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Openness and innovation in new small and micro firms - Exploring the external search processes of entrepreneurial ventures

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Abstract

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Existing state of the art:

The notion of how firms use external search to achieve innovation is a long running, and continuously debated, topic in current innovation and entrepreneurship studies (Laursen, 2012). Additionally, studies relating firm openness and external search processes to innovativeness have proliferated in recent years (Dahlander and Gann, 2010).

Research gap:

OECD (2008) has argued that small and micro firms are some of the most important firms driving these economic growth and industrial change. However, few studies address the relationship between innovativeness and openness among entrepreneurial small- and micro-firms (Forsman and Rantanen, 2011). An increased understanding is needed about how and why such firms are able to utilize, assimilate, and internalize external resources related to knowledge in order to innovate. This paper analyzes the innovative performance of entrepreneurial small and micro (ESM) firms by utilizing an established concept of openness using breadth and depth of external search (Laursen and Salter, 2006).

This paper can thus contribute to our theoretical and empirical understanding openness and innovative performance of these firms, an underrepresented population in terms of innovation surveys and theory, which has been mainly focused on medium to large manufacturing firms.

Main theoretical arguments:

While openness has had documented positive impacts on new small and micro firm performance (de Jong and Marsili, 2006), small and micro firms also face steep challenges when attempting to use networks to increase their competitiveness (Forsman, 2009). Thus, a firm relying on too many external sources of knowledge may experience diminishing returns from excessive additional sources. This paper tests the hypotheses that ESM firms in both goods and service-oriented sectors will experience a curvi-linear relationship between openness and innovative performance. As found for larger manufacturing firms (Laursen and Salter, 2006), innovative performance should be positively related to wide breadth and extensive depth of external search. Additionally, this paper argues that the more open the firm, the higher will be the degree of novelty, or radicalness, of innovations produced. There is evidence that new small and micro firms are often rather lacking in their experience and resources to properly innovate and commercialize invention drawing on external knowledge sources, and that resource scarcity of firms can trigger increased propensity towards exploratory activities and a recombining of internal and external firm resources (Lee et al., 2010; Keupp and Gassmann, 2013).

Research method:

The paper is based on empirical data from the EU sponsored AEGIS projectâ??s recent survey of 4004 entrepreneurial small and micro firms in Europe in diverse sectors. The paper employs Tobit, as well as alternating least squares optimal scaling, regression to estimate the effect of breadth and depth of external search (representing openness) on the latent dependent variable innovative performance, as represented by 3 dependent variables. This is followed by a principle component analysis, with all 3 models repeated with relevant components as independent variables, serving to further disambiguate the effect of the depth construct.

Results:

Regarding breadth of search, our hypotheses are confirmed. But, the depth variable is composed of 3 main components that seem to represent different categories of external knowledge sources, each with differing relationships to the innovative performance. Some results are statistically significant while others are not; possible explanations are listed in the conclusion. More research into the effect of depthâ??s principal components: Industry sources in the form of business and operations-based relationships; Non-industry sources mainly related to state, national or regional research-based (or academic) entities; And, sources stemming from non-collaborative public knowledge in academic and other research publishing communities, and their effects on innovative performance, is recommended.

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Openness and innovation in new small and micro firms:

A study of entrepreneurial firms' external search processes

Introduction

Collaboration and co-creation for innovation beyond the boundaries of the organization is not a new phenomenon, although recently there has been a surge in interest in the *open innovation* concept as a research theme in management and business studies, particularly within the fields of innovation and to some extent entrepreneurship. Scholars more than ever are attributing importance to how a firm utilizes its positioning within a collaborative network in order to produce innovations in a given business area (Carayannis and Alexander, 1999; Chesbrough, 2003; von Hippel, 1988; Wennberg et al., 2011). Open innovation is "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as [they] look to advance their technology (Chesbrough, 2003:XXIV)." Through interaction with external knowledge sources through varying forms of collaboration, the firm can become more innovative and more competitive in the long term. Despite the fact that its limitations and risks are rarely pointed out in the literature, it is generally agreed that more openness to innovation from external sources results in net positive gains for a firm (Dahlander and Gann, 2010).

Though open innovation remains a widely researched topic, attempts to trace its relationship with entrepreneurial[1] small and micro-firms is still under development, and the phenomenon remains under-explained by the literature (Forsman and Ratanen, 2011; van de Vrande et al., 2008; Vanhaverbeke, 2012) [2]. Consequently, little has been done to explain nuances of external openness[3] among firms of this size involved in both goods and service-based activities (Forsman and Ratanen, 2011). This paper investigates these issues of openness and innovativeness in the context of entrepreneurial small and micro-sized enterprises.

In this study openness is defined as follows: *the degree to which firms are open to external sources of knowledge in their innovative and entrepreneurial processes:* Innovative processes being the development and sale of new or significantly improved products or services; entrepreneurial processes being the identification and exploitation of new business opportunities. This paper asks the question:

[1] The concept of entrepreneurship is herein used to describe authentically *new* firms, and does not equate with opportunity seeking by individuals or within existing organizations.
[2] Ranging from 0-50 employees, with micro firms being those with 10 employees or less.
[3] Openness refers to the conceptualized form of *open innovation* popularized by scholars in recent years (cf. Katila & Ahuya, 2002; Laursen & Salter, 2006)

What is the effect of openness to external knowledge sources on the innovative performance of entrepreneurial (or new) small and micro-sized ventures?

This paper approximates search *breadth*; the "number of external sources or search channels that firms rely upon", and search *depth*; the "extent to which firms draw deeply from the different external sources or search channels", as representing a firm's openness to outside sources of knowledge (Laursen and Salter, 2006: 134). The data studied was collected during the EU project AEGIS. This paper expands on and contributes to the literature by investigating the relationship between the extent of reliance on external sources of knowledge and the approximated innovative performance in entrepreneurial small and micro-firms, a grouping of organizations that has been less often analyzed in the field of innovation studies, especially with large scale survey data.

The following sections of the paper give an overview of external search and openness in an innovation-specific context, as well as a review of the economic importance of small and micro-firms and their degree of openness. Specific theory regarding openness for firms involved in manufacturing as well as service activities will then be addressed. A review of the methods behind the research then follows, in addition to descriptive and empirical results. An analytical section, as well as limitations and future research directions/implications will close the paper.

Openness and Small Firms

It has become a stylized fact that both new and established small firms are a vital component of economic growth and industrial change (Birch, 1979; Rothwell and Zegveld, 1982; Rothwell, 1989). The OECD (2008) has argued that micro firms are some of the most important firms driving global economic growth, and that using policy as a tool to help them overcome challenges to their size, networking potential, and competitiveness could be a strong recipe for strengthening entrepreneurship. Prescriptions constitute the broadening of support programs; including better-tailored network building, greater policy awareness, and not least, encouraging more collaborative measures among these firms regarding innovation in order to become more internationally competitive (OECD, 2008; OECD, 2013). Through networks and inter-organizational collaborations, firms of a smaller scale can increase their overall innovative capacity (Szeto, 2000; Caniels, 2005; Forsman, 2011): Additionally, it has been argued that collaborations of a technological character are highly useful for enhancing innovative capacity of firms of varying size (Alonso and Bressan, 2014), and that achieving this is of critical importance for the smallest of firms (Nieto and Santamaría, 2010).

This dilemma is not limited to lack of policy initiatives, but includes also inherent shortcomings of the firm itself. Limited external collaboration is often the result of a wide variety of pressures impacting most small and micro firms, new and established, mainly that of competition and of limited resources

(Kotey and Sheridan, 2004; Franco and Haase, 2010; Thorgren et al., 2012; Alonso and Bressan, 2014). Additional problems such as ineffective opportunity identification, screening difficulties regarding relevant trends, and tendencies towards adaptive management and inhibited networks, affect smaller enterprises' growth potential and longevity (Scozzi and Garavelli, 2005; Forsman, 2011).

Concerning the innovative activities of the firm, Cohen and Klepper (1996) observed that smaller enterprises seem to invest more in product-based innovations while large firms invest more in process-based innovations. There is also evidence that between small and micro firms, relatively larger firms are often able to achieve the more capital intensive innovation, while smaller firms tend to pursue innovations that do not require a high degree of investment (Avermaete et al., 2003; Forsman, 2011). This may be related to resource constraints. Major sources for these constraints have been found to range from management, labor skills, lack of finance and information (Cressy and Olofsson, 1997), to lack of owner-specific and organization-specific resources, all of which are crucial for performance and growth (Brush and Chaganti, 1999). Nonetheless, smaller firms which "are aware of and use external information" (de Jong and Marsili, 2006: 221) have been found to be better off in terms of introducing successful innovations than those which do not.

So, what kind of collaborations should new small and micro firms derive the most benefit from? While there is limited research addressing the specific concept of *openness* related to innovation output in small and micro-firms, there is has been some work done on the learning capabilities of micro-firms through cooperative networks concerning resource collaboration and start-up performance (Chell and Banes, 2000; Mäkinen, 2002; Reinl and Kelliher, 2010). Other studies point to the performance enhancing properties of learning from and interacting with larger organizations (Anderson and Lööf, 2012) and that the collaboration with a larger multinational enterprise can play a vital role in completing the innovation process by introducing a micro firm's new product(s) to the market (Granstrand and Sjölander, 1990). More broadly; external networks and collaboration facilitate the ability of micro, small and medium sized enterprises to gain improved knowledge, acquire new access to markets, and reduce research and development costs (Glaister and Buckley, 1996; Forsman, 2011).

Moreover, literature investigating *co-opetition*, or, the simultaneity of cooperation and competition between (small) firms, has shown that new technologies and products are often the result of co-opetition in the form of increased technological diversity and new combinations of complementary resources between rival firms (Harbison and Pekar, 1998; Gnyawali and Park, 2009; Quintana-García and Benavides-Velasco, 2004). Additionally, competitors often collaborate in order to appropriate benefits from achieving scale economies, improved risk mitigation, and heightened resource-leveraging capacity (Morris, Kocak, and Özer, 2007). Thus, it seems highly likely that a broad

assortment of external sources of knowledge should positively contribute to a micro- or small firm's innovative performance.

However, while there are many benefits for building innovative capacity via networks and collaborative efforts, some smaller organizations may not be able to adequately utilize all the outside resources, capabilities, and knowledge that they gain access to. Due to their periphery status in production chains, smaller enterprises often face steep challenges when attempting to use networks to increase their competitiveness (Forsman, 2009; 2011). Additional interaction capabilities are required for reaping the benefits of a network relationship that smaller firms often lack or have not sufficiently developed. Thus, a firm relying on too many sources of knowledge may experience decreasing returns from this process.

Openness and Manufacturing Innovation

External search breadth and depth

Search processes in organizational science in general:

Taking its cue from the Marshallian (1949, p. 295) notion of the firm's tendency toward variation as being "a chief cause of progress", a substantial body of literature has addressed how firms carry out technological search processes spanning technological and organizational boundaries in the aim of attaining process and product innovation (Laursen, 2012). Indeed, much of the prominent literature in innovation studies deals with the idea of organizations *searching* for new knowledge in order to innovate. Much of this research has differentiated between internal and external search processes, or local and non-local search processes (Fleming and Sorenson, 2004), and how these search processes are used for both explorative and exploitative aims (March, 1991). Explorative (external/non-local) search involves conscious steps taken to move beyond or away from current routines and knowledge, and into domains that are new to the firm (Katila and Ahuja, 2002; Laursen, 2012). Exploitative (or internal/local) search refers to utilizing in-house sources of knowledge, or that which lies within the current knowledge base as embodied within the firm (Helfat, 1994; Fleming and Sorenson, 2004). Moreover, there exists a tradeoff between internal and external search strategies in terms of what a firm can gain through search and what it can effectively take advantage of (Laursen, 2012).

The notion of *oversearch* is exemplified in Katila and Ahuya's (2002) work on exploitative search processes within the firm in terms of *depth* and *scope*, and later in Laursen and Salter's (2006) work with explorative search processes, using their notions of search *breadth* (the amount of external knowledge sources utilized by a firm) and search *depth* (the degree of reliance on, and collaboration with, these external knowledge sources). The idea of over-searching, in both instances, emphasized that since search strategies are influenced by past managerial behavior and future expectations, the

outcome of carrying out too many search processes could have diminishing returns for the firm and even lead to a detrimental outcome (Laursen and Salter, 2006, p. 136). The same rationale follows for the *depth* construct: That too deep reliance could lead to decreasing marginal benefits. These constructs were operationalized by Laursen and Salter (2006) using a Community Innovation Survey (CIS) sample of UK manufacturing firms. They found that *breadth* and *depth* are curvi-linearly related to innovative performance. There is insufficient theory to say to a certainty whether this relationship holds for entrepreneurial small and micro-firms, however, a similar result is expected. Thus, those small and micro-firms with manufacturing activities captured in the sample should experience a similar relationship. However, especially due to the types of resource constraints detailed above, excessive breadth in sources of knowledge as well as excessive depth of collaboration with these sources may result in a negative relationship:

> Hypothesis 1a: Openness in terms of external search breadth is curvi-linearly related to innovative performance in entrepreneurial small and micro-sized manufacturing firms.
>
> Hypothesis 1b: Openness in terms of external search depth is curvi-linearly related to innovative performance in entrepreneurial small and micro-sized manufacturing firms.

Openness & Service innovation[4]

Service firms have also been studied in terms of their external openness, though not on as large a scale as firms with traditional manufacturing activities. Hipp and Grupp (2005) researched knowledge drawn upon for innovation among service-oriented firms from Germany. They categorized their results based on Pavitt's (1984) taxonomy**,** and emphasize the importance of knowledge intensive business services (KIBS) as a group which supplies a large number of economic actors with new knowledge. The OECD has also relied on this concept of KIBS to describe the drivers of service innovations in many knowledge-intensive organizations. These organizations tend towards generation of *ad hoc* and highly customized solutions to problems, with a high reliance on professional skills (Sundbo and Gallouj, 2000). Information regarding these innovations "may flow through professional networks and associations, or other communities of practice" (Miles, 2012: 11). External collaborations can generally be seen as beneficial for service-based innovation, especially in firms fitting the mold of knowledge intensive business services.

[4] This paper assumes that "existing instruments will work effectively to describe the service economy" i.e. an *assimilative* approach (Miles, 2012: 11).

In terms of degree of innovativeness, entrepreneurial service firms may produce innovations that are technological in nature or reliant on new business models which are based on a radical innovation: Subsequently, a firm may begin moving away from the radical towards other modes of innovation (Sundbo and Gallouj, 2000). Den Hertog et al. (2010: 494) argue that service innovations are more and more the result of a realization of opportunities to create and appropriate value within a wide network of actors, including providers, value chain partners, and others, and that new and improved services are often generated within large communities through linked platforms and business relationships.

Two of the most important activities by firms performing service innovations are signaling user needs and recognizing and sorting between technological options (den Hertog et al., 2010). These technological options provide opportunities for new paths of innovation, and remaining open to external (as well as internal) sources of information is crucial to translate potential technological options into new service innovations (Teece, 2007; Wang and Ahmed, 2007; den Hertog et al., 2010). Teece (2007) discusses utilizing users and customer networks, as well as relevant science and technology, in order to heighten an organization's sense of alertness regarding new technological options. Bruni and Verona (2009: 107) similarly attribute these abilities to a firm's "dynamic marketing capabilities". There has been a significant attribution of user interaction as a key variable in a firm's ability to generate innovations in services (Kindström et al., 2013).

Based on indications from the literature, it is expected that a wide breadth (and extensive depth) of external sources of knowledge will positively affect innovative performance of service-oriented firms, but that in the long run, the marginal benefits of additional sources will recede.

> Hypothesis 2a: External search breadth is curvi-linearly related to innovative performance in entrepreneurial small and micro-sized service firms.
>
> Hypothesis 2b: External search depth is curvi-linearly related to innovative performance in entrepreneurial small and micro-sized service firms.

Novelty of innovation:

Innovations are often classified according to their degree of radicalness compared to the current standard of technology (Freeman & Soete, 1997; Fagerberg, 2005). Continuous improvements are often referred to as *incremental* innovations, while the introduction of something truly novel, new, or revolutionary in economic terms is often called *radical* innovation. Laursen and Salter (2006) have shown that for manufacturing firms, increased depth is more beneficial than increased breadth for companies' radical innovation turnover rates, due to patterns of narrowed source reliance in product life-cycle innovation (cf. von Hippel, 1988). Because of the association of radical innovation with a discontinuous reliance on knowledge sources, and some forms of knowledge becoming obsolete as an

innovative process narrows in focus (Abernathy & Utterback, 1975) increased breadth may produce smaller gains than depth. Incremental innovations often become more important after a dominant design has emerged (ibid.), thus, Laursen and Salter (2006) argued that breadth becomes more relevant with product maturation, market expansion, and knowledge of the design becoming more widespread. This has led to the assertion that breadth of search is more strongly associated with incremental innovations for manufacturing firms.

A relevant question then becomes whether or not this relationship remains constant regardless of firm size and age. In this study concerning predominantly small and micro-firms, the effect of search breadth and search depth on the overall degree of radicalness exhibited by firms is of particular interest.

Vahter et al. (2012), in their panel-data based study of Irish SMEs, suggest that although SMEs might normally be conceived of as drawing less benefit from openness than larger firms, certain factors; such as having generally weaker knowledge resources and internal investment capacity; starting out with lower overall knowledge resource reserves; and being more susceptible to the costs and risks of internal R&D activity; could make openness more beneficial for smaller firms than larger firms. Vahter et al. (2012) additionally found SMEs to experience a curvi-linear relationship between breadth of openness and innovative performance, with maximum benefit occurring with less breadth than for large firms. This result unfortunately does not address the degree of novelty involved in the small and micro-firm level innovations manifested in part through the phenomenon of open innovation.

Based on previous reasoning regarding larger firms, search breadth may provide marginally less, and depth marginally more, benefit to innovative performance the more radical the firm is in terms of its innovations. However, concerning small and micro-firms in their initial stages of development, the difference in scale may be so vast that breadth and depth of sources of knowledge might have other effects on novelty of innovation. Increased breadth of sources of knowledge, that is, contact and collaboration across a wider spectrum of actors could also help the firm increase the novelty of its innovation. Love et al. (2013) find that organizations build off their prior innovation linkages in order to draw more benefit from extended search breadth and "experience higher innovation returns", and this may be more characteristic of small and micro-firms.

Lee et al. (2010) argue that small and medium-sized enterprises may be quite capable when it comes to invention, but rather lacking in their resources to properly innovate and commercialize invention. This notion of innovations requiring complementary assets (Teece, 1986) is not new, but it could be nonetheless relevant for explaining radicalness of innovations in small and micro firms. *Viz.*, this could mean that small and micro firms, while radical in their inventions, require extensive collaboration to

properly reach innovation. And that the more open an SME becomes, in terms of both breadth and depth, the more likely they are to realize the process of invention through radical innovations. Keupp and Gassmann (2013) find strong support for the hypothesis that knowledge constraints on a firm spur radical innovations (defined as new to the firm innovations), arguing that resource scarcity of firms can trigger an increased propensity towards explorative activities and recombining of resources both internal and external to the firm in order to innovate. Openness can be seen as being a reactive attempt of small and micro-firms to overcome their own resource constraints in order to seek out new combinations of their own resources as well as that of others, therefore: We expect the more breadth and depth a small or micro-firm has in terms of sources of knowledge, the more radical the innovations produced by said firm will be. Moreover, due to constrained resources, network limitations, and other related factors detailed above, breadth should be more effective in than depth in producing gains from openness for degree of radicalness of innovations produced. Successful commercialization of radical innovations may be more tied to the amount of sources more so than to the deep interaction with those sources.

> Hypothesis 3: The more breadth a (small or micro-) firm has in terms of sources of knowledge, the more radical the innovations produced, and excessive breadth will yield negative marginal returns.
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> Hypothesis 4: The more depth a firm has in terms of sources of knowledge, the more radical the innovations produced, and excessive depth will yield negative marginal returns
>
> Hypothesis 5: Breadth should have a stronger positive effect on radicalness of innovations produced than depth.

Data and Methods

For this study, the population is the entire population of small and micro firms in Europe that at the time of the survey administration were 5 years of age or less. The sample itself is the firms sampled by a survey carried out during the AEGIS project.

The AEGIS project was carried out to investigate knowledge intensive entrepreneurship in Europe given different national, sectoral and socio-economic contexts (Caloghirou et al., 2011). The sampling frame for the survey consisted of the Amadeus dataset; a pan-European database of public and private companies publishing financial statements which combines data from national sources; in addition to supplemental country and sectoral level data obtained from the Dun and Bradstreet commercial database, the Kompass business directory, and selects other sources in the selected industries. A benchmark sample of 4000 firms, broken up into three response size categories depending on the size of the national economies, was estimated. The sample is the firms interviewed (4004) out of this

sampling frame approximating the benchmark. The survey captured results from 10 European countries[5], and focused on broad indicators such as: Information about the firm and founding team; the firm's formation process; the market environment; strategy; innovation and business models; and firm performance. The interviews were conducted using telephone interviews by 174 individual native language-speaking interviewers. The survey sample firms in various sectors containing potentially knowledge intensive entrepreneurial firms, as shown in Table 1 below:

The AEGIS Survey: *Selected Sectors*	***NACE rev. 1.1 code***
High-technology manufacturing sectors	
Aerospace	35.3
Computers and office machinery	30
Radio-television and communication equipment	32
Manufacture of medical, precision & optical instruments (scientific instruments)	33
Pharmaceuticals	24.4
Medium to high technology manufacturing sectors	
Manufacture of electrical machinery & apparatus	31
Manufacture of machinery and equipment	29
Chemical industry (excluding Pharmaceuticals)	24 (except 24.4)
Low technology manufacturing sectors	
Paper and printing	21, 22
Textiles and clothing	17, 18, 19
Food, beverages and tobacco	15, 16
Medium to low manufacturing sectors	
Wood/Furniture	36
Basic metals	27
Fabricated metal products	28
Knowledge intensive business service (KIBS) sectors	
Telecommunications	64.2
Computer and related activities	72
Research and experimental development	73
Other business service activities: (Legal/accounting; technical consulting incl. architectural and engineering activities; technical testing and analysis; labor recruitment and personnel provisioning; other misc. business activities.	74.1 – 74.4, 74.5, 74.8

Table 1: Selected sectors of the AEGIS survey (Caloghirou et al., 2011).

Micro firms constitute the majority of the firms sampled in the AEGIS survey (64%). Since the CIS is known to exclude firms with personnel amounting to less than 10 employees (de Jong & Marsili, 2006), this survey presented an opportunity to assess a population of firms that has received considerably less attention from innovation surveys and surveyors.. This study covers firms ranging mainly from micro to small sized (0-50 employees)[6] according the OECD definition of small enterprises. In terms of formulation of survey questions regarding innovation processes and knowledge sources, much of the

[5] Croatia, Czech Republic, Denmark, France, Germany, Greece, Italy, Portugal, Sweden and the UK constituted the sampled EU countries.

[6] A handful of medium sized and large firms occur in the dataset.

AEGIS survey was originally modelled after the CIS, including similarly subject oriented data and questions.

Descriptive results

In the survey, firms were asked to rate the important of 11 different sources of knowledge for exploring new business opportunities; *1* being not important and *5* being extremely important. Table 2 presents the results of the (*n = 4004*) firms on this indicator in terms of percentage of the sample:

Table 2: Sources of knowledge used to build independent variables

Source of Knowledge	Not important	2	3	4	Extremely important
Clients or customers	2%	2	10	24	62%
Suppliers	13%	13	23	25	26%
Competitors	9%	15	33	26	17%
Public research institutes	44%	22	20	9	5%
Universities	47%	20	18	10	5%
External commercial labs/R&D firms/technical institutes	48%	20	18	10	4%
In house (know how, R&D laboratories)	24%	7	16	25	28%
Trades fairs, conferences, and exhibitions	18%	18	30	21	13%
Scientific journals and other trade or technical publications	20%	18	29	21	12%
Participation in nationally funded research programs	58%	16	13	9	5%
Participation in EU funded research programs (Framework Programs)	62%	13	11	8	6%

The following figures present the number of firms sampled in each sector, the degree of radicalness of innovation, average R&D intensity of the sector, and the calculated means of the breadth and depth indicators. Lastly, the percentage of innovative goods and innovative services as a proportion of total sales by sector is displayed (explanations of derivation of these independent variables in the section to follow).

Table 3

SAMPLE SECTOR [7]	# Of Firms	% No Innovation	% New to Firm	% New to Mkt	% New to World	Average R&D intensity	Breadth mean	Depth mean
ICT manufacturing	150	26.67	42.00	18.67	12.67	19.24	7.57	3.78
Manufacture of machinery and equipment	184	38.04	39.13	15.76	7.07	11.40	7.02	3.14
Chemical industry (including pharmaceuticals)	43	23.26	51.16	16.28	9.30	19.37	7.67	4.00
Paper and printing	518	39.19	39.38	16.22	5.21	10.71	6.69	3.26
Textile and clothing	176	45.45	32.95	14.20	7.39	10.78	6.76	3.50
Food, beverages, and tobacco	233	39.06	37.77	16.31	6.87	8.16	7.10	3.58
Wood and furniture	203	41.87	36.45	13.30	8.37	9.44	6.87	3.29
Telecommunications	20	30.00	55.00	10.00	5.00	14.00	7.35	3.35
Computer and related activities	451	29.05	38.80	24.17	7.98	18.22	6.61	2.84
Research and experimental development	57	31.58	28.07	21.05	19.30	41.45	8.14	3.91

[7] The sector Aerospace was not part of the sample following listwise deletion of "*don't know*" values regarding the dependent variable(s) of interest.

Other business service activities	1175	46.64	32.85	16.34	4.17	10.40	6.52	2.98
Mfg. of metals	219	37.44	42.01	15.98	4.57	9.73	7.04	2.98

Table 4

SAMPLE SECTOR	% of Innovative Goods/Sales	% of Innovative Services/Sales
ICT manufacturing	32.23	16.59
Manufacture of machinery and equipment	23.69	9.91
Chemical industry (including pharmaceuticals)	26.77	12.81
Paper and printing	17.11	17.59
Textile and clothing	23.87	9.06
Food, beverages, and tobacco	19.11	8.21
Wood and furniture	23.61	8.74
Telecommunications	13.20	32.95
Computer and related activities	19.27	24.75
Research and experimental development	25.58	23.82
Other business service activities	9.79	19.16
Manufacture of metals	17.67	12.88

Measures

Dependent variables:

Innovative performance

Innovative performance has commonly been measured through turnover of new or substantially improved products or services over a relatively recent time period, usually three years (Caloghirou et al., 2004; Jantunen, 2005). Laursen and Salter (2006) measured innovative performance in terms of ability to produce radical and incremental innovations in terms of turnover. This paper takes a combinative approach in order to measure innovative performance: In terms of research design, the concept of interest is *innovativeness,* the conceptualized construct of which is *innovative performance* at the firm level. This dependent variable is measured by 3 indicator variables, or measures on the construct: Thus, The latent dependent variable, *INNP*,* or innovative performance of the firm, is captured/approximated by 3 dependent variables, built using the following questions from the AEGIS survey:

Q27a. *Did this company introduce new or significantly improved goods or services during the past three years? (Exclude the simple resale of new products purchased from other enterprises and changes of solely aesthetic nature).*

1 Yes
2 No

Q27b. *Please estimate:*
1 The share of new or significantly improved goods to total sales
2 The share of new or significantly improved services to total sales

***Q28**. The new or significantly improved goods or services were...*
1 New to the firm
2 New to the market
3 New to the world

The first and second dependent variables combined uses the proportion of innovative sales of goods/services to the total sales generated by the firm over the past three years, approximating the amount of sales generated by this recent innovation activity

1. *INNGOODS:* The proportion of innovative (new or improved) goods to that of total sales.
2. *INNSERV:* The proportion of innovative (new or improved) services to that of total sales

The third dependent variable measures the degree of radicalness/novelty of the innovation practices of the firm during the past three years, approximating the degree of radicalness/novelty of innovation in that firm in general. Originally the respondent was given three mentions to indicate different products or services that were new or significantly improved, and rank them according to the provided scale. In order to construct a meaningful model from the data, a new variable was constructed using conditional indicators of the highest *achieved* level of novelty for each firm:

3. *RADINN:* The Degree of Radicalness of innovations (goods or services) introduced to the market by the firm over the past 3 years.
   - 0 = No new innovations introduced.
   - 1 = Up to the "new to the firm" level innovations introduced.
   - 2 = Up to and including "new to the market" level innovations introduced.
   - 3 = Up to and including "new to the world" level innovations introduced.

Independent variables

Breadth and Depth of External Search are used to approximate the construct of *Openness* (Laursen & Salter, 2006):

BREADTH*:* This represents the combination of the sources of knowledge expressed in regards to exploring new business opportunities in the AEGIS survey questionnaire (Q24_1 – Q24_11 while omitting Q24_7 due to this option representing in-house R&D activities). The value 0 is assigned if the observation indicated the source was not important (a score of 1), the value 1 is assigned if the observation indicated that it was anything greater than not important (a score between 2 and 5). The number external sources are then summed for each firm to create the BREADTH variable (min = 0, max = 10; Cronbach's alpha coefficient = 0.81). Firms with more sources are assumed to be more open as per Laursen and Salter (2006).

DEPTH: This variable represents the deepness of collaboration of the same measures as BREADTH. It was coded 0 if the observation was coded 1, 2 or 3; assigning a 1 if the observation was coded 4 or 5. As BREADTH**,** this variable takes on values between 0 and 10, where firms getting a score of 10 deeply

collaborate with all external sources of knowledge listed in the questionnaire (Cronbach's alpha coefficient = 0.69) This binary coding approximates the method employed by Laursen and Salter (2006). Similar to BREADTH, DEPTH is assumed to measure openness.

These two variables are also used to test the hypothesis that there is also a curvilinear, or inverse quadratic, relationship between the concepts of interest. This is done by including the quadratic interaction effect of both variables in the regressions.

Control variables:

STARTYEAR*:* The year the venture was established (screened for change in legal status of existing firm).

INTLSALES*:* Percentage of international sales estimated by survey respondents.

USER: Binary variable specifying whether the firm saw implicated users in their sources of knowledge as important (values 2 – 5) or not (value of 1). This is included to control for the presence of 'lead users' in the innovation process, shown to affect innovative performance in firms (von Hippel, 1988).

R&DINT: R&D intensity (by % of sales invested) estimated by survey respondents, in order to control for the effect of R&D on our variables of interest (Hagedoorn & Cloodt, 2003) and the effect of absorptive capacity of the firm (Cohen & Levinthal, 1990; Tsai, 2001).

LOGEMP*:* The number of employees (full + part-time) is used to control for the size of the firm.

Industry: HTMS (High-tech manufacturing sectors)¸ LTMS (Low-tech manufacturing sectors); KIBS (Knowledge intensive business services); OBS (Other business services). These were constructed based on the sector selection of the AEGIS survey itself (see Table 1).

SAMPLESECTOR: Additionally, country of origin was included in the regression to control for national differences.

Statistical method

In the AEGIS questionnaire, respondents where provided with the option of indicating that they don't know what proportion of innovative goods or services are representative of the firm's total sales during the past 3 years. A substantive interpretation of these answers is difficult, due to the fact that in this situation, don't know gives no indication of the true ratio of goods or services to sales. As *don't know* answers are difficult to interpret when the question asked requires specific knowledge and/or not interpretable via any underlying continuum (here the latent variable *INNP**), these cases were subject

to listwise deletion in accordance with the recommended missing value analysis literature (Acock, 2005; Little & Rubin, 2002). As a result the number of cases drops from 4004 to 3429 firms[8].

Being that two of the variables of interest are doubled censored, a percentage figure ranging between 0 and 100, Tobit's model of censored regression was used (Long, 1997) in the modelling of the dependent variables INNGOODS and INNSERV. Recommended procedure of evaluation of the normality of residuals while using the Tobit model, and the subsequent decision to utilize a lognormal transformation of the Tobit model using a lognormal distribution of Tobit residuals (cf. Long, 1997; Green, 2002), was adhered to in this study. That is to say, a natural logarithmic transformation of the percentage values of these two dependent variables was carried out prior to the modelling procedure. The third variable, RADINN was originally intended for use in an ordered logit model. However, due to violations of the parallel regression assumptions of that particular model using a Brant (1990) test[9], an alternating least squares optimal scaling (ALSOS) routine was conducted using the `optiscale` package in the *R* statistical computing environment, and the optimally scaled variable was then modelled using OLS regression (cf. Young, 1981; Jacoby, 1999; Jacoby, forthcoming). The resultant variable RADINN_OS, is proposed to also represent the latent variable *INNP**. Tables 5-6 document the results of the analysis. ALSOS is commonly used in order to test the measurement assumptions of a variable, and through it, empirical transformations of variable values may give insights about the appropriate level of measurement for that variable (Jacoby, 1999). The technique, commonly used in psychometric analysis, optimally scales the variable to find the maximized goodness of fit between the analytical model and empirical observations (Young, 1987), by relaxing the assumption that the measurement scale of the variable is fixed. Using this, I have rescaled the dependent variable RADINN, which is assumed to be interval level data, into an ordinal variable which minimizes the sum of squared residuals (For a more comprehensive discussion of the ALSOS method, see Young, 1981 and Jacoby, 1999). Once this is done the optimally scaled variable lends itself very well to standard OLS regression.

[8] Additionally, firms that introduced no innovations in the last 3 years were given the value of 0 for the dependent variables *INNGOODS, INNSERV,* and *RADINN*

[9] In the ordered logit model, the cumulative probability curves, that is, the probability that the unit being analyzed falls into one of the ordered categories of the dependent variable, are assumed to be parallel. The Brant test is used to test if any variables violate this. In this case, several variables were in violation, thus an alternative model was needed.

Table 5

Variable	Observations	Mean	Std. Dev.	Min	Max
INNGOODS	3429	17.04	25.53	0.00	99.00
INNSERV	3429	16.85	24.48	0.00	99.00
RADINN	3429	0.90	0.90	0.00	3.00
RADINN_OS	3429	0.90	0.90	-0.08	2.98
BREADTH	3429	6.78	2.53	0.00	10.00
DEPTH	3429	3.16	2.10	0.00	10.00
STARTYEAR	3429	2003	2.1614	2000	2007
INTLSALES	3429	14.01	25.99	0.00	100.00
R&DINT	3429	12.34	19.13	0.00	100.00
USER	3429	0.86	0.35	0.00	1.00
LOGEMP	3429	1.86	1.03	0.00	7.26

Table 6: Empirical models' coefficients

	I	II	III
	Tobit 1	**Tobit 2**	**ALSOS OLS**
VARIABLES	INNGOODS	INNSERV	RADINN_OS
BREADTH	0.795***	0.848***	0.165***
	(0.173)	(0.163)	(0.0335)
DEPTH	0.273**	0.0724	0.0371
	(0.115)	(0.112)	(0.0251)
BREADTH2	-0.0519***	-0.0551***	-0.0106***
	(0.0127)	(0.0120)	(0.00252)
DEPTH2	-0.0159	0.00101	-0.00106
	(0.0118)	(0.0116)	(0.00262)
STARTYEAR	0.0118	-0.0251	-0.00453
	(0.0313)	(0.0305)	(0.00682)
USER	-0.123	0.200	0.0138
	(0.218)	(0.212)	(0.0467)
LOGEMP	0.455***	0.291***	0.101***
	(0.0714)	(0.0690)	(0.0155)
INTLSALES	0.00823***	-0.00582**	0.00216***
	(0.00259)	(0.00260)	(0.000576)
R&DINT	0.0376***	0.0265***	0.00806***
	(0.00355)	(0.00347)	(0.000803)
Industry dummies	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Observations	3,429	3,429	3,429
Left-Censored obs.	1931	1842	.
Right-censored obs.	68	70	.
Log likelihood	-5015.73	-5298.8	.
Chi-square	575.8***	305.2***	.
F	.	.	25.00***
Pseudo R-squared	0.054	0.0280	.
R-squared	.	.	0.1279

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Analysis

As indicated above, BREADTH is strongly statistically significant and positive across all three dependent variables. While the BREADTH coefficients for INNGOODS and INNSERV are relatively similar in size (0.79 and 0.84 respectively), the corresponding coefficient for the RADINN_OS variable is considerably less (0.165), possibly indicating a stronger correlation between breadth of search and percentage of innovative products or services as a proportion of total sales than with the level of novelty of the innovation[10]. For all three dependent variables BREADTH2 is statistically significant and negative, confirming its curvi-linear relationship to innovative performance of small entrepreneurial firms.

The results regarding DEPTH of external search are less robust: For INNGOODS, the model returns a statistically significant value at the 5% level for DEPTH, but DEPTH2 is insignificant; additionally, neither DEPTH nor DEPTH2 are found to be statistically significant for INNSERV or RADINN_OS, indicating an ambiguous relationship between depth of external search, as it has thus far been derived, and innovative performance[11]. Thus, support can be offered for hypotheses regarding external search breadth (H1a, H2a, H3), but due to insignificant coefficients of the depth parameter in the two of the three models and no significance found of the squared depth parameter, we cannot fully support H1b, H2b, and H4. A Wald test (P =0.0068; F = 7.34) reveals that the coefficients of BREADTH and DEPTH for Model III are not equal, thus we can conclude that the larger BREADTH coefficient indicates a stronger effect than DEPTH, confirming H5.

Principal Components of Depth

The summation of binary outcomes used to construct DEPTH perhaps fails to capture the more nuanced underlying variance conveyed by the summated rating scale for openness to external sources of knowledge and degree of reliance. In the hope of uncovering an underlying pattern of explained variance in the summated rating scale used to derive the DEPTH variable, a principal components analysis (PCA) of this summated rating scale was carried out. PCA is "a statistical technique that linearly transforms an original set of variables that represents most of the information in the original set of variables [in order to] reduce the dimensionality of the original data set", for use in subsequent analyses (Dunteman, 1989: 7). These derived variables are orthogonal with one another, and maximize the variance accounted for in the original set of variables (ibid.). This technique can be extremely useful in understanding the underlying dimensions which account for the variation in a set of correlated

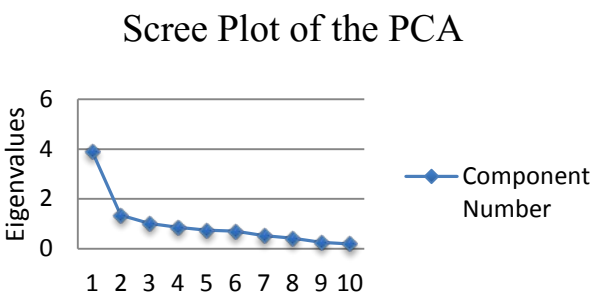
[10] Also, considering that this is in essence an ordered variable with only 3 outcomes, there may not be enough information to get a high valued coefficient.

[11] Note: When running the models without the DEPTH2 term, DEPTH became positive and significant in all analyses, potentially indicating that while non-linearly related to the dependent variable(s), the quadratic form does not give us a representative model for depth.

variables. Here, it is of interest to model the preceding regressions with principal components added in.

```
Principal components/correlation                  Number of obs    =      3429
                                                  Number of comp.  =        10
                                                  Trace            =        10
    Rotation: (unrotated = principal)             Rho              =    1.0000

    --------------------------------------------------------------------------
       Component |   Eigenvalue   Difference         Proportion   Cumulative
    -------------+------------------------------------------------------------
           Comp1 |      3.90152      2.55169             0.3902       0.3902
           Comp2 |      1.34983       .33532             0.1350       0.5251
           Comp3 |      1.01451      .148535             0.1015       0.6266
           Comp4 |      .865975      .124222             0.0866       0.7132
           Comp5 |      .741752     .0305962             0.0742       0.7874
           Comp6 |      .711156      .177545             0.0711       0.8585
           Comp7 |      .533611      .112775             0.0534       0.9118
           Comp8 |      .420836      .158731             0.0421       0.9539
           Comp9 |      .262105     .0634007             0.0262       0.9801
          Comp10 |      .198704            .             0.0199       1.0000
    --------------------------------------------------------------------------
```



The fact that the components are per-construction orthogonal with one another facilitates their interpretation as regression coefficients. Using the scree plot comparing the Eigenvalues generated by the PCA with the number of components, it can be seen that 3 principal components account for a cumulative 62.6 percent of the total variance of the 10 variables used to estimate DEPTH. Following the Kaiser-Guttman criterion (Kaiser, 1960; Guttman, 1954) commonly applied to PCA, only those with an eigenvalue of $\Lambda > 1$ are retained for analysis.[12] Upon closer inspection through a bivariate correlation matrix comparing the components with the original variables, a pattern begins to emerge:

	pcadepth1	pcadepth2	pcadepth3
pcadepth1	1.0000		
pcadepth2	-0.0000	1.0000	
pcadepth3	-0.0000	-0.0000	1.0000
Q24_1	0.2138	**0.6733**	-0.2551
Q24_2	0.3698	**0.6270**	-0.1422
Q24_3	0.3816	**0.5403**	-0.0087
Q24_4	**0.8007**	-0.1415	-0.1468
Q24_5	**0.7939**	-0.1785	-0.1566
Q24_6	**0.7485**	-0.1157	-0.1447
Q24_8	0.5298	0.2003	**0.6318**
Q24_9	0.5432	0.0090	**0.6472**
Q24_10	**0.7835**	-0.2451	-0.1389
Q24_11	**0.7430**	-0.2144	-0.1573

[12] OLS regressions on the dependent variables were also carried out using all 10 components, and while a few of the lower order components were significant in the regressions, they were not substantively interpretable.

How high PCA bivariate correlations must be in order to be interpretable by the researcher is highly discretionary, as no reliable guidelines exist. Though it is generally thought that patterns in the correlations must be readily identifiable in order for substantive interpretation of the components to follow (Dunteman, 1989). Hence, of most interest are the correlations of components with certain variables relative to the other components. The first principle component seems to be most highly correlated with Q24_4, Q24_5, Q24_6, Q24_10, and Q24_11. Comparing these codings with the labels assigned to the questions by the AEGIS survey, one can see that the first principal component is highly correlated with these *external, non-industry sources of knowledge,* mainly related to the collaboration with state, national, or regional research-based or academic entities: Roughly equivalent to Tether and Tajar's (2008) specialist knowledge providers (SKPs). Conversely, the second principal component is most correlated with Q24_1 - Q24_3: Representing clients or customers; suppliers; and competitors. This second component can thus be interpreted as explaining the shared variation of sources of knowledge through *business and operations-based relationships*. The third principal component is most correlated with Q24_8 and Q24_9: Trade fairs, conferences and exhibitions; and scientific journals and other trade or technical publications. This last component can be seen as *sources of knowledge stemming directly from academia and related communities.*

Regression on innovative performance using principal components analysis

Substituting the variables DEPTH with these three principle components returns some interesting results[13] (See following page):

By breaking down the summated rating scale used to construct depth into its principal components and using these components as independent variables, one can trace the effect of the components, which can be argued to represent certain substantive categories of knowledge sources, on innovative performance.

[13] I see this approximation of depth as a summarizing measure of the rating scale employed, and it does not take into account the value of depth across multiple sources of knowledge and sum them, as was done in the previous regressions (I – III). Therefore, interpretation of these principal components as being directly related to the depth variable employed earlier in the study would be insubstantive. It is measuring the summated average of depth across all respondents, which is the main function of principal component analysis (Dunteman, 1989).

	IV	V	VI
	PCA Tobit 1	**PCA Tobit 2**	**PCA ALSOS OLS**
VARIABLES	INNGOODS	INNSERV	RADINN_OS
BREADTH	0.624***	0.770***	0.133***
	(0.177)	(0.167)	(0.0347)
PCADEPTH1	0.113*	0.146**	0.0383***
	(0.0650)	(0.0636)	(0.0145)
PCADEPTH2	0.170**	-0.0334	-0.00654
	(0.0758)	(0.0738)	(0.0164)
PCADEPTH3	0.185***	0.117*	0.0594***
	(0.0715)	(0.0692)	(0.0156)
BREADTH2	-0.0395***	-0.0541***	-0.00930***
	(0.0133)	(0.0126)	(0.00268)
STARTYEAR	0.0111	-0.0248	-0.00449
	(0.0313)	(0.0305)	(0.00681)
USER	-0.0800	0.391	0.0952*
	(0.249)	(0.242)	(0.0535)
LOGEMP	0.458***	0.297***	0.104***
	(0.0714)	(0.0690)	(0.0155)
INTLSALES	0.00801***	-0.00600**	0.00207***
	(0.00259)	(0.00260)	(0.000576)
R&DINT	0.0386***	0.0260***	0.00800***
	(0.00357)	(0.00349)	(0.000807)
Industry dummies	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes
Observations	3,429	3,429	3,429
Left-censored obs.	1931	1842	.
Right-censored obs.	68	70	.
Log likelihood	-5013.5	-5296.8	.
Chi-square	580.5***	309.5***	.
F	.	.	24.5***
Pseudo R-squared	0.055	0.0284	.
R-squared	.	.	0.131

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

PCADEPTH1, representing *non-industry sources of knowledge,* is significant in all three of the PCA models. This suggests that the relationship between non-industry sources of knowledge has a statistically significant and positive effect on innovative performance. Its strongest effect is on that of services, followed by goods, and lastly by degree of radicalness: Suggesting that these particular sources of knowledge may exhibit stronger ties to innovativeness in terms of sales than to novelty of goods or services offered. PCADEPTH2 has a statistically significant positive effect on only innovative goods as a proportion of total sales. Finally, PCADEPTH3 has a statistically significant positive effect on all dependent variables representing our latent dependent variable.

Discussion and conclusions

Results indicate a curvilinear relationship between both breadth and depth and the sale of innovative goods, while only a curvilinear relationship between breadth (no relationship at the 5% level was found regarding depth) and sales of innovative services and novelty of innovations produced: Much like larger firms involved in manufacturing activities, small new manufacturing firms benefit initially from involving themselves in external networks of information, and deeper collaborations yield higher innovative returns. However excessive breadth could yield negative marginal benefits[14], though effects of depth as constructed by Laursen and Salter (2006) are here found to be inconclusive for small entrepreneurial firms. Through principal components analysis, external sources of information from all three components; representing research, business, and published knowledge were all found to be significant for innovative performance measure by goods.

For innovative services, the depth component was not significant. Due to the intangibility of services in many industries, an organization might rely more deeply on non-industry sources of knowledge through the form of applied research, academia, and public sector initiatives, especially when the firm is new, and has not adequately forged relationships with its business partners and competitors to rely on knowledge from these sources for innovation and new business opportunities. The newness of the firm also may limit the amount of external knowledge that can even be absorbed into the firm. Indeed, using principal components analysis, the component explaining most of the variance in the scale, with high correlation to *non-industry sources of knowledge in the form of business and operations-based relationships*, was found to be statistically significant with proportion of innovative services to that of sales.

Concerning radicalness of innovation, our results are in line with the expectations regarding breadth, though not with that of Laursen and Salter's (2006) depth*,* the latter being insignificant. This could mean that a new small or micro-firm, again perhaps due to resource constraints and liability of newness, may need to set a greater focus on its explorative capabilities, that is, seeking out external information for innovative and entrepreneurial opportunities (Cf. Katila and Ahuja (2002)) than multiple deep collaborative efforts (which they consequentially may lack the resources to enact and maintain). Thus, it is likely that exploration in March's (1991) sense is an important factor for new small firms in increasing the degree of radicalness in innovations realized. Again, radicalness of innovations was positively associated with the first and third principal components, suggesting that depth in terms of *non-industry and academic* sources of knowledge may be positively related to radicalness of

[14] A fitted model of residuals indicates that the predicted breadth "tipping point" lies between 8 and 9 sources for Models I and II, between 9 and 10 sources for Model III. For depth's tipping point in Model I, between 7 and 9 sources.

innovations, while depth of *industrial, business, and operations-based sources of knowledge* may not be possible for small new firms to achieve at this snapshotted level of development as represented by the survey**.**

Summarily, hypotheses regarding the role of breadth in innovative performance of small entrepreneurial firms are confirmed in this study, but those regarding depth cannot be. However, a more nuanced view of the summated rating scale by which depth was constructed reveals that the underlying principle components are uniquely correlated with certain groupings of knowledge sources, which have their own relationships with innovative performance. A more parsimonious approach to explaining the outcomes of collaborative depth with these types of knowledge sources for small firms is recommended. An alternative model could better capture the relationship between depth of search and innovative performance for small entrepreneurial firms. For the small new firms captured in the sample, it is possible that constraints of networks and of resources as outlined in the literature prevents firms from establishing deeper search relationships and hence curvi-linearity might not appropriately characterize the effect.

Most surprising are the almost counter-theoretical results of the effects of depth of search on innovative services. Our PCA analysis does not find a significant relationship between clients, customers, competitors and suppliers as knowledge sources, with that of innovative services as a proportion of sales. This is surprising, since the literature detailed above in the theoretical section points towards the importance of user communities, business networks, etc., in the innovation process of services. However, this reliance on these sources of knowledge, especially for services and for producing more radical as opposed to incremental innovation, could be strong *regardless* of overall innovative performance. Depth of collaboration could be important for all small service firms, so the measure may not capture the sought-after relationships when applied to firms relying on these sources of knowledge regardless of their innovativeness. Also, given the theoretical reasoning, it seems that constraints of size and newness have a real effect on what sources successful service innovations may be drawn from and how deep collaborations need be (or can be) in the initial phases of firm development.

Limitations and future research

It need be noted that using self-reported data-driven questionnaires in survey data imposes various limitations on the analysis, as well as does the use of large scale databases in general, especially when quantifying this material. Also, future researchers should be wary of summarizing all outside sources of knowledge into a single construction representing firm openness, as the underlying clusters of knowledge sources seem to have varying degrees of effects on this latent variable. Further investigating the linkages between innovative performance and depth in business relationships as

opposed to non-corporate, publically, academically, or scientifically driven relationships with outside sources of knowledge is encouraged.

Most crucial is perhaps that work is done to try and understand how newness affects a firm's ability to innovate in diverse sectors and in different national contexts. This survey has included a variety of industries (both goods and services) as well as 10 different EU countries that differ on a number of indicators (including the macro-economic landscape, science policy, and demography). More work should be directed towards exploring the confines placed on new firms in different national contexts in regards to fulfilling the innovative potential of the firm and the availability of sources of external knowledge from the different channels analyzed here.

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