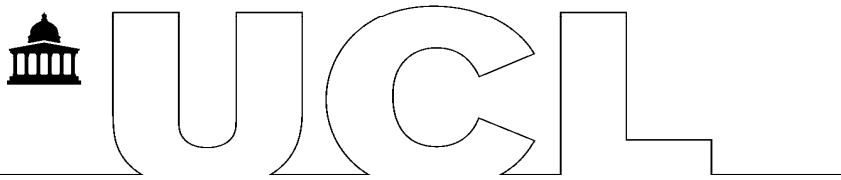

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Knowledge Source Preferences as Determinants of Strategic Entrepreneurial Orientation

Slavo Radosevic[a], Esin Yoruk[b], and Richard Woodward[c]

[a] University College London, UK, email: s.radosevic@ucl.ac.uk

[b] University College London, UK

[c] University of Edinburgh Business School, and
CASE – The Centre for Social and Economic Research, Poland

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Centre for Comparative Economics
UCL School of Slavonic and East European Studies
Gower Street, London, WC1E 6BT
Tel: +44 (0)20 7679 8519
Fax: +44 (0)20 7679 8777
Email: cce@ssees.ucl.ac.uk

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Slavo Radosevic[23] and Esin Yoruk[4]
Centre for Comparative Economics
School of Slavonic and East European Studies
University College London

Richard Woodward[5]
University of Edinburgh Business School
and
CASE – The Centre for Social and Economic Research, Poland

Abstract

In the knowledge intensive context, firms' capacity to integrate external and internal sources of knowledge becomes an important competitive advantage and may distinguish entrepreneurial from conservative firms. This paper explores the proposition that differences in strategic entrepreneurial orientation (EO) across firms may be significantly determined by differences in firms' preferences regarding knowledge sources. Our research is based on 208 firms operating in knowledge intensive industries in six Central and East European countries (CEEC). We identified three types of firms in terms of patterns of sources of knowledge: external R&D knowledge based firms, in-house knowledge based firms and value chain dependent firms. By using different proxies or different dimensions of EO, we have found that the EO is strongest in firms based on external knowledge. Firms with in-house based knowledge have an intermediate strength of the EO, and firms dependent on value chains are the least entrepreneurially oriented. We have also found moderate support for grouping different proxies of EO into three dimensions identified in literature – innovativeness, pro-activeness and risk-taking. Value chain firms are not pro-active, have the lowest innovativeness, and are the most risk averse. External knowledge based firms are the most active in all three dimensions of EO, while in-house knowledge based firms are in an intermediate position. Our results point to strong systemic features of entrepreneurial activities; i.e., EO is inherently different in different sub-populations of firms depending on their patterns of sources of knowledge. It seems that these patterns operate as a moderating factor between performance and the EO, which explains mixed results from the literature.

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[2] E-mail: s.radosevic@ucl.ac.uk
[3] Corresponding author. University College London, 16 Taviton Street, London WC1H0BW, Tel: +4402076798806; fax: 4402076698777
[4] E-mail: e.yoruk@ssees.ucl.ac.uk
[5] E-mail: rick.woodward@ed.ac.uk

1. Introduction

Much of the literature on entrepreneurship focuses on the characteristics of individuals classified as entrepreneurs. However, there is a widespread recognition that entrepreneurship is not simply an individual matter but also refers to characteristics of entire organizations. Since the pioneering paper by Miller (1983), a sizable literature has grown up that investigates the entrepreneurial activity of the firm and employs measures of the degree to which a firm can be classified as entrepreneurial. Entrepreneurial orientation (EO), as this measure is usually referred to, is seen as consisting of a number of different dimensions. Miller and Friesen (1982), Miller (1983) and Covin and Slevin (1989) have defined entrepreneurially oriented organisations as those that are innovative, proactive (pioneering) and risk taking. More precisely, according to Miller (1983:771) "an entrepreneurial firm is one that engages in product-market innovation, undertakes somewhat risky ventures, and is first to come up with 'proactive' innovations". Drawing on Miller's definition, for Covin and Slevin (1989:77) "entrepreneurial firms are those in which the top managers have entrepreneurial top management styles, as evidenced by the firms' strategic decisions and operating management philosophy".

The empirical literature in this area largely focuses on EO as a how it determines firms' performance (Covin and Slevin, 1989, Guth and Ginsberg, 1990, Lumpkin and Dess, 1996, Zahra, 1996, Wiklund 1999, Wiklund & Shepherd 2003, Salaran & Maritz 2009). The results of this line of research have produced quite mixed results, indicating that this relationship is quite complex. It seems that various factors internal and external to firms may affect this relationship (Lumpkin and Dess, 1996), so that our increasing understanding of this relationship yields decreasing returns in terms of theoretical clarity. Another stream of literature explores the relationships between features of individual entrepreneurs such as their self images (Mitchell and Shepherd, 2010) or their information processing mechanisms (Vaghely and Julien, 2010) and EO. In this paper, on the other hand, we explore how differences in the source of knowledge preferences critical for competitive advantage affect EO, maintaining the original focus of the EO literature's pioneers on firms (as opposed to individual entrepreneurs). The utilisation of both external and internal sources of knowledge depends on the knowledge integration capacity of the firm (Cohen and Levinthal, 1990). We argue that the development of this capacity also requires entrepreneurial management – an entrepreneurially oriented firm. The degree of EO and its nature may differ significantly across different types of firms depending on their networking, learning, and competitive strategies regarding their exploration and exploitation of EO (March 1991, Shane and Venkataraman 2000, Lumpkin and Dess 2001, Shane 2003), especially as these relate to technological, market and institutional opportunities (Radosevic, 2007).

This paper is based on evidence from a survey of 208 firms operating in knowledge-based industries[6] (KBI) in six Central and East European countries[7] (CEEC). The OECD (1999) defines these industries as ones that are relatively intensive in their inputs of technology and/or human capital. High technology and medium-high technology industries, based on their R&D intensity, fall into the

[6] See Appendix 1 for the list of industries in this research.
[7] Croatia, Czech Republic, Hungary, Lithuania, Poland and Romania.

category of KBIs. For the purposes of this paper we assume that firms in knowledge-based industries generate, utilise and transmit knowledge that has been generated within the fields of science, technology and engineering in anticipation of commercial application (Grant, 1996).

In the next section we present the theoretical background on EO and the role of knowledge sources in firms in knowledge-based industries and derive hypotheses. Section three describes the sample of firms studied as well as the data and methodology, while section four presents the results. These are discussed in section five, and section six concludes.

2. Theoretical background and hypotheses

2.1. Entrepreneurial orientation and its dimensions

As developed by Covin and Slevin in a series of papers (1986, 1988, 1989) extending Miller's (1983) work, the strategic posture of EO has three dimensions (innovativeness, proactive stance and risk-taking), and the composite score for all three dimensions determines whether a firm is classified as entrepreneurial. So, the distinction between level and type of EO emerges as important. For Covin and Slevin (1989), what is captured by these three dimensions is the following:

- *innovativeness* refers to the importance of research and development (R&D) for the organization, to the number of new products or services it introduces, and to its preference for radical as opposed to incremental innovation;
- *proactiveness* captures the tendency of a firm to lead rather than follow (that is, the extent to which it acts and its competitors react, rather than vice versa), to be the first to introduce new products, services, and/or processes, and the degree to which it is aggressively competitive, and
- *risk-taking* embraces a firm's predilection for risk, its perception of risk as necessary for success in the competitive environment in which it finds itself, and its tendency to act boldly and aggressively under conditions of uncertainty.[8]

It is worth noting the observation of Lumpkin and Dess (1996: 137) that while EO studies typically create a single measure of EO based on indicators for the various above-mentioned dimensions, "successful new entry also may be achieved when only some of these factors are operating" and add that "although some prior research suggests that the dimensions of an EO covary … [they] may vary independently,

[8] While some later work, beginning with Lumpkin and Dess (1996), adds two dimensions (competitive aggressiveness and autonomy), these are not of concern to us here in our work on knowledge-based industries. This is because these two dimensions are less related to the generation of knowledge than the other three. Autonomy, for Lumpkin and Dess, means that leaders are independent, unencumbered by bureaucracy (i.e., if they are leading a project within a corporation, they have to be set free by management, while within a small organization autonomous leaders may tend toward autocracy). Competitive aggressiveness differs from proactiveness for Lumpkin and Dess in that proactiveness is about creating opportunities (i.e., getting to a place where the competition hasn't been yet), but competitive aggressiveness is about defending them (i.e., keeping the competition out of that place, or throwing them out if they do arrive).

depending on the environmental and organizational context." Exploring the idea that the various dimensions of EO are worthy of independent examination, they cite research (Morris and Paul, 1987) showing on the basis of factor analysis that measures of innovativeness and proactiveness were captured by one factor, and those of risk taking in another; Lumpkin and Dess (2001) also found empirical support for this approach.

2.2. Entrepreneurial orientation and knowledge networks

In this paper, we examine the relationship between EO of the enterprise and its sources of knowledge. The underlying idea is that the structural and strategic features of enterprises in terms of sources of knowledge to which they are oriented strongly affects their strategic EO, both in terms of level as well as type (or dominant dimension). The importance of networks for entrepreneurship emerges from the interactive nature of knowledge generation and utilisation, especially in the case of KBIs.

Malerba (2010) stresses the importance of systems and networks for entrepreneurship. "Successful entrepreneurs are consummate networkers who thrive in communities", he writes, and lists the assets that firms are able to access through networks, including, very importantly, knowledge: "information and assessments on markets and technologies". Referring to views of the firm as a 'processor of information', Cohendet and Llerena (2010) note the link between information processing and firm strategy ("those activities that emerge from the positioning of an end product within an industry structure") and competencies. They posit that in an evolutionary theory of the firm, knowledge processing must link the evaluation of informational inputs to the creation of new knowledge. Indeed, they see the governance of the firm as consisting primarily in "the coordination of distributed pieces of knowledge and distributed learning processes." Innovation is crucial in a dynamic and uncertain environment, and the entrepreneur is seen as the main agent of innovation. This "agent in charge of the process of creation of resources … ensure[s] the missing link between the internal and the external environments of the firm … designing the internal organization and being proactive towards the external environment."

Knowledge, then, is the crucial resource of a firm and it needs to access external knowledge through its networks and process that knowledge, combining it with internal knowledge in order to innovate. Innovation, as we have seen, is a crucial dimension of EO. It is therefore clear that for the innovative firm, the entrepreneurial function is related to the character and strength of the set of linkages and interactions, both external and internal, that bring knowledge into the firm from outside, process it, and release it again to the external environment in the form of product and service innovations. Much research has been done to open up this "black box", and it is here that we see our contribution.

Zahra's (1996) work on technology strategy provides us with valuable insights into the role of different types of knowledge sources in the firm's strategic posture as an innovator. For Zahra, technology strategy is comprised of at least six dimensions. The first is whether the firm adopts a pioneer or follower posture (with implications

for its choices regarding radical versus incremental innovation). Two further dimensions measure the content and breadth of the firm's portfolio of product and process innovations (i.e., how many of both types the firm engages in). The fourth concerns the intensity of investment in innovation (R&D); the fifth the use of external sources of technology, and the sixth the use of technological forecasting. Zahra's (1996) first dimension corresponds closely to the proactiveness dimension of EO of Covin and Slevin (1989), the second, third and fourth with the innovativeness dimension of EO, while the fifth and sixth dimensions are concerned with the internal and external sources of knowledge used in innovation.

The firm's efforts to create or acquire the knowledge necessary for its competitiveness and innovations may take a number of different forms. First, the firm may create knowledge through its own in-house R&D. Second, it may attempt to access relevant external knowledge. This may come from a number of sources, including cooperation with supply chain partners, but also from cooperation with other kinds of organizations specifically devoted to research, or from various published sources, such as journals and patent disclosures. The role in innovation of supply chain partners, in particular that of "lead users" or "lead customers", whose importance such researchers as Roy Rothwell and Eric von Hippel began stressing in the 1970s, is discussed in Shaw (1994). It has become commonplace to note that the importance of networking for innovation has grown in recent decades in industries where knowledge is advancing rapidly due to the fact that knowledge is distributed. A number of studies have demonstrated a positive link between a firm's R&D intensity and the number and intensity of its strategic relationships (for a discussion, see Powell and Grodal, 2005). Moreover, some research has also pointed to a link between networking and various dimensions of EO, as in the case of a 1996 study by Eisenhardt and Schoonhoven showing that in the US semiconductor industry, the more a company's strategy is oriented toward risk-taking, the more alliances it forms.

With regard to the literature on EO's effect on firm performance, Lumpkin and Dess (1996) suggest that the effects of EO need to be examined in a framework allowing for contingency, and state that this means not only allowing for the way that different external environments might affect the relationship between EO and performance (a subject studied, for example, by Covin and Slevin (1989)), but also considering how various internal variables (such as firm resources and culture and characteristics of the top management team) might affect the nature and strength of that relationship.

Taking a cue from Lumpkin and Dess' (1996) call to take the contingency of this relationship into consideration, a considerable number of studies have examined how either networks, internal knowledge resources of the firm or the knowledge accessed from external sources affects the EO-performance link. Table 1 presents a summary of the variables used in these studies and their findings. Influenced by Cohen and Levinthal's (1990) work on absorptive capacity, Wiklund & Shepherd (2003) examine the role of internal knowledge resources in the firm in the discovery and exploitation of new opportunities; while Knight and Cavusgil (2004) depart from the resource-based view of the firm (Penrose, 1959; Nelson and Winter, 1982) to investigate international success.Walter et al. (2006), Stam and Elfring (2008) and Salaran and Maritz (2009) have conducted studies examining how various aspects of networking (both internal and external to the organization) relate to EO. Walter et al.

(2006) examine the networking capability of firms and the nature and quality of these relationships with external partners. Stam and Elfring (2008) investigate whether the intensity of networking can lead to higher levels EO. However, these studies do not distinguish between the different *types* of sources of knowledge involved in the process. Finally, although Lee and Sukoco (2007) examine both knowledge and networking, the knowledge management capabilities variable they employ is concerned with the firm's ability to source external knowledge and convert it into new knowledge, but again not the *types* of sources from which knowledge is obtained, whereas the social capital measures were exclusively internal to the firm. Therefore, the relationship between the types of knowledge sources of the firm and its entrepreneurial strategic orientation remains unexplored in the literature.

Table 1. Studies of entrepreneurial orientation (EO), networks, knowledge and organizational performance

Study	Independent Variables			Results
	EO	Networks	Knowledge	
Wiklund & Shepherd (2003)	Standard measure[9]	-	Internal "knowledge-based resources"[10]	Positive relationship between knowledge resources and performance enhanced by EO
Knight & Cavusgil (2004)	International EO[11]	-	"Global technological competence"[12]	International EO positively affects technological innovativeness
Walter et al. (2006)	Standard measure	Network capability[13]	-	Relationship depends on network capability (NC), with high NC leading to positive and significant relationships between EO and performance
Lee & Sukoco (2007)	Standard measure	Social capital	Knowledge management capabilities	Positive effect of knowledge management capabilities and EO on innovation; social capital (exclusively internal to firm) moderates this effect
Stam & Elfring (2008)	Standard measure	Intra- and extra-industry network ties[14]	-	Combination of high network centrality and extensive bridging ties strengthened link between EO and performance
Salaran & Maritz (2009)	Standard measure	Social capital[15]	-	Significant relationship between social capital and interactions and both innovativeness and EO

[9] By standard measure, we are referring to the technique developed by Covin and Slevin (1989), based on nine questions with seven-point Likert scales.
[10] These were defined as market and technological knowledge, which were gauged on the basis of responses to survey questions asking how the firms surveyed compared with the competition in terms of: "staff with a positive commitment to the company's development, technical expertise, expertise regarding development of products or services, highly productive staff, expertise in marketing, special expertise regarding customer service, special expertise regarding management, innovative markets, staff educated in giving superior customer service, staff who like to contribute with ideas for new products/services, and staff capable of marketing your products/services well" (Wiklund & Shepherd 2003: 1311).
[11] A measure on how energetically the firm moves into foreign markets. The components of international EO are quite different from the standard dimensions of EO (Knight and Cavusgil, 2004).
[12] The extent to which firm innovates in product technologies and is ahead of competition and on cutting edge of technology. The reader will note that this is defined in a way very similar to the EO dimensions of proactiveness and innovativeness.
[13] Ability to develop and utilize inter-organizational relationships.
[14] i.e., how central founding team's members are in relevant networks, and its "bridging" ties to organizations in other fields.
[15] Frequency of interactions among colleagues and trust. For trust the authors employed a number of submeasures gauging, for example, the reliability, openness, honesty and competency of partners in interactions.

2.3. Exploration and exploitation of entrepreneurial opportunities

The concepts of exploration and exploitation were introduced by March in his classic 1991 paper to characterize the learning strategies of firms, linking them to the firms' sources of competitive advantage. For March (1991: 71), exploration "includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation", while exploitation "includes such things as refinement, choice, production, efficiency, selection, implementation, execution." Later elaborations of these ideas have identified exploration with radical innovations and exploitation with incremental innovations. For instance, Auh and Menguc (2005: 1653) state that "whereas exploration is concerned with challenging existing ideas with innovative and entrepreneurial concepts, exploitation is chiefly interested in refining and extending existing skills and capabilities," and, in a phrasing which is slightly but importantly different from March's, observe that "exploration … entails activities such as search, variation, risk-taking, discovery, innovation, and research and development." In a similar vein, Ireland and Webb (2009: 472) write that

> exploitation activities are used to incrementally enhance the firm's existing competitive advantages. Because the firm is building on existing advantages, exploitation processes are characterized by fewer and less influential sources of uncertainty; for example, the market size and location may already be well known, *or the technology base may be accepted by suppliers, partners, and customers* (emphasis added).

These descriptions suggest that exploration and exploitation may be associated with preferences of firms for certain types of knowledge sources; in particular, that exploitation may be linked to a substantial role of supply chain partners in providing knowledge, whereas exploration may be more strongly associated with external and in-house R&D activity. It is also clear that the exploration and exploitation of opportunities are linked to all three strategic dimensions of EO (innovativeness, proactiveness, and risk-taking), where exploration involves the search for resources and creation of new niches and exploitation the implementation and strengthening of existing resources (Lumpkin and Dess 2001, Brown et al. 2001). If this is the case, one may wonder what, if any, role exploration and exploitation play in the entrepreneurially oriented firm with regard to their preferred knowledge sources, especially in the knowledge-based industries. Our research tackles this issue in ways we will discuss in Section 2.4.

2.4. Conceptual framework and hypotheses

In the knowledge intensive context, firms' capacity to integrate external and internal sources of knowledge becomes an important competitive advantage and may distinguish entrepreneurial from conservative firms. Also, structural features of knowledge integration (i.e., differences in reliance on internal and external knowledge) could affect EO. This leads us to formulate our major hypothesis:

Hypothesis: A firm's strategic EO is related to its preferences regarding the sources of strategically important knowledge.

This major hypothesis can be further disaggregated into three specific hypotheses. These hypotheses are based on distinctions between exploration and exploitation of opportunities and between reliance on external or internal knowledge. In conceptual terms, the issue can be presented in matrix below (Table 2) and elaborated in three hypotheses.

Table 2. Exploration and exploitation of opportunities and sources of knowledge

		Technology Strategy	
		Exploration	***Exploitation***
Knowledge Source	***External***	External R&D knowledge oriented firms	Value chain oriented firms
	Internal	In-house knowledge oriented firms	

Table 2 assumes three types of firms: external R&D knowledge, value chain and in-house knowledge oriented firms. This taxonomy has emerged previously based on the analysis of data collected on a sample of 304 knowledge intensive enterprises (KIE) in six CEE countries (see Radosevic et al., 2010).[16] This paper builds on this taxonomy by investigating the relationship between sources of knowledge and EO of firms. Two dimensions form the type of dominant knowledge orientation: the balance between exploration and exploitation of opportunities, and the balance between external and internal knowledge sources. Firms that rely more on external R&D knowledge could be more entrepreneurially oriented in order to find, capture and then integrate that knowledge in products and processes. We assume that the more the firm is oriented towards external R&D knowledge sources and exploration, the more likely it is that it will develop stronger EO. By contrast, the more it is oriented towards exploitation and towards internal knowledge sources, the less it will be entrepreneurially oriented. In terms of the matrix in Table 2, the direction of relationship should go from the lower right towards the left upper box.

The outward orientation of firms is particularly strong in exploration activities, which seem to be more strongly linked to EO than exploitation activities. An exploitative learning strategy can be linked with a strong dependence on value chain partners as a strategic knowledge source (i.e. there is a dependency on external sources of knowledge). However, evidence presented in Radosevic et al (2010) strongly suggest that the balance between exploration and exploitation type of knowledge activities strongly differs across three types of firms. In addition, the econometric evidence on dependence of the CEE firms on value chain partners is quite strong in the case of local FDI subsidiaries which represent the most productive segment of enterprises in these economies (see Majcen et al. 2009). Value chain dependent firms could produce less R&D and intellectual property of their own, which might imply a non-positive relationship between this knowledge source type and EO dimensions. It is important to remember that this does not mean that cooperation with suppliers and customers implies low innovativeness, especially in the case of KBIs. What it does mean is that where such cooperation *dominates* over

[16] The same taxonomy emerged for the sample of firms (n=208) used in this research. See Table A1 in Appendix for factor scores.

own efforts in R&D and intellectual property creation, there will be a lower tendency for innovation to be radical. Thus, despite the external knowledge orientation of value chain dependent firms, the dominance of exploitation activities makes them inherently less entrepreneurially oriented, in particular in the case of KBIs.

In-house knowledge oriented firms may be oriented towards their own sources of knowledge, but presumably they are good at combining external and in-house knowledge. This ambidexterity - that is, the simultaneous employment of exploration and exploitation (Tushman and O'Reilly 1996; Burgelman 1991, 2002; Knott 2002) - is important to the entrepreneurially oriented firm, but may lead to ambiguous analytical results, as these firms may be both inward and outward oriented. We imagine that a firm with a high weight of in-house knowledge in innovation is very successful in assimilation of external knowledge, but also that these firms may be ignorant of the work of others, as they may operate in a local knowledge context quite successfully based on accumulated in house know-how. Therefore, based on this logic, we suggest the three following specific hypotheses:

Hypothesis 1: There is a positive relationship between dimensions of EO and a firm's preference for external R&D sources of knowledge.
Hypothesis 2: There is a negative relationship between the dimensions of EO and a firm's preference for value chain sources of knowledge.
Hypothesis 3: There is an ambiguous relationship between the dimensions of EO and a firm's preference for in-house knowledge sources.

3. Data and research methods

3.1. The sample and data collection

During 2007 we administered an extensive questionnaire to the owners and/or chief executive officers (CEOs) in a sample of 304 firms in six Central and East European countries. However, some firms have not disclosed the required information particularly on their R&D expenditures, so the final sample involved 208 firms, 52 firms in Hungary, 46 in Czech Republic, 40 in Lithuania, 12 in Croatia, 39 in Poland and 19 in Romania. The two-page questionnaire consisted of 18 questions divided into four categories: (a) information about the firm, (b) information about the CEO, (c) information about the demand and firm growth and (d) information about sources of knowledge and networks of the firm. The data refer to 2006.

The firms were selected, first, on the basis of industrial classification, using a list, prepared by E. Wayne Clendenning and Associates (Clendenning and Associates, 2000), of industries considered to be knowledge-based. This also complies with the OECD (1999) definition of KBIs. Thus, the sample of firms were selected from five knowledge-based industries Pharmaceuticals and Chemicals, selected Manufacturing sectors, Software, Media and R&D (for the list of NACE sub-sectors included in each, see Appendix 1).Since the exclusive use of industry classification as a selection criteria would likely result in some companies being inappropriately categorised as knowledge-based, we have additionally employed a set of auxiliary criteria for final

selection of firms. These included, for example, whether the firm continuously invests in R&D and whether it employs highly skilled personnel (MSc's, PhD's).[17]

Table 3. Distribution of firms by country and industry type.

	Number of firms	% in total		Number of firms	% in total
Hungary	52	25.0	**Pharma, chemicals and plastics**	19	9.1
Czech Rep.	46	22.1	**Manufacturing**	95	45.6
Lithuania	40	19.2	**Software**	39	18.8
Croatia	12	5.8	**Media**	6	2.9
Poland	39	18.8	**R&D**	49	23.6
Romania	19	9.1			
Total	208	100	**Total**	208	100

In the survey, we asked firms about the following:

- *The sources of knowledge* – Firms were asked to identify the importance of the following sources of knowledge used in the firm as the basis of product/process/service innovations: customers, suppliers, research organizations such as universities and research institutes, patent disclosures, and fairs/exhibitions, as well as in-house sources such as internal R&D and employees.
- *Education of staff and management* – Firms were asked to provide the percentage of their skilled employees with graduate and postgraduate degrees at the master's or PhD level. Additionally, they were asked a similar question about the education level of the CEO.
- *S&T indicators and financial information related to innovations in the firm* – This included the ratio of R&D spending to sales, the share of turnover in 2006 realized from new or significantly improved products (goods or services) introduced during the period 2004–2006, whether they had at least one registered patent, and the average share of income from licensing (and royalties) or other form of intellectual assets in total revenues.
- *Degree of preparatory market research prior to starting the business* – Firms were asked to indicate which of the three statements best reflected their preparation in the area of market research when the firm was started: "we knew exactly who our first customer(s) would be", "we had identified a target market but not specific customers", or "we had developed a product but had to look for a market".
- *Search for external finance* – Firms were asked whether they had either obtained or sought external equity finance in the form of venture capital and details were asked about public sector sources.
- *Market position and strategy* – Firms were asked whether they were producing for new or mature markets, and whether they regarded themselves as pioneers or followers in the national market.

[17] As our classification is product-based, we were unable to include in our sample firms that are innovative in terms of knowledge-based or high-tech production processes but produce traditional products. Hence it is likely that some types of knowledge-based firms are omitted from our sample. However, any other approach to identification would be prohibitively costly.

3.2. Operationalization of variables

3.2.1. Independent variables: The sources of knowledge

We intend to explain how different sources of knowledge used and assessed for their importance by the firms influence the individual dimensions of their entrepreneurial orientation. In the questionnaire, firms were asked to identify the importance of a number of sources of knowledge in innovations (as less important, important and very important), as discussed in section 3.1. The list of sources is aimed to capture the most-used sources in the context of CEECs. We then applied factor analysis to the sources of knowledge data. The factor analysis identified three factors (see Table A.1 in Appendix 2 for the factor loadings):

(i) Value chain sources (suppliers and customers, fairs and exhibitions), representing firms dependent on value chain partners;
(ii) External R&D sources (research organizations and patent disclosures), representing external R&D knowledge oriented firms and
(iii) In-house sources, representing in-house knowledge oriented firms.

The variables for sources of knowledge used in the regression analyses are the factor scores for these three factors. Additionally, we use five industry dummies to control for differences in dimensions of entrepreneurial orientation across industries.

3.2.2. Dependent variables: Entrepreneurial orientation

Covin and Slevin (1989), measure EO by an index constructed from responses to seven-point Likert scale questions. The traditional Covin-Slevin approach has been criticised by Brown et al. (2001: 954) because the questions are a mixture of current attitudes and past behaviour and the fact that it fails to address to what extent firms are involved in the exploration and exploitation of opportunity. Staying within the boundaries of the well-recognised Covin and Slevin (1989) approach, we prefer to employ objective and measured indicators and data that we obtained from our sample of firms. These indicators also capture well the intensity of exploration activity (R&D, skilled staff, patent, licensing income) and exploitation activity (licensing payment, new or improved product turnover) in the firms.

We also prefer not to use the aggregate measure of the EO for the reason that, as suggested by the literature, EO is a multi-dimensional concept, with unknown interactions between different dimensions, summing up different qualities is methodologically questionable. Instead we use the occurrence of statistically significant results for different EO indicators as a proxy for its level. The more indicators for a given dimension of EO are statistically significant, the more likely that this dimension (and thus overall EO) is higher. We will now discuss the variables for each of the EO dimensions in turn.

The dependent variables are associated with different dimensions of EO. Since we employ a number of binary logistic regressions (see Section 4), we explain each dichotomous dependent variable.

Innovativeness. The existence of substantial R&D expenses[18], skill levels of staff and managers with postgraduate levels of education indicate the degree to which firms are oriented towards innovation activities as their core strategic entrepreneurial orientation. Hence, for the innovativeness dimension of EO, we use:

- **Skilled staff** = 1, if the percentage of staff with MSc and PhD degrees in total employees of the firm is greater than 32%; skilled staff = 0, otherwise.
- **R&D intensity25** = 1, if the ratio of R&D expenditure in total sales of the firm is greater than 24% in year 2005; R&D intensity25 = 0, otherwise.
- **R&D intensity50** = 1, if the ratio of R&D expenditure in total sales of the firm is greater than 49% in year 2005; R&D intensity50 = 0, otherwise.
- **CEOPhD =** 1, if the CEO had a PhD qualification; CEOPhD = 0, otherwise.
- **CEOMSc =** 1, if the CEO had an MSc qualification; CEOMSc = 0, otherwise.

Proactiveness. The variables used here reflect the degree to which the firm's innovations have been designed to put it in an advantageous position relative to the competition. Intellectual property is one aspect of this, and the share of innovative products in the firm's entire product offering is another. Also, whether the firm sells or buys licences indicates its pro-active attitude towards knowledge generation (exploration) and utilization (exploitation). These proxies of proactiveness seem particularly relevant in the case of enterprises and countries, which are behind the technology frontier as is the case in our sample. Hence, for the proactiveness dimension of EO, we use:

- **Registered patent** = 1, if the firm had registered patent(s); Registered patent = 0, if not.
- **Licensing income** = 1, if the firm had income from licensing and royalties or other form of intellectual assets; Licensing income = 0, otherwise.
- **Licensing payment** = 1, if the firm had payment for licensing and royalties or other form of intellectual assets; Licensing payment = 0, otherwise.
- **New product turnover** = 1, if share of new or improved products in total turnover in 2006 was greater than 24%; New product turnover = 0, otherwise.
- **Pioneer** = 1, if the firm is a pioneer in terms of strategic position in the national market; **Pioneer** = 0, if the firm is a follower.

Risk-taking. The level of risk in a firm's activity is usually gauged using a measure of the volatility of some form of returns (see, for example, Chakraborty et al. 2007). It also seems reasonable to regard a firm's quest for venture capital (VC) as a measure of risk, given VC is by definition used in ventures, which are highly risky. Therefore, we propose to use an indicator of whether the firm has sought VC, whether it has obtained it, and also whether it has obtained VC from public funds. These are all proxies of the readiness of firms to assume risks in different forms, including negotiations with public sector funders. In addition, we use two more indicators for whether the firm targets new markets and has identified its customers before embarking on sale of new products. Hence, for the risk taking dimension of EO, we use:

[18] In the sample of firms, particularly small and young firms with less than 10 employees in the software and R&D sectors (in natural sciences, architecture and engineering and technical testing and analysis) tend to invest heavily in R&D up to the ratios more than 50% of their total sales.

- **Market strategy** = 1, if the firm is aiming to produce for new markets; Market stratgey = 0, if mature markets.
- **Customer** = 1, if customers were not identified at the start of the firm; Customer = 0, if identified.
- **VCsought** = 1, if the firm sought external equity finance; VCsought = 0, if not.
- **VCobtained** = 1, if the firm successfully acquired external equity finance; VCobtained = 0, if failed.
- **VCpublic** = 1, if the firm acquired external equity finance from a public source; VCpublic= 0 otherwise.

4. Results

4.1. Descriptive Results

Table 4 presents the frequencies observed in the sample firms for use of sources of knowledge for innovation. Strikingly different from other sources, in-house sources of knowledge are considered to be very important by 81% of firms, whereas external R&D knowledge and value chain sources of knowledge are largely assessed as important by majority of the firms in the sample (40% and 43% respectively).

Table 4. Sources of knowledge in the firm for innovation (%) (N=208)

Category	Knowledge source	less important	important	very important
Value chain	**Customers**	17.3	38.5	44.2
	Suppliers	28.8	43.8	27.4
	Fairs and exhibitions	29.8	45.7	24.5
	Total (average)	25.3	42.6	32.1
External R&D knowledge	**Research organizations**	29.8	40.9	29.3
	Patent disclosures	32.7	39.9	27.4
	Total (average)	31.3	40.4	28.4
In-house knowledge	**In-house sources**	1.4	17.3	81.3

Source: Interviews.

Table 5 presents descriptive statistics for the variables. 28% of the sample firms invest in R&D in proportions that is more than 24% of their total sales, and 14% invest heavily in R&D as more than 49% of their total sales. 28% of firms have CEOs with a PhD; 47% have CEOs with an MSc degree. 37% have already at least one registered patent; 32% receive income from licenses and royalties, whereas 38% pay for them. The share of new products in total turnover in 2006 was greater than 24% in 56% of the firms, and 64% of firms consider themselves as pioneers in their domestic market. 46% of the firms in the sample target a new market as a strategy; 43% have not had identified their first customers when they started their operations. 51% of them actively sought external finance, 42% successfully managed to acquire the external finance, and 22% of the firms acquired external finance from public bodies.

Table 5. Descriptive statistics and Pearson correlation coefficients (N=208)

		Min	Max	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
INNOVATIVENESS	1.Skilled staff	0	1	0.44	0.50														
	2.R&D intensity >25%	0	1	0.28	0.45	0.18**													
	3.R&D intensity >50%	0	1	0.14	0.35	0.31**	0.65**												
	4.CEO with PhD	0	1	0.28	0.45	0.24**	0.04	0.12											
	5.CEO with MSc	0	1	0.47	0.50	0.16*	-0.11	0.01	-0.58**										
PROACTIVENESS	6.Registered patent	0	1	0.37	0.48	0.09	0.06	0.13	0.04	0.05									
	7.Licensing income	0	1	0.32	0.47	-0.07	-0.01	-0.04	-0.12	0.11	0.17*								
	8.Licensing payment	0	1	0.38	0.49	-0.05	-0.12	-0.12	-0.18*	0.15*	0.12	0.63**							
	9.New product turnover	0	1	0.56	0.50	0.17*	0.10	0.08	-0.09	0.11	0.17*	0.02	0.05						
	10.Pioneer	0	1	0.64	0.48	0.06	0.13	0.07	0.06	-0.11	0.11	0.01	-0.11	0.17*					
RISK TAKING	11.New market	0	1	0.46	0.50	0.22**	0.11	0.16*	0.20*	-0.05	0.18**	0.01	0.02	0.20**	0.31**				
	12.Customer not identified	0	1	0.43	0.50	0.01	-0.13	-0.10	0.09	0.01	-0.15	-0.13	-0.14*	-0.05	0.01	0.02			
	13.Venture capital sought	0	1	0.51	0.50	0.27**	-0.03	0.14*	0.05	0.18**	0.25**	-0.05	-0.07	0.04	0.05	0.10	-0.22**		
	14.Venture capital obtained	0	1	0.42	0.50	0.20**	-0.03	0.13	0.03	0.17*	0.30**	0.00	-0.02	0.08	0.07	0.11	-0.21**	0.84**	
	15.Venture capital public fund	0	1	0.22	0.41	0.24**	0.06	0.16*	0.06	0.05	0.25**	-0.03	-0.01	0.00	0.12	0.15*	-0.10	0.52**	0.62**

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

4.2. Econometric results

The bivariate correlation tests reveal that some of the EO variables are significantly correlated with each other (Table 5). To prevent further problems, which may arise with multicollinearity in the regressions, a different model is set up for each variable used as a dependent variable. Since the dependent variables in Models 1 through 15 are dichotomous variables, we apply binary logistic regressions to estimate the influence of sources of knowledge on dimensions and characteristics of entrepreneurial orientation (see Hosmer and Lemeshow, 2000).

Table 6 presents the results of logistic regressions. The Hosmer and Lemeshow tests show that the overall fit of the models are quite good, except for Model 1 and Model 10, where the significance values are just below the threshold value 0.05 as applied in SPSS.

Our results confirm that EO is strongly related to the sources of knowledge preferred by the enterprise. First, we found a positive relationship between all dimensions of EO and firms that are oriented towards external sources of knowledge (research institutes and patent disclosures). This confirms our first hypothesis. For instance, firms that are more oriented towards external sources of knowledge are more likely to employ staff with MSc and PhD qualifications in more than one third of their total employees; they are also likely to invest in R&D in rates more than 25% and 50% of their total sales. Moreover, the strength of the relationship between the use of external sources of knowledge and R&D expenditures as more than 50% of total sales is stronger than the when R&D expenditures are 25% of total sales (see Exp(B) values in Table A.2. 1.922>1.506, respectively). This suggests that the tendency to innovate and thus to use more skilled staff and invest in R&D increases with increasing use of external sources of knowledge. On the other hand, we did not find a statistically significant relation between CEO qualifications (i.e. PhD and MSc) and orientation towards external sources of knowledge. It seems that formal R&D knowledge is not the major or only source of knowledge as a PhD level is not prerequisite for managing a firm operating in a KBI.

Among the proactiveness measures of EO, having at least one registered patent, having a share of new products exceeding one quarter of total turnover and being a pioneer in the national market are closely associated with the preference of external sources of knowledge. The variables we used here reflect the degree to which the firm's innovations have been designed to put it in an advantageous position relative to the competition. The share of innovative products in the firm's entire product offering is one aspect of this, and intellectual property is another. Receiving income from own licenses and paying for licenses did not appear to be statistically significantly associated with external sources. Moreover, the coefficient on licensing payment is negatively associated with in-house knowledge oriented firms, which suggests that for these firms external knowledge is a substitute, not a complement. The coefficient on licensing incomes suggests weak proactive behaviour of the CEEC firms as they are not very active in selling their own licenses. We only find some supportive positive evidence for this in the software industry dummy.

All the risk-taking measures of EO are positively and statistically significantly associated with the preference of external knowledge sources. These involve aiming

Table 6. Results of binary logistic regressions (N=208)

independent variables	**Dependent variables**									
	Model 1		Model 2		Model 3		Model 4		Model 5	
A) INNOVATIVENESS	**skilled staff**		**R&D(25)**		**R&D(50)**		**CEOPhD**		**CEOMSc**	
Sources of knowledge	B	z	B	z	B	z	B	z	B	Z
Value chain	-0.126	0.692	-0.252	2.141	-0.688	9.218***	-0.571	11.19***	0.263	3.126*
External R&D knowledge	0.266	2.853*	0.409	4.783**	0.653	6.634**	-0.053	0.092	0.035	0.054
In-house sources	0.299	3.477*	0.211	1.287	0.102	0.199	0.194	1.318	0.033	0.049
Industry dummy (R&D control group)										
Pharmaceuticals	-0.480	0.733	-1.023	2.763*	-1.528	3.205*	-0.187	0.102	-0.390	0.410
Manufacturing	-0.936	6.178**	-1.631	14.10***	-1.720	8.477***	-0.666	2.772*	0.731	3.791*
Software	0.193	0.172	-0.008	0.000	0.219	0.133	-0.845	2.567	0.486	1.102
Media	-1.420	1.486	1.486	2.287	-0.065	0.003	-20.558	0.000	1.330	1.974
Constant	0.213	0.495	-0.350	1.298	-1.455	14.29***	-0.527	2.808*	-0.577	3.450*
Hosmer and Lemeshow Test (df=8)										
Chi-square (sig.)	15.883 (0.044)		8.4443 (0.391)		8.2616 (0.408)		4.06809 (0.851)		9.3803 (0.311)	
Log likelihood	-528.90		-424.76		-271.38		-441.86		-548.66	
Pseudo R2 (Nagelkerke)	0.13		0.22		0.26		0.16		0.08	

	Model 6		Model 7		Model 8		Model 9		Model 10	
B) PROACTIVENESS	**registered patent**		**license income**		**license payment**		**new product**		**Pioneer**	
	B	z	B	z	B	z	B	z	B	Z
Value chain	-0.051	0.100	0.199	1.535	0.251	2.675	-0.169	1.261	-0.439	6.820***
External R&D knowledge	0.674	14.82***	0.260	2.488	0.250	2.563	0.329	4.555**	0.261	2.565
In-house sources	-0.029	0.031	-0.159	1.043	-0.296	3.932**	0.236	2.493	0.435	7.827***
Industry dummy (R&D control group)										
Pharmaceuticals	0.633	1.125	0.255	0.192	-0.394	0.401	-0.490	0.759	-0.096	0.024
Manufacturing	-0.438	1.292	-0.250	0.372	0.335	0.733	0.420	1.266	-0.372	0.868
Software	-1.739	7.721***	0.957	3.922**	0.708	2.171	0.841	3.152*	0.786	2.139
Media	-1.268	1.137	0.147	0.024	0.566	0.383	-0.260	0.074	-0.120	0.016
Constant	-0.209	0.453	-0.906	7.60***	-0.770	5.647**	-0.056	0.035	0.707	4.544**
Hosmer and Lemeshow Test (df=8)										
Chi-square (sig.)	4.0029 (0.857)		7.6136 (0.472)		15.428 (0.051)		14.7504 (0.064)		15.754 (0.046)	
Log likelihood	-460.8		-494.8		-527.3		-546.86		-493.46	
Pseudo R2 (Nagelkerke)	0.25		0.08		0.09		0.08		0.15	

	Model 11		Model 12		Model 13		Model 14		Model 15	
C) RISK TAKING	**market strategy**		**customer**		**VCsought**		**VCobtained**		**VCpublicfund**	
	B	Z	B	z	B	z	B	z	B	Z
Value chain	-0.452	7.917***	0.002	0.000	0.032	0.046	-0.040	0.071	-0.478	7.014***
External R&D knowledge	0.478	8.166***	0.311	4.185**	0.409	7.069***	0.414	7.048***	0.625	9.419***
In-house sources	0.272	2.774*	-0.025	0.030	0.160	1.149	0.045	0.089	0.022	0.015
Industry dummy (R&D control group)										
Pharmaceuticals	-1.710	7.318***	0.713	1.518	0.688	1.374	0.731	1.648	0.911	2.306
Manufacturing	-0.710	3.430*	0.472	1.630	0.231	0.387	0.177	0.226	0.143	0.100
Software	0.296	0.384	0.529	1.325	-0.214	0.214	-0.202	0.178	-0.377	0.321
Media	2.036	2.927*	0.921	0.943	-0.278	0.086	-1.011	0.751	-19.612	0.000
Constant	0.194	0.387	-0.106	0.126	-0.078	0.067	-0.416	1.874	-1.550	16.73***
Hosmer and Lemeshow Test (df=8)										
Chi-square (sig.)	12.246 (0.141)		5.428 (0.711)		11.048 (0.199)		1.896 (0.984)		5.979 (0.650)	
Log likelihood	-507.32		-553.94		-547.74		-537.02		-375.94	
Pseudo R2 (Nagelkerke)	0.20		0.05		0.09		0.09		0.20	

***Statistically significant at 1% level. **Statistically significant at 5% level. *Statistically significant at 10% level.

at new markets, having no customers identified at the start of the business and search for venture capital funds. Thus, the external knowledge oriented firms are more likely to take the risks for operating in new markets and more likely to actively seek financial funds even from public authorities in the context of CEECs.

Secondly, confirming our second hypothesis, we found that there is a negative relationship between the dimensions of EO and value chain dependent firms. This relationship is not statistically significant for variables such as skilled staff and R&D intensity more than 25%; but it is statistically significant for higher levels of innovativeness measures such as R&D intensity more than 50% and CEO with PhD. This suggests that value chain dependent firms are not likely to invest over 50% of sales in R&D and they are less likely to have CEOs with PhDs compared to CEOs with MSc degrees. Neither proactiveness measures nor risk-taking measures are positively associated with the use of value chain sources of knowledge. On the proactiveness side, only the variable for being a pioneer in the national market is statistically significantly associated with the use of value chain sources of knowledge (negatively, as expected). On the risk-taking side, we found a negative relationship between firms that use value chain sources of knowledge and the use of public funds and activity in mature markets, as expected.

Thirdly, we did not find any clear relationship between EO and firms dependent on in-house sources of knowledge. We can only identify positive relationships with the higher rates of use of skilled staff, being a pioneer firm in the national market and aiming at new markets as well as a negative relationship with paying for licenses in relation to use of in-house sources of knowledge. Yet, all other indicators we used did not have any statistically significant relationship with in-house sources. A more extended analysis is probably necessary to show a pattern of in-house sources of knowledge that firms use and some other aspects of EO in the context of CEECs.

5. Discussion

Our results suggest that differences in the patterns of sources of knowledge are related to different dimensions of EO and to the overall EO (Table 7). Firms that are oriented towards external sources of knowledge have the largest number of significant and positive coefficients, while value chain dependent firms have all but one variable (CEO MSc) significantly negative. In-house knowledge oriented firms are in an intermediate position with significant and positive coefficients on skilled staff, pioneer strategy and new markets. This type of firms have negative coefficients on licensing payments indicating that licensing for these firms operate more as substitute rather than as complement. This is at odds with the conventional wisdom on the role of external knowledge as a complement to in house knowledge and further confirms the distinctive pattern of sources of knowledge of these types of firms. In summary, our results suggest that the EO of external knowledge based firms is the highest and that of value chain firms the lowest, with in-house knowledge oriented firms in an intermediate position.

Table 7. Summary of results of regressions on dimensions of EO

	Innovativeness	**Proactiveness**	**Risk-taking**
External R&D knowledge oriented firms	R&D(25) R&D(50) Skilled staff	Patents New product turnover	New market strategy Customer not identified VC sought VC obtained VC public funds
In house knowledge oriented firms	Skilled staff	*(-) Licensing payments* Pioneer	New markets strategy
Value chain dependent firms	*(-) R&D(50)* *(-) CEO PhD* CEO MSc	*(-) Pioneer*	*(-) New market strategy* *(-) VC public funds*

(Significant and negative coefficients are in italics; others are positive and significant.)

Our results are much less conclusive regarding the different dimensions of EO and in that respect they conform to the previous literature. However, our results also help explain why research on the EO is fraught with difficulties. Tables 6 and 7 show that each of dimension of the EO operates differently across different types of firms depending on their preferences of sources of knowledge. The innovativeness dimension is significantly and positively present in the case of external R&D knowledge oriented firms but is negative in the case of value chain dependent firms. The proactiveness dimension of EO is not significant in value chain dependent firms, while it plays a large role in the other two types of firms. External R&D oriented firms are absolute risk-takers, while value chain dependent firms are risk-averse and in-house knowledge oriented firms showing some signs of risk-taking behaviour. We believe that these results explain the mixed results in the literature that explores the relationship between EO and firm performance. The preferences of sources of knowledge are a moderating factor mediating the relationship between performance and the EO.

In order to explore the validity of this result further, we ran a factor analysis based on all the proxies of the EO used in our sample (we do not report this here). The intention was to check whether all our proxies will correlate into one-factor solutions – i.e. whether all of the measures used for each dimension of EO will generate one factor solution corresponding to the respective dimension. As would have been expected based on results summarised in Table 7, the factor analysis generated two factor solutions for each of three dimensions (innovativeness, proactiveness and risk taking). However, by throwing out some of measures for a given dimension, we can get a one-factor solution. In conclusion, this exercise indicates moderate support for using three dimensions of EO and suggests that research is highly sensitive to the choice of variables, which again explains mixed results from the literature.

6. Conclusions

This paper contributes to the literature on the EO of enterprises by demonstrating that the differences in preferences of knowledge sources are significantly associated with differences in levels and types of EO. Based on the survey sample of 208 firms operating in knowledge based industries in six Central and East European Countries we have identified three types of firms in terms of their

preferences for sources of knowledge: (i) external R&D knowledge based firms, who source strategically important knowledge primarily from research organizations and patent disclosures, (ii) in-house knowledge based firms and (iii) value chain dependent firms. In exploring different dimensions of EO we followed the standard method in the literature by using innovativeness, proactiveness and risk taking as distinctive dimensions of the EO.

Based on a series of logit regressions, this paper shows that in the CEEC context, EO is strongest in firms based on external R&D sources of knowledge. Firms dependent on value chain sources are the least entrepreneurially oriented, and in-house knowledge dependent firms show ambiguous characteristics. With regard to the dimensions of EO, firms that prefer external R&D knowledge sources are the most innovative, with heavy investments in R&D and skilled labour; the most active in risk-taking, targeting new markets and new customers and actively seeking and obtaining venture capital; and the most pro-active in terms of introducing new products and registering patents. This suggests that they are well-endowed and largely oriented toward the exploration of entrepreneurial opportunities. Value chain dependent firms are found to be the least innovative, the most risk averse and the least pro-active. They do not heavily invest in R&D, their CEOs tend to have master's degrees rather than PhDs, and they seem to be technology followers. All of this implies that they are rather exploiters than explorers, who feel safe operating in mature markets due to their risk aversion. Finally, the results for the firms preferring in-house knowledge sources show ambiguous characteristics: on the one hand, they have skilled staff, do not license technology from others, and their market strategies indicate that they are pioneers in their national markets. On the other hand, the analyses did not provide enough support in terms of key indicators such as R&D, patent and venture capital suggesting that these firms are entrepreneurially oriented with respect to exploration or exploitation of technological and financial opportunities. The reasons for this may well be explained by the different technological dynamics of the CEEC firms compared to those of advanced countries. This calls for further research in this area.

Our results clearly suggest that EO is also a phenomenon which varies depending on the morphology of knowledge sources (i.e. on the relationship between internal and external sources of knowledge).The more the firm is oriented towards exploration and external knowledge the more likely it is that it will develop stronger EO in order to network with the external actors.

On the whole, the results point to strong systemic features of entrepreneurial activities. EO is inherently different in different sub-populations of firms depending on their dominant knowledge source patterns. It seems that these patterns operate as a moderating factor between performance and the EO, which may explain the mixed results from the literature.

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Appendix 1: NACE classifications in industrial breakdown

Pharmaceuticals, chemicals and plastics
NACE Division 24 (manufacture of chemicals and chemical products)
NACE Group 24.4 (manufacture of pharmaceuticals, medicinal and chemicals and botanical products)
Manufacturing
NACE Division 29 (machinery and equipment)
NACE Division 30 (manufacture of office machinery and computers)
NACE Division 31 (electrical machinery)
NACE Division 32 (radio, TV and communication equipment)
NACE Division 33 (instrument engineering)
NACE Division 35 (other transport equipment)
NACE Group 35.3 (manufacture of aircraft and spacecraft)
Software
NACE Group 72.1 (hardware consultancy)
NACE Group 72.2 (software consultancy and supply)
NACE Group 72.21 (publishing of software)
NACE Group 72.22 (other software consultancy and supply)
NACE Group 72.3 (data processing)
NACE Group 72.4 (database activities)
NACE Group 72.5 (maintenance and repair)
NACE Group 72.6 (other computer related activities)
Media
NACE Group 64.2 (telecommunications)
NACE Group 92.1 (motion picture and video activities)
NACE Group 92.2 (radio and television activities)
NACE Group 92.3 (other entertainment activities)
NAICS 52.8 (internet service providers; NACE code not available)
R&D
NACE Group 73.1 (research and experimental development in natural sciences and engineering)
NACE Group 74.2 (architectural and engineering activities and related technical consultancy)
NACE Group 74.3 (technical testing and analysis)

Appendix 2: Table A.1

Table A.1 Factor loadings for 'Sources of knowledge' variables

	Factor 1 Value chain	Factor 2 External R&D	Factor 3 In-house sources
Customers	**0.821**	-0.005	0.236
Suppliers	**0.822**	0.016	-0.077
Fairs and exhibitions	**0.658**	0.386	-0.189
Research organizations	-0.030	**0.841**	0.219
Patents and journals	0.184	**0.872**	-0.067
In-house sources	0.014	0.097	**0.956**
Eigenvalues	2.14	1.35	1.01
Percentage of total variance explained	35.67	22.56	16.90

(Extraction method: Principal Component Analysis, Varimax rotation with Kaiser normalization, N=208, KMO measure of sampling adequacy=0.722, Bartlett's test of sphericity Chi-square=448.373 and sig.=0.000)

Appendix 2: Table A.2

Table A.2. Exp (B) values from logistic regressions in Table 4.

	Dependent variables														
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15
Independent variables	**skilled staff**	**R&D(25)**	**R&D(50)**	**CEOPhD**	**CEOMSc**	**reg. patent**	**lic. income**	**lic. payment**	**new product**	**pioneer**	**market**	**customer**	**VCsought**	**VCobtain**	**VCpubfund**
Value chain	0.881	0.777	0.503	0.565	1.301	0.950	1.220	1.286	0.845	0.645	0.636	1.002	1.032	0.961	0.620
External R&D	1.306	1.506	1.922	0.949	1.036	1.962	1.297	1.284	1.391	1.298	1.614	1.365	1.506	1.513	1.868
In-house sources	1.349	1.235	1.107	1.214	1.034	0.971	0.853	0.744	1.266	1.545	1.313	0.975	1.173	1.046	1.023
Industry dummy (Research control group)															
Pharmaceuticals	0.619	0.360	0.217	0.829	0.677	1.884	1.291	0.674	0.613	0.908	0.181	2.041	1.989	2.077	2.488
Manufacturing	0.392	0.196	0.179	0.514	2.079	0.645	0.778	1.398	1.522	0.689	0.492	1.603	1.260	1.194	1.154
Software	1.213	0.992	1.244	0.429	1.626	0.176	2.606	2.030	2.320	2.194	1.345	1.697	0.807	0.817	0.686
Media	0.242	4.420	0.937	0.000	3.780	0.281	1.159	1.762	0.771	0.887	7.666	2.512	0.757	0.364	0.000
Constant	1.238	0.704	0.233	0.590	0.562	0.812	0.404	0.463	0.946	2.028	1.214	0.900	0.925	0.660	0.212

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