer et al., 2018) our study advances knowledge spillover of innovation literature by describing the caveats and opportunities for innovation in Schumpeterian firms and the role of firm size in this relationship.

Our paper reinforces the main theme explored throughout knowledge-based entrepreneurship research (Cohen & Klepper, 1996; Audretsch & Keilbach, 2007; Nambisan et al., 2018), the contention that inter-organizational learning in an innovation ecosystem within local and global contexts and with local-embeddedness of knowledge collaboration.

First, the proposed hypotheses referred to the role played by the knowledge collaboration with innovation ecosystem actors within close geographical proximity with the relationship conditional on firm size. While the estimates of the knowledge collaboration within regional and national boundaries facilitate innovation sales in Schumpeterian firms, it is not associated with knowledge collaboration internationally. Smaller firms were found to be more innovative if they are able to create a temporary knowledge proximity with innovation ecosystems agents and source new knowledge from them across Europe.

Second, the regional and national dimension of knowledge collaboration with ecosystem agents enables tacit knowledge via innovation spillovers that have a strong and pronounced effect on innovation across all specifications in our model. In contrast, the international knowledge collaboration with ecosystem agents is unlikely to change innovation sales of Schumpeterian firms, providing further insights on the effect of multinationalization (Vanninen, Kuivalainen, & Ciravegna, 2017) and localization of startups (Boschma, 2005; Guerrero et al., 2020).

There is growing evidence that Schumpeterian firms, which seek to capture global opportunities rapidly, collaborate with businesses locally and nationally, building on common proximities (Balland et al., 2015) and building more substantial interrelationship and partnerships.

Third, small size Schumpeterian firms are known to attract the most knowledge Secondly, when collaborating with innovation ecosystem agents in Europe furthering research on knowledge spillovers between developed economies and firms' exposure to a "temporary" geographical proximity (Torre, 2008). This finding may have an important implication for policymaking and in particular during the post-Brexit period.

Fourth, knowledge-based firms rely on external knowledge sources embodied in employees and intermediate inputs who can commercialize knowledge produced by incumbent firms (Ács et al., 2009; Santamaria et al., 2009) and available in the region and country where Schumpeterian firms operate. Larger Schumpeterian firms were found to be less likely to increase their innovation performance in collaboration with European partners, compared to smaller size Schumpeterian firms. Also, large firms can be less dependent on the knowledge sources of the regions where they are 'located' because their size involves being present in other regions or countries from whose knowledge sources they can benefit.

In unpacking these heterogeneities effects in knowledge collaboration across different geographical proximities and between Schumpeterian firms of different size (Rogers, 2004) this study fits with the recent call in innovation and knowledge-based entrepreneurship literature on the drivers of firm growth process, on the nature of innovation and firm performance in firms of different types. Our findings also add to recent advances in the knowledge spillover literature which describe the limitations and opportunities realised by knowledge collaboration (West et al., 2014) and within knowledge-intensive industries (Del Giudice & Maggioni, 2014; Audretsch & Belitski, 2020a). Specifically, we advance the innovation ecosystems and knowledge spillover literature by considering the effects of intended knowledge collaboration in a form of knowledge transfer between different partner types and generated knowledge spillovers as the mechanisms of firm performance.

This study also addressed claims that firm and regional factors jointly determiner the propensity of Schumpeterian firms to innovate and scale up (Colombelli et al., 2014) and that external knowledge sourcing related to local knowledge is the paramount region-based externality (Balland et al., 2015; Audretsch, Belitski, & Desai, 2015) which explains the decision to innovate and the extent of innovation activity.

Our findings have important implication for manager-owners of Schumpeterian firms and policymakers as we expand the prior research on distinct knowledge transfer strategies for innovation and evidence-based innovation policies (Gokhberg & Meissner, 2016), what are they and which firms choose them. In doing this, we provide further rationale for looking at the geographical dimension and firm size as two boundary conditions of firm performance and provide further insights into the patterns of knowledge sourcing within the country and internationally. In this study, we explore the external knowledge sourcing factors (Chesbrough et al. 2006; Kobarg et al., 2019) in addition to firm-level factors that drive innovation (Santamari et al. 2009; Fischer et al., 2018). Third, this paper responds to the call in the special issue for (a) research on how to shape and foster innovation ecosystems as to connect technological evolution with the generation of Schumpeterian-type knowledge-intensive ventures; and (b) gain empirical insights into the multifaceted perspective on the knowledge collaboration for 'evidence-based' policy (Gokhberg & Meissner, 2016) relate do innovation management ion Schumpeterian firms in the innovation ecosystems context.

Finally, the UK case during the sample period (2002–2014) offers an interesting environment for such an analysis. In the sample period, UK has evidenced severe economic downturns and periods of economic recovery and growth.

The implications for innovation ecosystem development policy are are follows. Firstly, our findings confirm the importance of using both geographical and firm size perspective when studying innovation Schumpeterian firms. We found that 'European' collaboration with innovation ecosystems' agents enables small-sized Schumpeterian firms in the UK, which are not associated with multinational corporations and enterprise groups, to obtain competences and knowledge not available where they are located. The decision to relocate where specific competencies are present (for example, where agglomeration economies occur) could be costly in the UK, so small-sized firms substitute the "permanent" geographical proximity with forms of "temporary geographical proximity" (Torre & Rallet, 2005). It is a plausible explanation for small firms benefiting more from European innovation ecosystems' agents than medium and large-sized firms. "Temporary" geographical proximity allows Schumpeterian firms to reach competencies not available or not affordable outside national boundaries (Torre & Rallet, 2005; Torre, 2008).

Secondly, collaboration with European innovation ecosystems' agents on innovation is likely to be more efficient for innovative start-ups with substantial government support to be given to such collaboration. The collaboration may also include mentoring, access to European financial markets, and customers. The UK government policy should ensure that small and micro-Schumpeterian firms will access important European innovation ecosystems' agents after Brexit. European governmental and non-governmental support agencies may develop a guideline for the post-Brexit knowledge collaboration between knowledge-based firms in the UK and Europe.

The main limitations of this study are as follows. Firstly, due to the anonymous nature of the UK Innovation survey, no additional sources for information on external innovation ecosystems' agents could be added to the database, which could have been used to supplement the data. In particular, we cannot track the intensity/time of engagements between innovation ecosystems' agents. Cross country analysis could have provided more robust and generalizable results. Secondly, this research focuses specifically on the multi-dimension of innovation with the mixed effect model within one country. A cross-country study could be performed to measure differences in the institutional environment across countries and their link to Schumpeterian entrepreneurship. Finally, this study cannot measure the amount of jointly undertaken research and development nor the application on perception-based efficiency measures of collaboration from low to high. Subsequent research will address these limitations and expand the qualitative and quantitative measurements for the degree of collaboration between a Schumpeterian firm and an external innovation ecosystems' agent.

Future research will distinguish the breadth, depth, and length of knowledge collaboration across different sizes of firms and proximity. Also, future research may focus on different returns to necessity vs. opportunity-driven knowledge collaborations in Schumpeterian firms. It is important to distinguish between knowledge collaboration, financial compensation for the knowledge transfer, and knowledge spillovers as a knowledge externality. The research calls for future papers to address knowledge sourcing and Schumpeterian firms in other countries in order to understand better how innovation happens and further mechanisms that facilitate the knowledge spillover of innovation.

## CRediT authorship contribution statement

**David Bruce Audretsch:** Conceptualization, Investigation, Supervision, Writing – original draft. **Maksim Belitski:** Conceptualization, Data curation, Investigation, Methodology, Validation, Visualization. **Maribel Guerrero:** Conceptualization, Investigation, Validation.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References


Ács, Z. J., & Audretsch, D. B. (1990). *Innovation and small firms*. MIT Press.

Ács, Z. J., Braunerhjelm, P., Audretsch, D. B., & Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics, 32*(1), 15–30.

Ács, Z., Stam, E., Audretsch, D., & O'Connor, A. (2017). The lineages of the entrepreneurial ecosystem approach. *Small Business Economics, 49*(1), 1–10.

Ács, Z. J., Autio, E., & Szerb, L. (2014). National systems of entrepreneurship: Measurement issues and policy implications. *Research Policy, 43*(3), 476–494.

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of Management, 43*(1), 39–58.

Alvedalen, J., & Boschma, R. (2017). A critical review of entrepreneurial ecosystems research: Towards a future research agenda. *European Planning Studies, 25*(6), 887–903.

Asheim, B. T., & Coenen, L. (2005). Knowledge bases and regional innovation systems: Comparing Nordic clusters. *Research Policy, 34*(8), 1173–1190.

Asheim, B., Smith, H., & Oughton, C. (2011). Regional Innovation Systems: Theory, Empirics and Policy. *Regional Studies, 45*(7), 875–891.

Audretsch, D. B., & Feldman, M. P. (1996). R&D spillovers and the geography of innovation and production. *The American Economic Review, 86*(3), 630–640.

Audretsch, D. B., & Vivarelli, M. (1996). Firms size and R&D spillovers: Evidence from Italy. *Small Business Economics, 8*(3), 249–258.

Audretsch, D. B., & Lehmann, E. E. (2005). Does the knowledge spillover theory of entrepreneurship hold for regions? *Research Policy, 34*(8), 1191–1202.

Audretsch, D. B., & Keilbach, M. (2007). The theory of knowledge spillover entrepreneurship. *Journal of Management Studies, 44*(7), 1242–1254.

Audretsch, D. B., & Belitski, M. (2017). Entrepreneurial ecosystems in cities: Establishing the framework conditions. *The Journal of Technology Transfer, 42*(5), 1030–1051.

Audretsch, D. B., Belitski, M., & Desai, S. (2015). Entrepreneurship and economic development in cities. *The Annals of Regional Science, 55*(1), 33–60.

Audretsch, D. B., Belitski, M., & Desai, S. (2019). National business regulations and city entrepreneurship in Europe: A multilevel nested analysis. *Entrepreneurship Theory and Practice, 43*(6), 1148–1165.

Audretsch, D. B., & Belitski, M. (2020a). The limits to collaboration across four of the most innovative UK industries. *British Journal of Management, 31*(4), 830–855.

Audretsch, D. B., & Belitski, M. (2020b). The role of R&D and knowledge spillovers in innovation and productivity. *European Economic Review, 123*, Article 103391.

Autio, E., Kenney, M., Mustar, P., Siegel, D., & Wright, M. (2014). Entrepreneurial innovation: The importance of context. *Research Policy, 43*(7), 1097–1108.

Balland, P. A., Boschma, R., & Frenken, K. (2015). Proximity and innovation: From statics to dynamics. *Regional Studies, 49*(6), 907–920.

Battke, B., Schmidt, T. S., Stollenwerk, S., & Hoffmann, V. H. (2016). Internal or external spillovers—Which kind of knowledge is more likely to flow within or across technologies. *Research Policy, 45*(1), 27–41.

Beers, C., & Zand, F. (2014). R&D cooperation, partner diversity, and innovation performance: An empirical analysis. *Journal of Product Innovation Management, 31*(2), 292–312.

Bogers, M., Zobel, A.-K., Afuah, A., Almirall, E., et al. (2017). The open innovation research landscape: Established perspectives and emerging themes across different levels of analysis. *Industry and Innovation, 24*(1), 8–40.

Borgatti, S. P., & Halgin, D. S. (2011). On network theory. *Organization Science, 22*, 1168–1181.

Boschma, R. (2005). Proximity and innovation: A critical assessment. *Regional Studies, 39*(1), 61–74.

Boschma, R., & Frenken, K. (2010). The spatial evolution of innovation networks. A proximity perspective. *The Handbook of Evolutionary Economic Geography*, 120–135.

Bughin, J., & Jacques, J. M. (1994). Managerial efficiency and the Schumpeterian link between size, market structure and innovation revisited. *Research Policy, 23*(6), 653–659.

Cappelli, R., Czarnitzki, D., & Kraft, K. (2014). Sources of spillovers for imitation and innovation. *Research Policy, 43*, 115–120.

Cassiman, B., & Veugelers, R. (2002). R&D cooperation and spillovers: Some empirical evidence from Belgium'. *American Economic Review, 92*(4), 1169–1184.

Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science, 52*, 68–82.

Cervantes, M., & Meissner, D. (2014). Commercialising public research under the open innovation model: New trends. *Foresight and STI Governance, 8*(3), 70–81.

Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.). (2006). *Open Innovation: Researching a New Paradigm*. Oxford: Oxford University Press.

Cohen, W. M., & Klepper, S. (1996). Firm size and the nature of innovation within industries: The case of process and product R&D. *The Review of Economics and Statistics*, 232–243.

Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: The two faces of R & D. *The Economic Journal, 99*(397), 569–596.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 128–152.

Colombelli, A., Krafft, J., & Quatraro, F. (2014). High-growth firms and technological knowledge: Do gazelles follow exploration or exploitation strategies? *Industrial and Corporate Change, 23*(1), 261–291.

Colombelli, A., Krafft, J., & Vivarelli, M. (2016). To be born is not enough: The key role of innovative start-ups. *Small Business Economics, 47*, 277–291.

Colombelli, A., & Quatraro, F. (2018). New firm formation and regional knowledge production modes: Italian evidence. *Research Policy, 47*(1), 139–157.

Colombo, M. G., Laursen, K., Magnusson, M., & Rossi-Lamastra, C. (2011). Organizing inter-and intra-firm networks: What is the impact on innovation performance? *Industry and Innovation, 18*(6), 531–538.
De Clercq, D., Hessels, J., & van Stel, A. (2008). Knowledge spillovers and new ventures' export orientation. *Small Business Economics, 31*, 283–303.
Del Giudice, M., & Maggioni, V. (2014). Managerial practices and operative directions of knowledge management within inter-firm networks: A global view. *Journal of Knowledge Management, 18*(5), 841–846.
Darr, E. D., Argote, L., & Epple, D. (1995). The acquisition, transfer and depreciation of knowledge in service organizations: Productivity in franchises. *Management Science, 41*(11), 1750–1762.
De Massis, A., Audretsch, D., Uhlaner, L., & Kammerlander, N. (2018). Innovation with limited resources: Management lessons from the German Mittelstand. *Journal of Product Innovation Management, 35*(1), 125–146.
Eisenhardt, K. M., & Schoonhoven, C. B. (1996). Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. *Organization Science, 7*(2), 136–150.
Feldman, M. (1999). The new economics of innovation, spillovers and agglomeration: A review of empirical studies. *Economics of Innovation and New Technology, 8*, 5–25.
Feldman, M. P., & Kelley, M. R. (2006). The ex-ante assessment of knowledge spillovers: Government R&D policy, economic incentives and private firm behavior. *Research Policy, 35*, 1509–1521.
Fischer, B., Queiroz, S., & Vonortas, N. (2018). On the location of knowledge-intensive entrepreneurship in developing countries: Lessons from São Paulo. *Brazil. Entrepreneurship and Regional Development, 30*(5–6), 612–638.
Frenz, M., & Ietto-Gillies, G. (2009). The impact on innovation performance of different sources of knowledge: Evidence from the UK Community Innovation Survey. *Research Policy, 38*, 1125–1135.
Ghio, N., Guerini, M., Lehmann, E. E., & Rossi-Lamastra, C. (2015). The emergence of the knowledge spillover theory of entrepreneurship. *Small Business Economics, 44*(1), 1–18.
Giovannetti, E., & Piga, C. A. (2017). The contrasting effects of active and passive cooperation on innovation and productivity: Evidence from British local innovation networks. *International Journal of Production Economics, 187*, 102–112.
Gokhberg, L., & Meissner, D. (2016). Seizing future opportunities for national STI Development. In L. Gokhberg, D. Meissner, & A. Sokolov (Eds.), *Deploying foresight for policy and strategy makers. Creating opportunities through public policies and corporate strategies in science, technology and innovation* (pp. 267–273). Heidelberg: Springer.
Goldstein, H. (2011). *Multi-level statistical models* (Vol. 922). John Wiley & Sons.
Griliches, Z. (1991). The search for R&D spillovers. *The Scandinavian Journal of Economics, 94*(Suppl.), 29–47.
Guerrero, M., Liñán, F., & Cáceres-Carrasco, F. R. (2020). The influence of ecosystems on the entrepreneurship process: A comparison across developed and developing economies. *Small Business Economics*, 1–27.
Hornsby, J. S., Kuratko, D. F., Holt, D. T., & Wales, W. J. (2013). Assessing a measurement of organizational preparedness for corporate entrepreneurship. *Journal of Product Innovation Management, 30*(5), 937–955.
Jaffe, A. B. (1986). *Technological opportunity and spillovers of R&D: evidence from firms' patents, profits and market value*.
Jaspers, F., & Van den Ende, J. (2010). Open innovation and systems integration: How and why firms know more than they make. *International Journal of Technology Management, 52*(3/4), 275–294.
Kelley, M. R., & Helper, S. (1999). Firm size and capabilities, regional agglomeration, and the adoption of new technology. *Economics of Innovation and New technology, 8* (1–2), 79–103.
Kirzner, I. M. (1973). *Competition and Entrepreneurship*. Chicago: University of Chicago Press.
Kirzner, I. M. (1999). Creativity and/or alertness: A reconsideration of the Schumpeterian entrepreneur. *The Review of Austrian Economics, 11*(1–2), 5–17.
Kleinknecht, A., Van Montfort, K., & Brouwer, E. (2002). The non-trivial choice between innovation indicators. *Economics of Innovation and new technology, 11*(2), 109–121.
Knight, F. H. (1933). *The Economic Organization*. Chicago: University of Chicago Press.
Kobarg, S., Stumpf-Wollersheim, J., & Welpe, I. M. (2019). More is not always better: Effects of collaboration breadth and depth on radical and incremental innovation performance at the project level. *Research Policy, 48*(1), 1–10.
Laursen, K., & Salter, A. J. (2006). Open for innovation: The role of openness in explaining innovative performance among UK manufacturing firms. *Strategic Management Journal, 27*, 131–150.
Laursen, K., & Salter, A. J. (2014). The paradox of openness: Appropriability, external search and collaboration. *Research Policy, 43*(5), 867–878.
Love, J. H., Roper, S., & Vahter, P. (2014). Learning from openness: The dynamics of breadth in external innovation linkages. *Strategic Management Journal, 35*(11), 1703–1716.
Luke, D. A. (2004). *Multi-level modeling* (Vol. 143). Sage.
Malerba, F., & Orsenigo, L. (1996). Schumpeterian patterns of innovation are technology-specific. *Research Policy, 25*(3), 451–478.
March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization Science, 2*(1), 71–87.
Maskell, P., Bathelt, H., & Malmberg, A. (2004). Temporary clusters and knowledge creation: the effects of international trade fairs, conventions and other professional gatherings.
Meissner, D., Polt, W., & Vonortas, N. S. (2017). Towards a broad understanding of innovation and its importance for innovation policy. *The Journal of Technology Transfer, 42*(5), 1184–1211.
Meissner, D., & Kotsemir, M. N. (2016). Conceptualizing the innovation process towards the 'active innovation paradigm'—Trends and outlook. *Journal of Innovation and Entrepreneurship, 5*(1), 1.
Meissner, D. (2016). Identification of stakeholders' hidden agendas for technology diffusion. In L. Gokhberg, D. Meissner, & A. Sokolov (Eds.), *Deploying foresight for policy and strategy makers. Creating opportunities through public policies and corporate strategies in science, technology and innovation* (pp. 33–48). Heidelberg: Springer.
Meissner, D. (2015). *Measuring innovation—A discussion of innovation indicators at the national level*. The Swiss Science and Innovation Council. Series SSIC Secretariat, No 3.
Miotti, L., & Sachwald, F. (2003). Co-operative R&D: Why and with whom?: An integrated framework of analysis. *Research Policy, 32*(8), 1481–1499.
Mthanti, T., & Ojah, K. (2017). Entrepreneurial orientation (EO): Measurement and policy implications of entrepreneurship at the macroeconomic level. *Research Policy, 46*(4), 724–739.
Narula, R. (2004). R&D collaboration by SMEs: New opportunities and limitations in the face of globalisation. *Technovation, 24*(2), 153–161.
Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V., & Van den Oord, A. (2007). Optimal cognitive distance and absorptive capacity. *Research policy, 36*(7), 1016–1034.
O'Connor, A., Stam, E., Sussan, F., & Audretsch, D. B. (2018). Entrepreneurial Ecosystems: The Foundations of Place-based Renewal. In *Entrepreneurial Ecosystems* (pp. 1-21). Springer, Cham.
Pakes, A., & Griliches, Z. (1984). Patents and R and D at the Firm Level: A First Look. In Z. Griliches (Ed.), *R & D Patents & Productivity* (pp. 55–72). Chicago: University of Chicago Press.
Qian, H., & Ács, Z. J. (2013). An absorptive capacity theory of knowledge spillover entrepreneurship. *Small Business Economics, 40*(2), 185–197.
Rabe-Hesketh, S., Pickles, A., & Taylor, C. (2000). Generalized linear latent and mixed models. *Stata Technical Bulletin, 53*(sg129), 49–57.
Rogers, M. (2004). Networks, firm size and innovation. *Small Business Economics, 22*(2), 141–153.
Roper, S., & Hewitt-Dundas, N. (2015). Knowledge stocks, knowledge flows and innovation: Evidence from matched patents and innovation panel data. *Research Policy, 44*(7), 1327–1340.
Roper, S., Love, J. H., & Bonner, K. (2017). Firms' knowledge search and local knowledge externalities in innovation performance. *Research Policy, 46*(1), 43–56.
Rugman, A. M., & Verbeke, A. (2001). Subsidiary-specific advantages in multinational enterprises. *Strategic Management Journal, 22*(3), 237–250.
Santamaria, L., Nieto, M. J., & Barge-Gil, A. (2009). Beyond formal R&D: Taking advantage of other sources of innovation in low-and medium-technology industries. *Research Policy, 38*(3), 507–517.
Schamberger, D. K., Cleven, N. J., & Brettel, M. (2013). Performance effects of exploratory and exploitative innovation strategies and the moderating role of external innovation partners. *Industry and Innovation, 20*(4), 336–356.
Schumpeter, J. A. (1934). *The theory of economic development*. Cambridge, Mass: Harvard University Press.
Torre, A., & Rallet, A. (2005). Proximity and localization. *Regional Studies, 39*(1), 47–59.
Torre, A. (2008). On the role played by temporary geographical proximity in knowledge transmission. *Regional Studies, 42*(6), 869–889.
Tsai, W., & Ghoshal, S. (1998). Social capital and value creation: The role of intrafirm networks. *Academy of Management Journal, 41*(4), 464–476.
Vanninen, H., Kuivalainen, O., & Ciravegna, L. (2017). Rapid multinationalization: Propositions for studying born micromultinationals. *International Business Review, 26* (2), 365–379.
West, J., Salter, A., Vanhaverbeke, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy, 43*(5), 805–811.
Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review, 27*(2), 185–203.



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