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Regional Advantage and the Geography of Networks: Explaining Global-Local Knowledge Sourcing Patterns

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ABSTRACT

There is a dearth of systematic evidence concerning the extent to which being located in economically advantaged regions assists firms in accessing knowledge from global sources. This paper explores this issue by utilizing data from a survey of firms in the UK. It shows that local knowledge sourcing widely assists firms in economically advantaged regions by acting as a springboard for international knowledge sourcing, whilst this is not the case for their counterparts in disadvantaged regions. The analysis suggests that the springboard effect and the geography of external knowledge networks are associated with regional economic context.

KEYWORDS

Innovation; knowledge; sourcing; networks; geography; regions.

INTRODUCTION

Concomitant with the emergent view of innovation as an increasingly open process (Chesbrough, 2003), a significant change has occurred in the discourse on the spatial aspects of knowledge networks (Ter Wal and Boschma, 2011; Fitjar et al., 2016). A key feature of this discourse has long concerned the role of spatially proximate and co-located external organizations, such as other firms, R&D labs, and universities, in a firm's innovation process and particularly knowledge sourcing activities (Cooke et al., 2004; Laursen et al., 2012; Mattes, 2012). In general, compared with explicit knowledge that can be easily communicated among individuals, tacit knowledge – such as skills, competence, and talent – is more difficult to directly communicate to someone else in a verbal or other symbolic form and thus more sensitive to spatial distance, rendering its flow more likely to be bounded within specific spatial contexts (Jenkins and Tallman, 2016).

More recently, and alongside the recognized importance of spatial proximity to network development, there is an increasing emphasis on the importance of understanding knowledge flows in an environment that is simultaneously local and global (Broekel and Boschma, 2012; Trippl et al., 2018). In particular, it is argued that the knowledge base of the world's most advanced local and regional economies is no longer necessarily local, but positioned within global knowledge networks, as firms in these economically advantaged regions seek new

knowledge and the means to better exploit their existing knowledge base. These regions, often dubbed as global clusters, are increasingly connected through the networks resulting from the internationalization of markets and the broadened scope of knowledge networking activities (Bathelt and Li, 2014).

With the growing emphasis on global networks for knowledge sourcing, there is a requirement to better understand the relationship between knowledge sourcing at the local and international levels. Implicit in the arguments stemming from observations of advanced local and regional economies is the view that local interactions in knowledge-rich environments better prepare firms for obtaining knowledge from overseas sources (Ter Wal and Boschma, 2011). However, there is a dearth of systematic evidence on this issue, particularly with regard to the following question: When accessing overseas knowledge sources, does knowledge sourcing at the local level better assist firms located in economically advantaged regions than their counterparts in economically disadvantaged regions?

Against this backdrop, the key aim of this paper is to fill this gap by theorizing the process of external knowledge sourcing and testing a set of hypotheses concerning the potential advantages for firms located in economically advantaged regions, through an analysis of the frequency of knowledge sourcing, or the depth of knowledge search (Laursen and Salter, 2006), within a firm's own region and overseas. To achieve these aims, the analysis draws on data from a unique survey of firms across the UK, which provides detailed information on external knowledge sourcing activities by type and location of sources.

The analysis reveals that firms in economically advantaged and disadvantaged regions are distinct from each other in the way local knowledge sourcing facilitates international knowledge sourcing. Local knowledge sourcing widely assists firms in economically advantaged regions by acting as a springboard for international knowledge sourcing. In contrast, their counterparts in disadvantaged regions are more likely to either seek ties with overseas sources through other channels or remain inactive in overseas knowledge sourcing. The remainder of the paper is structured as follows: the next section presents the conceptual framework and a set of hypotheses, followed by an outline of the context, data and method employed for the empirical analysis. The results of the study are followed by a discussion of their meaning and implications.

KNOWLEDGE SOURCING AND GEOGRAPHY

Knowledge can be generally defined as information that changes something or somebody, either by becoming grounds for action or by making an organization capable of different or more effective action (Drucker, 1989). Knowledge sourcing from external sources has long been acknowledged as a significant factor in successful innovation, allowing firms to access knowledge that they do not, or cannot, generate internally based on their own capabilities (Bergenholtz and Waldstrøm, 2011; Huggins and Thompson, 2014).

In general, external knowledge sourcing consists of three phases (Zahra and George, 2002). It begins by searching, identifying, and evaluating external sources for a particular knowledge a focal firm requires to innovate and enhance economic returns (i.e., ideas, inventions, technologies, latent innovations, as well as 'know-who' or information about other knowledge sources). The firm then approaches sources which are judged to be most appropriate against its goals and circumstances; develops and manages relationships with them; enables conditions suitable for knowledge sourcing; and finally accesses the relevant knowledge (Kramer and Revilla Diez, 2012). This is followed by a firm's internal undertaking of knowledge assimilation, transformation, and exploitation, aiming to integrate externally-sourced knowledge into its own knowledge base and commercialize innovations (Cohen and Levinthal, 1990;Grillitsch et al., 2016).

External knowledge sourcing activities are clearly subject to considerable risks and costs (West and Bogers, 2014). Besides the internal challenges of adapting a firm's management orientation and employee behaviours (van de Vrande et al., 2009), these activities necessarily involve the process of finding the right sources of knowledge and building relationships with them. Although the growing availability of online communities, crowdsourcing, and Internet platforms have decreased the costs of searching for potential sources of knowledge (Maskell, 2014), the process of judging their quality and building relationships with them remains specific to the knowledge sources in question, often forcing a focal firm to go through a period of trial and error to build up an understanding of the norms, habits, and routines of the knowledge sources, to reduce the chance of miscommunication and conflicts (Kankanhalli et al., 2006). Interactions with external sources of knowledge are also associated with risks of 'involuntary outgoing spillover', namely, leakage of critical knowledge concerning the focal firm's innovation efforts and core competencies (Laursen and Salter, 2014). The risks prompt the focal firm to pay managerial attention to the protection of its intellectual assets through intellectual property rights and secrecy (Dahlander and Gann, 2010). However, the effort to control the risks through legal rights and secrecy is necessarily

accompanied by some degree of openness, requiring the formation of trust with partners (Laursen and Salter, 2014).

There are two preferred ways in which firms seek to manage the risks and reduce the costs of external knowledge sourcing. One is to source knowledge locally. Geographical proximity with knowledge sources provides opportunities for frequent, iterative interpersonal contacts, allowing the focal firm to identify and observe potential collaboration partners, reduce information asymmetries, and calculate the likelihood that trust will be honored (Lorenzen 2007; Fitjar et al., 2016). Ease of face-to-face meetings is also suitable for the transfer of complex combinations of both tacit and codified knowledge (Li et al., 2013). Furthermore, when sourcing knowledge locally, the focal firm often draws on a shared culture of trust that develops at the local level through numerous mechanisms such as the mobility of workers, informal contacts through professional associations, and a long history of cooperation (Berchicci et al., 2016).

Within the context of firms held within a corporate group, another means of knowledge sourcing is to internally transfer from the focal firm's subsidiaries and parent company know-who used for searching, identifying, and evaluating external knowledge sources (Bathelt and Cohendet, 2014; West and Bogers, 2014). Regardless, however, of whether a firm is independently owned or not, it is through a combination of local sourcing and internal transfer that global circuits of knowledge creation and diffusion develop over time (Fitjar and Rodríguez-Pose, 2011). Whilst the professional and business networks of individuals and organizations that share disciplines, functions, and common markets initially tend to be local configurations, some of their constituents are likely to be affiliated with global organizations that have access to knowledge pools overseas (Müller and Ibert, 2015). Knowledge, particularly know-who of knowledge providers, transmitted across national borders through the internal networks of global organizations, as well as the international migration of labor (Coe and Bunnel, 2003; Saxenian, 2005), may spill over locally to other individuals and organizations at the end of global pipelines, in turn enabling them to connect with distant sources, and embark on their own cross-national knowledge exchanges. Sustained and repeated processes of the knowledge circulation multiply trans-local and cross-national feedback loops, intertwining the local and global dimensions of knowledge sourcing activities.

Knowledge gained through external sourcing is not uniform. Viewed by the knowledge-seeking focal firm, a significant proportion of knowledge sources fall within two types according to the form of knowledge and mode of learning and innovation (Jensen et al., 2007).

A first group of sources consists of customers, suppliers, and competitors doing business in the same or related market as the focal firm, which is characterized by experience-based know-how and informal interactive processes of learning. In contrast, a second group consists of research organizations such as government research institutes, private R&D laboratories, and universities, which are characterized by the production and use of more codified scientific and technical knowledge. While these two groups may overlap in varying degrees by industry (Moodysson et al., 2008; Asheim et al., 2011), a number of empirical studies provide evidence supporting the general typology (Roper et al., 2008; Doran and O'Leary, 2011). From the focal firm's viewpoint, the first 'market-based' group of sources offers more obvious inputs and operates in a similar context of market actions. In contrast, the second 'research-based' group exhibits a greater distance from application and often operates with disparate motivations (Dussauge et al., 2000; Siegel et al., 2004; Grimpe and Sofka, 2009). As a result, establishing links with and sourcing knowledge from the two groups require different protocols and practices, forming distinct circuits (Laursen and Salter, 2006; Grimpe and Sofka, 2009).

Finally, constituents of global knowledge circuits vary across regions in their distribution. Regional locations within a nation typically vary in the amount of organizations constituting the two groups of sources. Economically advantaged regions are generally populated by a greater number of knowledge-based firms and research institutes, providing greater opportunities for collaboration and networking. In particular, organizations located in economically advantaged regions may be more likely to be part of global networks of cross-national corporations (Huggins and Johnston, 2009). In contrast, economically disadvantaged regions tend to be organizationally and institutionally 'thin', with a lack of innovation-driven public or private sector entities, often coupled with a presence of small and medium enterprises exhibiting low growth trajectories (Grillitsch and Nilsson, 2015).

With a firm's drive to reduce risks and the costs of knowledge sourcing, and the cross-regional variations in global ties for their reduction, economically advantaged and disadvantaged regions may be differentiated in their local-global relationships for knowledge sourcing. A firm's proclivity to acquire knowledge from overseas sources derives in part from its openness, namely, its propensity to source knowledge externally. In searching, identifying, and evaluating overseas sources, a firm is most likely to begin by seeking their information through local channels with a view to reducing the risks and costs of search. A focal firm's likelihood of discovering local sources that possess know-who of overseas sources increases with (a) the focal firm's engagement in local knowledge sourcing activities and (b) the availability of local sources that possess know-who of overseas sources. While (a) depends on

a focal firm's openness, (b) may vary across regions. In economically advantaged regions, local sources possessing know-who of overseas sources may be widely distributed. As a focal firm takes an open search strategy to a greater extent, the firm is likely to discover a larger number of know-who providers, which in turn allows the focal firm to: analyze a greater amount of know-who, be more likely to catch vital information, and have it corroborated; have a greater confidence in their decisions; and approach identified knowledge sources outside the country (Huber, 2012; Boschma et al., 2014). In contrast, being situated in economically disadvantaged regions may not offer benefits from such concentrations of internationally-linked organizations and individuals. If a focal firm is out of luck locally, the firm is likely to either seek ties with overseas sources directly or through other channels or stop short of seeking overseas sources for a particular piece of knowledge. Other channels for obtaining know-who of overseas sources include sources elsewhere in the country and local intermediary organizations. Some argue that 'temporary clusters', such as trade fairs, exhibitions, conferences, and the like, are designed to facilitate this type of network building (Panitz and Glückler, 2017).

Although the current literature indicates that there may be different patterns of knowledge sourcing across firms in either economically advantaged or disadvantaged regions, there is little empirical evidence to support this argument. In particular, it may be the case that regional context matters for international knowledge sourcing, with knowledge sourcing-active firms in economically advantaged regions drawing on the intermediary role played by local sources, while firms in disadvantaged regions are less likely to be able to use local sources as a springboard for the establishment of links to more global knowledge sources. In order to empirically explore this, the following hypotheses are suggested:

> Hypothesis 1: In economically advantaged regions there is a significant positive relationship between the types of knowledge sources firms utilize at both the local and global level.

> Hypothesis 2: In economically disadvantaged regions there is no significant relationship between the types of knowledge sources firms utilize at the local and global level.

These hypotheses suggest an overall theoretical model as illustrated by Figure 1, whereby in aggregate firms located in economically advantaged are able to better utilize local knowledge sources as a means of accessing more global sources. Firms located in both types of region may equally access global knowledge sources through direct or other channels, such as the use of

specific intermediaries, but firms located in disadvantaged regions may have less opportunity to access global knowledge sources indirectly via local knowledge sources. If this is the case, it is likely to be mainly due to disadvantaged regions lacking the density of firms with preexisting connections to global knowledge sources compared with the relative density of such firms in more economically advantaged regions. The hypotheses are tested with each of the two groups of knowledge, 'market-based' and 'research-based' sources, since knowledge sourcing from the two groups may require different protocols and practices.

CONTEXT

In the case of the UK, the differential between economically advantaged and disadvantaged regions is manifested by the 'North-South divide', whereby regions in the southern half of the nation, in particular London, South East England, and East of England, are the nation's core economic drivers. The divide has deepened in recent decades with the burgeoning concentration of economic, social and cultural resources in the south (Faggian et al., 2013; Fotopoulos, 2014; Cunningham and Savage, 2015). Concentrations of globally-linked organizations in the advantaged regions are evident, with these three regions alone accommodating 43.5% of private sector enterprises and 54.6% of firms owning subsidiaries, indicating a concentration of high-order functions. In particular, 65.1%, of those owning foreign subsidiaries and 66.2% of the firms owned by parent companies outside the UK are concentrated in the economically advantaged regions. Together, these show that units of cross-national corporations are predominantly based in the three economically advantaged regions, channeling the hands-on, market-based knowledge of their overseas locations.

As for firms in scientific and research development, 64.8% of them are located in the economically advantaged regions, a sign of the concentration of research-based organizations. The economically advantaged regions are again dominant as a location for those with overseas ties. They accommodate 65.9% of those owing foreign subsidiaries and 66.8% of those owned by parent companies outside the country. Clearly, those firms with internal overseas ties that may act as global pipelines are predominantly concentrated in the three economically advantaged regions. Such pipelines are likely to provide access to reliable information about key players of scientific and research development in their overseas locations (Bathelt et al., 2004).

Furthermore, the three economically advantaged regions account for a disproportionate proportion of the international migration of labor as their destination. For example, this is evidenced by the fact that, while only 36.4% of the country's population reside in the three

advantaged regions, they accommodate 57.9% of non-UK born population and attract 53.9% of international migration inflows in 2015 (Office for National Statistics, 2016).

DATA

The empirical part of this paper is based on information collected from a survey of 3,622 firms in the UK administered on firm knowledge sourcing practices. The survey sought to capture data for firms with a potential propensity towards innovation and knowledge-based interactions, and therefore the key source in preparing the sample was a systematic mining of listings of firms based on science and technology parks, and business incubators in the UK, using multiple regional and local directories of firms. There is considerable evidence that firms based on these sites are more technology and innovation oriented with a propensity to source knowledge from a range of external organizations, representing a cohort of firms suitable for the analysis (Minguillo et al., 2015).

For each of the identified firms, the team sought further details such as business size, location, and sector of activity, matching identified firms with entries in business information databases. This principally made use of the FAME (Financial Analysis Made Easy), which is regarded as a reliable and robust source of information (Ritchie and Evans, 2009), supplemented by a range of other commercial business information databases. This ensures the capability to define the structure of the sample, with the information obtained from databases helping to triangulate survey responses with secondary data.

A majority of the survey sample, approximately 86.7%, were in three broad sectors: manufacturing; information and communication technologies; and professional, scientific, and technical services, with the remainder of the sectors covering: agriculture and mining; construction; wholesale and retail trade; financial, insurance, and real estate activities; human health and social work activities; arts, entertainment, and recreation; and other service activities. The sample was dominated by small firms with 0–50 employees (79.6%), followed by medium firms with 51–250 employees (12.8%) and large firms with 251 employees and more (7.7%). In terms of geographical distribution, 42.7% were located in South East, East of England, and London. The lowest proportion of firms came from Northern Ireland, Wales and North East (2.0%, 3.1%, and 3.3% respectively), resembling the distribution of the population of all active firms (Office for National Statistics, 2010). As for firm age, the mean average was 20.5 years.

The questionnaire was administered by post and achieved a response rate of approximately 10.9%, obtaining 393 responses. For our current analytical purposes, we select

299 firms that answered all questions relevant to this paper's analysis. To investigate the potential for response bias, χ^2-test comparisons of responding versus non-responding firms on sector, size, and geographical location, and Mann-Whitney U test on age were conducted, revealing no significant differences (p=0.76, 0.93, 0.20, and 0.64 respectively).

In cases where data from a single informant is relied upon there is a possibility that the design or administration of the questionnaire can introduce common method variance (CMV) (Podsakoff et al., 2012). As a means of examining whether CMV remained a problem, confirmatory factor analysis was employed to conduct a single-factor test on all measured variables (Podsakoff and Organ, 1986). If CMV is present, a single factor model should fit the data as well as a more complex model. In this case, the goodness of fit statistics for a single factor model showed a poor fit (CFI=0.329 and RMSEA = 0.161 with 90% confidence interval of 0.155–0.168), suggesting that CMV is not an issue.

The survey collected information on knowledge sourcing activities by the type and location of knowledge sources as well as firm profiles, with a mix of ordinal and scale data through the use of Likert scales and open numerical questions. In the survey, knowledge is defined as broadly consisting of research and development, ideas, skills, expertise and other information that is, or potentially can be, used to make the operation of respondent firms more effective. Whilst this definition of knowledge ranges broadly from explicit to tacit, the knowledge sources covered in the survey restrict the range to the one involving some tacit element communicated through direct human interactions. Therefore, the survey does not include knowledge firms may access from sources such as scientific journals, websites, trade literature as well as access to other sources that are based on little or no communicative interaction between the knowledge source and its receiver.

To measure levels of knowledge sourcing activities at different geographical levels, each firm was asked to rate on an 11-point Likert scale (0 = never, 10 = very often) their frequency of use for each of the following five knowledge sources that fall within two groups of formal entities: (1) 'market-based' sources including (a) suppliers of equipment, materials, services, and software; (b) customers; and (c) competitors and other businesses in the firm's industry; and (2) 'research-based' sources including (d) private research institutes and commercial labs and (e) government and public research institutes. Additionally, firms were asked to rate their frequency of sourcing knowledge from universities and higher education institutes. Universities and higher education institutes are treated separately from the 'market' or 'research'-based groupings as their role for firms is often multifunctional. For some they will clearly be a research-based source, but for others they make act as a supplier of equipment,

software and data, or indeed they may be a customer for these same goods and services, i.e. a market-based source. Firms were also asked to rate the frequency of using trade fairs, exhibitions, and conferences. This particular type of temporary events facilitates knowledge exchange often on the basis of informal interactions between individuals (Panitz and Glückler, 2017).

The question for each knowledge source type was repeated for each of three geographical levels: located within the firm's own region; located within the rest of the UK; and located outside the UK. The frequency with which a firm accesses a particular type of knowledge source indicates the degree of the firm's embeddedness in the innovation system at the geographical level concerned (i.e., regional, national, international) and, conversely, the degree of the particular source's integration into the firm's internal innovation efforts (Laursen and Salter, 2006; Huggins and Thompson, 2017; Trippl et al., 2018).

In order to validate the two groups of knowledge sources, namely, 'market-based' and 'research-based', and to merge the utilization frequencies of each group's respective sources into a single factor score, confirmatory factor analysis is performed at each of the three geographical levels. Unlike exploratory factor analysis deriving factors not from theory but from statistical results, confirmatory factor analysis shows how well a theoretical specification of factors matches actual data, enabling us to either confirm or reject a conceived theory. While all measured variables are related to every factor in explanatory factor analysis, each variable is assigned to only a single factor in confirmatory factor analysis (Kline, 2011).

The results of confirmatory factor analysis are shown in Table 1. Of the three geographical levels, the model for international knowledge sourcing shows the most satisfactory results, confirming latent factors for the two groups of sources. All standardized loadings are higher than 0.5 and three of them are higher than 0.7. Raykov's ρ coefficients are either higher or around 0.7, showing an adequate level of construct reliability. Furthermore, covariance residuals are less than |2.5| for a majority of pairs and are not greater than |4.0| for any pair (not reported in the table). Standardized factor covariance (0.55) is only moderate in size, suggesting discriminant validity. All goodness-of-fit statistics are within a range that would be associated with good fit, confirming measurement model validity.

TABLE 1 ABOUT HERE

The model for knowledge sourcing within a firm's own region also shows a good overall fit, although the standardized loadings and Raykov's ρ coefficients for the factor concerning

research-based sources are relatively lower, meaning that a greater proportion of the factor's observed score variance is due to random error than the market-based sources factor. Factor scores for international sourcing and regional sourcing are derived on the basis of the structure coefficients shown in Table 1. In contrast, the model for knowledge sourcing within the rest of the UK shows poor results. Therefore, the scores for respective sources (a) to (e) are used in the regression analysis.

MODEL AND ESTIMATION METHOD

The specifications of models employed to test Hypotheses 1 and 2 are as follows:

$$OV_1 = RE_1\alpha_{11} + RE_1 \cdot LO\alpha_{12} + RE_2\alpha_{13} + RE_2 \cdot LO\alpha_{14} + LO\alpha_{15} + OV_2\alpha_{16} + \mathbf{UK}\,\boldsymbol{\alpha}_{17} + \mathbf{OS}\boldsymbol{\alpha}_{18} + \mathbf{x}\boldsymbol{\alpha}_{19} + \varepsilon_1 \quad (1)$$

$$OV_2 = RE_1\alpha_{21} + RE_1 \cdot LO\alpha_{22} + RE_2\alpha_{23} + RE_2 \cdot LO\alpha_{24} + LO\alpha_{25} + OV_1\alpha_{26} + \mathbf{UK}\,\boldsymbol{\alpha}_{27} + \mathbf{OS}\boldsymbol{\alpha}_{28} + \mathbf{x}\boldsymbol{\alpha}_{29} + \varepsilon_2 \quad (2)$$

where OV_1 and OV_2 are a firm's factor scores for the utilization frequencies of market-based sources and research-based sources outside the UK respectively. RE_1 and RE_2 are factor scores for the utilization frequencies of market-based sources and research-based sources within the firm's region respectively, and LO is a dummy for the firm's location, distinguishing whether the firm is located in the UK's economically advantaged regions (i.e., London, South East England, East of England) or in the rest of the nation. It would also be possible to utilize a more localised spatial measure based on location within a more or less advantaged local authority area. However, the spatial boundaries of many local authority areas are rather small and do not always represent a good measure of the likely spatial reach of what can be sensibly considered as 'local' connections, and therefore a regional level approach was adopted.

The dummy LO is also included in the form of interactions with RE_1 and RE_2 in order to examine the moderation effects of being located in economically advantaged regions. **UK** is a vector for variables representing the utilization frequencies of knowledge sources (a) to (e) within the rest of the UK. **OS** is a vector for the utilization of two other types of knowledge sources including universities and other higher education institutes, and trade fairs, exhibitions, and conferences, located at the three geographical levels. Vector **x** represents other control variables, α and $\boldsymbol{\alpha}$ are associated coefficients and coefficient vectors, and ε is the error term.

For market-based sources, Hypotheses 1 and 2 are tested by examining the partial effects of RE_1 on OV_1 in equation (1) for firms in economically advantaged and disadvantaged regions respectively. The partial effect for firms in economically disadvantaged regions ($LO = 0$) is expressed by α_{11} when regressing equation (1). The partial effect for firms in economically advantaged regions ($LO = 1$) is obtained as α_{11} after replacing $RE_1 \cdot LO$ with $RE_1 \cdot (LO - 1)$ and rerunning the regression. The same steps are repeated with α_{23} in equation (2) to test the two hypotheses for research-based sources. To control for firm heterogeneity in our sample, vector **x** contains a set of variables for firm characteristics, including firm size, subsidiarity, and exports. Firm size is controlled for based on a natural log of the number of employees.

While knowledge sourcing from external sources has been recognized as increasingly important to the growth of small firms (Faber and Hesen, 2004; Knoben and Oerlemans, 2006), it has been suggested that small firms tend to access knowledge from more local sources due to their limited financial and human resources (Torre, 2008). In this case, we take a natural log of employees to reduce the influence of outliers and skewed distributions. The degree to which a focal firm is embedded in international supply chain is controlled for by two variables: subsidiarity and exports. A dummy for subsidiarity shows whether a firm is owned by a parent company. As indicated earlier, subsidiaries are more likely to draw on their parents as an intermediary to seek other sources of knowledge. Exports as a fraction of total turnover is included to account for a firm's international trade, since such trade necessitates sourcing of overseas market information and user feedback, which builds a foundation for accessing other types of knowledge as well (Ganotakis and Love, 2012; Love and Ganotakis, 2013). It should be noted that a regression model was also run that included control variables for a range of other firm characteristics including firm age, number of innovations, absorptive capacity, and the general propensity of the firm to access external knowledge. This model produced very similar results to the one presented below, but is a little less robust given the reduced degrees of freedom.

Firm sector is controlled for in the form of sector dummies. Knowledge sourcing frequency may vary between industries, since some innovation activities demand more interaction with knowledge sources. Firms in our sample are classified into six groups according to Eurostat's (the European Commission's statistical office) scheme of industry classification on the basis of knowledge intensity (Hatzichronoglou, 1997; Laafia, 1999). The six groups include high-technology manufacturing, medium-high-technology manufacturing,

medium-low technology manufacturing, low-technology manufacturing, knowledge-intensive services, and less knowledge-intensive services. As a robustness check, we also tested other groupings including 13 groups and 23 groups, using combinations of the Eurostat classification scheme and the 2-digit level of UK SIC2007. Table 2 summarizes the descriptive statistics for the variables employed in our estimations (except for sector dummies). A variance inflation factor (VIF) test shows that the largest VIF is 5.84 for both equations (1) and (2), suggesting no concern with regard to serious multi-collinearity.

TABLE 2 ABOUT HERE

Equations (1) and (2) are estimated separately by robust OLS. Given a potential simultaneity bias, we considered simultaneous equation modelling with two-stage-least-squares (2SLS), instrumenting endogenous regressors in each equation. However, the availability of instruments is not always guaranteed. If an instrument is only weakly correlated with an endogenous regressor and is even slightly endogenous, 2SLS estimates are more biased and more likely to provide a wrong statistical inference than OLS estimates that make no correction for endogeneity. Good instrument variables are elusive in our case, and therefore we decided to estimate equations (1) and (2) separately by robust OLS with a potential simultaneity bias remaining.

RESULTS

Table 3 reports robust OLS estimation results for equation (1), which accounts for the frequency of accessing market-based sources outside the UK (OV_1). Model 1 examines the main effect of the utilization frequency of market-based sources within a firm's own region (RE_1) on OV_1, not including interaction terms with the firm location dummy (LO). Whilst the main effect is not significant in Model 1, a somewhat different picture emerges when interaction terms are introduced in Model 2. The moderation effect of firm location, expressed by the coefficient for the interaction term between the use of market-based sources within a firm's own region and the firm location dummy ($RE_1 \cdot LO$), is positive and significant at the 1% level, whereas the coefficient for RE_1 remains not significant. The partial effect of RE_1 on OV_1 is shown at the bottom of the table. For firms located in economically advantaged regions, the partial effect is significant at the 1% level and takes a positive coefficient value (0.29), meaning that the more frequently firms access market-based sources within their own region,

the more frequently they access market-based sources outside the UK. In contrast, for firms located in economically disadvantaged regions, the partial effect of RE_1 on OV_1 is not significant.

Models 3 and 4 add to Model 2 the frequencies of using trade fairs, exhibitions, and conferences and the frequencies of using universities and other HEIs at the three geographical levels, respectively. Key findings obtained from Model 2 remain unchanged. In particular, the partial effect of RE_1 on OV_1 remains at a similar level (0.29, 0.27, and 0.26 in Models 2, 3, and 4, respectively) for firms located in economically advantaged regions. Since both RE_1 and OV_1 are standardized scores, an increase of RE_1 by one standard deviation is associated with an increase of OV_1 by a standard deviation of 0.26 (Model 4). In contrast, for firms located in economically disadvantaged regions, the partial effect of RE_1 on OV_1 nears zero (from –0.12 to –0.03 and –0.05 in Models 3 and 4 respectively). Clearly, firms in economically disadvantaged regions show no meaningful association between the frequencies of accessing market-based sources at the regional and international levels.

The results in Table 3 show support for Hypotheses 1 and 2, showing (a) a significant positive association for firms in economically advantaged regions, and (b) no association for firms in disadvantaged regions between their utilization of market-based sources at the local and international level. Furthermore, if the utilization of market-based sources in their own region is the same, firms in economically advantaged regions on average use market-based sources outside the country to a greater extent than firms in disadvantaged regions.

TABLE 3 ABOUT HERE

As for market-based sources elsewhere in the UK, the frequency of accessing competitors and customers enterw the model with a positive coefficient value at either 1% or 5% level, meaning that the more frequently firms access competitors and customers elsewhere in the UK, the more frequently they access market-based sources outside the country.

Regarding the utilization of research-based sources on the right-hand side of equation (1), the interaction between the use of research-based sources within a firm's own region and the firm location dummy ($RE_2 \cdot LO$) enters the model at the 1% level across Models 2 to 4 with a negative coefficient value, while the use of the sources within a firm's own region (RE_2) does not enter the model significantly. The negative coefficient value for the interaction term makes intuitive sense as this sample of more innovation-driven firms, especially in advanced

regions, may be more likely to specialize in either market or research-based knowledge networks at the local and international level, leaving less resource to focus on the alternative forms of source, which partly confirms the results of the initial factor analysis. In the less advanced regions, the more limited choice of knowledge sources means that firms may not have the same capacity for such network specialization. As for the use of research-based sources outside the country (OV_2), it enters the model at the 1% level with a positive coefficient value across all models, meaning that firms which go to greater lengths to access overseas research-based sources also access overseas market-based sources.

As for other variables, the subsidiary dummy enters the models at either 1% or 5% level with a positive sign. The export percentage enters the model at the 1% level across all models with a positive sign. The frequency of attending trade fairs, exhibitions, and conferences elsewhere in the UK enters both Models 3 and 4 at the 1% level with a negative sign, suggesting that attendance at these events, which often attract visitors from overseas, works to substitute for more costly access to market-based sources outside the UK. In contrast, the frequency of attending temporary events outside the UK enters both models with a positive sign at the 1% level. For firms which go to such lengths to attend overseas temporary events, the events are complements that allow the firms to explore and deepen relationships with market-based sources outside the country.

As shown by Table 4, the robust OLS estimation results for equation (2), which accounts for the use of research-based sources outside the country (OV_2), repeats the patterns found in the regression of equation (1): the more frequently firms in economically advantaged regions access research-based sources within their own region (RE_2), the more frequently they access the same type of sources outside the country (OV_2), whilst no clear relationship is found for firms in economically disadvantaged regions between their utilizations of local sources and international sources. If the utilization of research-based sources within their own region is the same, firms in economically advantaged regions on average use research-based sources outside the country to a greater extent than firms in disadvantaged regions.

TABLE 4 ABOUT HERE

As for other independent variables in equation (2), there are a couple of differences from the regression of equation (1). First, the firm characteristic variables for being a subsidiary and the level of exports do not enter the models significantly, while firm size is generally found to be

positively significant at 5% and 10% levels.. Second, the frequencies for accessing universities and other HEIs enter equation (2) in the same manner as the frequencies of using trade fairs, exhibitions, and conferences enter equation (1), whilst the frequencies of using the temporal events show no significant relationship with the frequency of accessing research-based sources outside the UK. The results provide evidence that firms approach and make use of market-based and research-based sources outside the country in different ways.

Overall the regression results support Hypotheses 1 and 2, demonstrating significant moderation effects of firm location upon the way in which knowledge sourcing at the regional and international levels are related. For both market-based and research-based sources, firms located in economically advantaged regions show a close association between their utilization of local sources and international sources, whereas such an association is not found in disadvantaged regions. This suggests that local knowledge sourcing assists firms in economically advantaged regions by acting as a springboard for international knowledge sourcing. If knowledge sourcing-active firms access local sources, it increases the likelihood of discovering know-who of tried-and-tested overseas sources. This, in turn, helps focal firms to confidently approach and frequently access the sources outside the country.

In contrast, local sources possessing know-who of overseas sources are less widely distributed in economically disadvantaged regions, reducing the chance of obtaining overseas know-who through local knowledge sourcing. This 'forces' firms in the disadvantaged regions to either draw on a mix of different channels, including sources located elsewhere in the UK, or stop short of seeking overseas sources for a piece of knowledge in question. As a result, there is no association between the utilization of a particular type of local and overseas sources. In fact, when we test equations (1) and (2) with additional interaction terms between the firm location dummy and the utilization frequencies of knowledge sources within the rest of the UK, firms in the disadvantaged regions show significant associations: (i) between the frequencies of accessing customers and competitors elsewhere in the UK and the frequency of accessing market-based sources outside the country (OV_1); and (ii) between the frequency of accessing private research institutes elsewhere in the UK and the frequency of accessing research-based sources outside the country (OV_2) (not reported in the relevant tables). This suggests the possibility that firms in the disadvantaged regions draw on particular sources elsewhere in the UK (which include sources located in the economically advantaged regions) as channels for identifying, learning, and accessing overseas knowledge sources.

As a robustness check, we tested equations (1) and (2) with factor scores of unit weighting (i.e., equal weight given to each variable constituting a factor) for the frequencies of

using market-based and research-based sources, both local and overseas. We also ran the regressions with a sample of firms employing less than 250 persons and less than 100 persons. With both equations (1) and (2), the key findings remain unchanged.

DISCUSSION AND CONCLUSION

In view of the strong emphasis placed on the importance of local knowledge access in the innovation and economic development literatures (Cooke et al., 2004; Knoben, 2009), coupled with the growing evidence of international knowledge sourcing observed in many advanced regional economies (Fitjar and Huber, 2015), the focus of this paper has concerned the advantage afforded to innovation-driven and knowledge-based firms firms in terms of their international knowledge sourcing as a result of their spatial location. Overall, firms of this type located in economically advantaged regions and their counterpart firms in disadvantaged regions are found to use different channels when accessing knowledge sources outside the UK. Whilst these patterns may not be replicable for all firms within a particular region, local knowledge sourcing assists these more innovation-driven firms in economically advantaged regions by acting as a springboard for sourcing knowledge overseas, whereas this is not the case for similar firms in disadvantaged regions. This difference is evident for both market-based knowledge sources including customers, suppliers, and competitors, and research-based sources including private and government research institutes when firm characteristics are controlled for.

The analysis has focused on a particular cohort of firms with a potential propensity towards innovation and knowledge-based interactions. However, the springboard effect can be seen to be the result of the higher density of firms in advantaged regions with a proclivity towards global knowledge sourcing. From a theoretical perspective, this suggests that innovative and knowledge-based firms located in economically advantaged regions move towards a ‘transnational’ structure in a distinct way. In essence, high rates of local buzz appear to facilitate access to global pipelines (Moodysson, 2008; Maskell, 2014; Müller and Ibert, 2015). Such facilitation can be considered to consist of two underlying advantages. First, there are denser concentrations of organizations that can spread know-who of international links across knowledge-seeking firms in economically advantaged regions. Such organizations include the global networks of cross-national corporations that internally circulate overseas know-who in a more reliable way than market transactions that may be subject to opportunistic behaviour. Second, higher rates of international migration in economically advantaged regions

form part of global labor markets to a greater extent than in relatively disadvantaged regions. Inflows of knowledge workers and expatriates allow firms in economically advantaged regions to construct international knowledge sourcing networks, providing know-who of their contacts at their former work places outside the country. Outflows of international migration from economically advantaged regions also reinforce this process, connecting overseas knowledge sources with either former employers, colleagues, or contacts that previously resided in locally based firms (Saxenian, 2005).

Firms in economically advantaged regions are more likely to trade and network locally with actors who are themselves positioned within international networks through which the focal firm can take advantage. In contrast, the findings indicate that, when seeking for knowledge sources outside the country, firms in economically disadvantaged regions do not draw on local buzz as widely as their counterparts in advantaged regions. To compensate for the relative lack of organizations and actors possessing know-who of overseas sources, firms in economically disadvantaged regions draw on a mix of different channels, including sources located elsewhere in the UK among others, with local sources playing a less marked role than in economically advantaged regions.

An issue for future research to address is the extent to which this advantaged region phenomenon is likely to be found in other nations. The UK is rather unique, especially compared to many other European nations, in that it has a single super-agglomeration around London and the South East of England that is the home to a far higher than (national) average of firms with linkages outside the UK. Also, as an island nation its patterns of international connectivity may not be representative of those for nations within mainland Europe. However, the wealth of existing research on regional clusters, innovation systems, and more recently entrepreneurial ecosystems suggests that the existence of local buzz and global pipelines of knowledge tends to be complementary (Bathelt and Cohendet, 2014; Trippl et al., 2018). A further question this leads to is: how advantaged does a region need to be, compared with its national counterparts, for this effect to be found? In other words, how big a regional development divide is required for these effects to be witnessed. The answer is likely to be that it is a matter of scale, with economic convergence across regions resulting in more equal access to springboard effects, whilst divergence will lead to an increasing concentration of spring-boarding in the already advantaged regions.

Finally, this study is not without limitations. In particular, the cross-sectional nature of the analysis means that our findings are unable to shed light upon the evolution of local-international networks (Glückler and Doreian, 2016). A close tie between local buzz and global

pipelines, which marks economically advantaged regions, is likely to attract knowledge seekers linked to international sources, which in turn act as intermediaries for further international knowledge sourcing (Kramer and Revilla Diez, 2012). With a growing number of knowledge seekers themselves becoming sources for other local firms, and acting as intermediaries for global sourcing, a cumulative, self-reinforcing process may deepen ties between local and international networks in economically advantaged regions over time. Further research is called for to examine these dynamics in greater detail.

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Figure 1: Global Knowledge Sourcing Channels for Firms Located in Economically Advantaged or Disadvantaged Regions

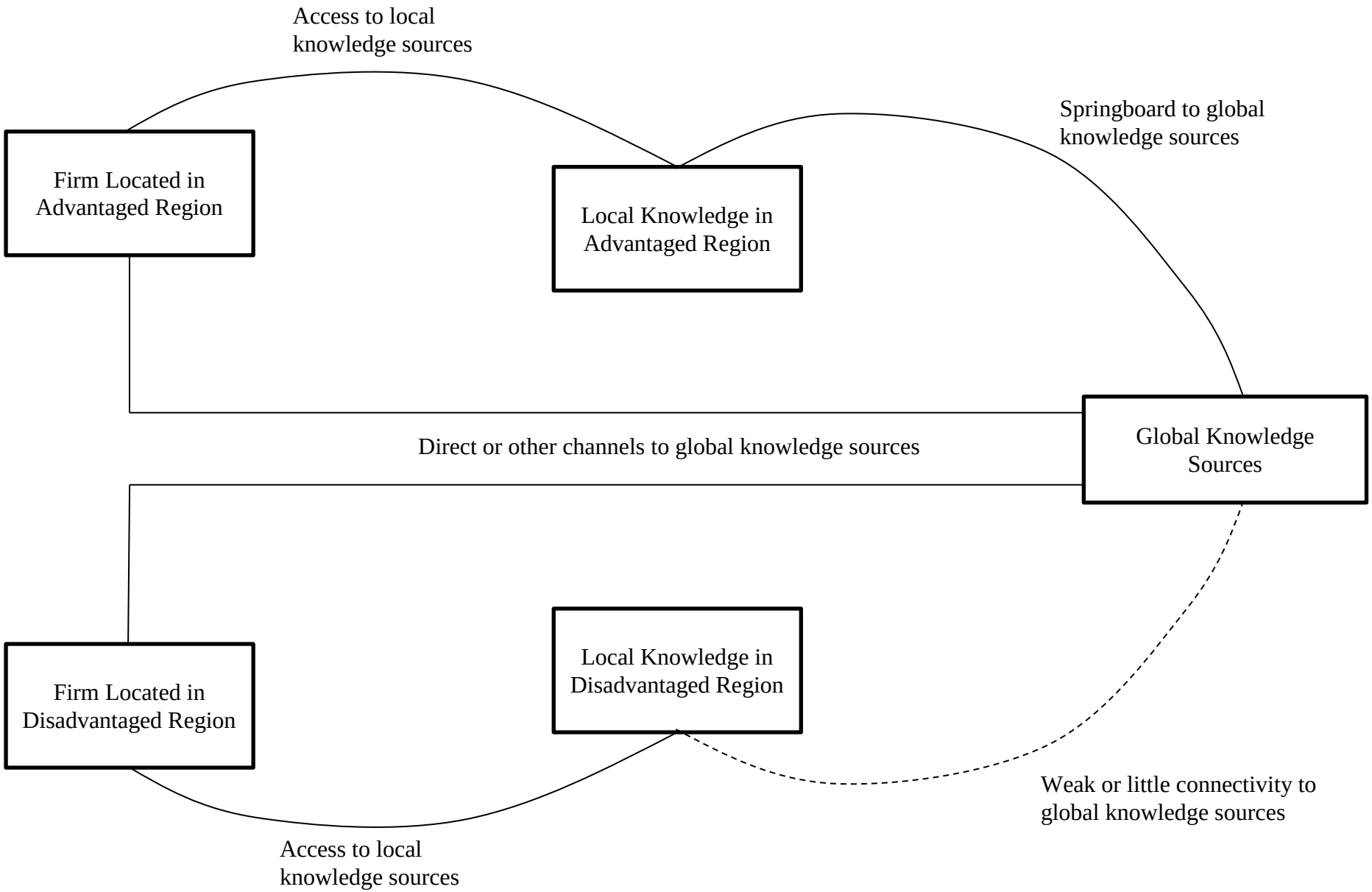

Table 1: Confirmatory Factor Analysis: Maximum Likelihood Estimates for a Two-Factor Model

	Regional		National		International	
Standardized factor loadings						
	Market-based sources	Research-based sources	Market-based sources	Research-based sources	Firm-based sources	Research-based sources
Suppliers	0.52		0.63		0.55	
Customers	0.79		0.66		0.80	
Competitors and other businesses	0.77		0.66		0.82	
Private research institutes and commercial labs		0.52		0.39		0.89
Government and public research institutes		0.67		0.60		0.58
Standardized factor covariance						
Market-based * Research-based	0.57		0.52		0.55	
Reliability of construct measurement						
Raykov's factor ρ coefficient	0.74	0.54	0.69	0.41	0.77	0.70
Goodness-of-fit statistics						
$\chi^2_M(4)$	4.22		6.38		2.39	
p	0.38		0.17		0.66	
RMSEA (90% confidence interval)	0.014 (0.000 – 0.089)		0.045 (0.000 – 0.106)		0.000 (0.000 – 0.069)	
$p_{close-fit\ H_0}$	0.69		0.48		0.88	
CFI	1.00		0.99		1.00	
SRMR	0.014		0.022		0.014	

Table 2: Descriptive Statistics, *N* = 299

	Mean	S.D.
Market-based sources within a firm's region (factor score)	0.00	1.62
Market-based sources within a firm's region × Firm location	–0.04	0.91
Research-based sources within a firm's region (factor score)	0.00	0.88
Research-based sources within a firm's region × Firm location	–0.04	0.50
Location in economically advantaged regions (0/1)	0.38	0.49
Market-based sources overseas (factor score)	0.00	1.73
Research-based sources overseas (factor score)	0.00	1.45
Suppliers elsewhere in the UK (0–10 scale)	5.20	3.26
Customers elsewhere in the UK (0–10 scale)	5.53	3.39
Competitors elsewhere in the UK (0–10 scale)	3.42	3.01
Private research institutes and commercial labs elsewhere in the UK (0–10 scale)	1.35	2.28
Government and public research institutes elsewhere in the UK (0–10 scale)	2.12	2.76
Other knowledge sourcing activities		
Universities and other HEIs within a firm's region (0–10 scale)	3.63	3.37
Universities and other HEIs elsewhere in the UK (0–10 scale)	3.02	3.15
Universities and other HEIs overseas (0–10 scale)	1.39	2.47
Trade fairs, exhibitions, and conferences within a firm's region (0–10 scale)	2.75	3.14
Trade fairs, exhibitions, and conferences elsewhere in the UK (0–10 scale)	4.06	3.07
Trade fairs, exhibitions, and conferences overseas (0–10 scale)	3.45	3.39
Firm profiles		
Log employees (persons)	2.91	1.49
Subsidiary (0/1)	0.29	0.46
Exports (fraction of total turnover)	0.36	0.33

Note: Sector dummies are not reported.

Table 3: Robust OLS Estimation of the Frequency of Accessing Overseas Market-based Sources

	Dependent variable: Frequency of accessing overseas market-based sources (OV_1)							
	Model 1		Model 2		Model 3		Model 4	
Explanatory variables								
Market-based sources within a firm's region (RE_1)	0.05	(0.08)	–0.12	(0.09)	–0.03	(0.09)	–0.05	(0.09)
Market-based sources within a firm's region × Firm location ($RE_1 \cdot LO$)			0.41***	(0.13)	0.31***	(0.11)	0.31***	(0.11)
Research-based sources within a firm's region (RE_2)	–0.19	(0.15)	0.07	(0.16)	0.11	(0.15)	0.12	(0.15)
Research-based sources within a firm's region × Firm location ($RE_2 \cdot LO$)			–0.60***	(0.22)	–0.51***	(0.19)	–0.53***	(0.20)
Location in core region (LO)	0.02	(0.14)	0.01	(0.14)	–0.04	(0.12)	–0.01	(0.12)
Research-based sources overseas (OV_2)	0.61***	(0.08)	0.63***	(0.08)	0.48***	(0.07)	0.45***	(0.07)
Suppliers elsewhere in the UK	0.00	(0.02)	0.00	(0.02)	0.00	(0.02)	0.00	(0.02)
Customers elsewhere in the UK	0.08***	(0.03)	0.08***	(0.03)	0.06**	(0.03)	0.06**	(0.03)
Competitors elsewhere in the UK	0.15***	(0.03)	0.16***	(0.03)	0.18***	(0.03)	0.18***	(0.03)
Private research institutes and commercial labs elsewhere in the UK	–0.01	(0.04)	–0.01	(0.04)	–0.02	(0.04)	0.00	(0.04)
Government and public research institutes elsewhere in the UK	–0.04	(0.05)	–0.04	(0.03)	–0.01	(0.03)	–0.01	(0.03)
Other knowledge sourcing activities								
Universities and other HEIs within a firm's region							0.01	(0.02)
Universities and other HEIs elsewhere in the UK							–0.03	(0.02)
Universities and other HEIs overseas							0.03	(0.03)
Trade fairs, exhibitions, and conferences within a firm's region					–0.05	(0.03)	–0.05	(0.03)
Trade fairs, exhibitions, and conferences elsewhere in the UK					–0.08***	(0.03)	–0.09***	(0.03)
Trade fairs, exhibitions, and conferences overseas					0.20***	(0.02)	0.20***	(0.02)
Firm profiles								
Log employees	0.03	(0.14)	0.03	(0.05)	0.05	(0.05)	0.06	(0.05)
Subsidiary	0.47***	(0.16)	0.43***	(0.16)	0.34**	(0.15)	0.34**	(0.15)
Exports	1.26***	(0.22)	1.24***	(0.22)	0.52***	(0.20)	0.50**	(0.21)
Constant	–1.52***	(0.21)	–1.49***	(0.20)	–1.48***	(0.20)	–1.56***	(0.20)
Partial effect of market-based sources within a firm's region								
Firms in economically advantaged regions			0.29***	(0.11)	0.27***	(0.09)	0.26***	(0.09)
Firms in economically disadvantaged regions			–0.12	(0.09)	–0.03	(0.09)	–0.05	(0.09)
Industry dummies (6 groups)	Yes		Yes		Yes		Yes	
Observations	299		299		299		299	
R^2	0.622		0.639		0.727		0.729	

Notes: * (**) (***) denote significance at the 10 (5) (1) % level respectively. Standard errors are given in parentheses. The null hypothesis of homoscedasticity is rejected in Breusch-Pagan/ Cook-Weisberg tests.

Table 4: Robust OLS Estimation of the Frequency of Accessing Overseas Research-based Sources

	Dependent variable: Frequency of accessing overseas research-based sources (OV_2)							
	Model 1		Model 2		Model 3		Model 4	
Explanatory variables								
Market-based sources within a firm's region (RE_1)	–0.05	(0.05)	0.09	(0.06)	0.04	(0.06)	0.04	(0.06)
Market-based sources within a firm's region × Firm location ($RE_1 \cdot LO$)			–0.29***	(0.10)	–0.23**	(0.09)	–0.23**	(0.09)
Research-based sources within a firm's region (RE_2)	0.22*	(0.12)	–0.09	(0.13)	–0.02	(0.11)	–0.01	(0.12)
Research-based sources within a firm's region × Firm location ($RE_2 \cdot LO$)			0.76***	(0.24)	0.68***	(0.22)	0.67***	(0.22)
Location in core region (LO)	0.02	(0.11)	0.04	(0.11)	0.08	(0.11)	0.08	(0.11)
Market-based sources overseas (OV_1)	0.46***	(0.05)	0.47***	(0.05)	0.39***	(0.05)	0.40***	(0.06)
Suppliers elsewhere in the UK	–0.02	(0.02)	–0.02	(0.02)	–0.01	(0.02)	–0.02	(0.02)
Customers elsewhere in the UK	–0.03	(0.02)	–0.03	(0.02)	–0.02	(0.02)	–0.02	(0.02)
Competitors elsewhere in the UK	–0.05*	(0.03)	–0.05*	(0.03)	–0.03	(0.03)	–0.03	(0.03)
Private research institutes and commercial labs elsewhere in the UK	0.20***	(0.05)	0.20***	(0.05)	0.20***	(0.04)	0.20***	(0.04)
Government and public research institutes elsewhere in the UK	0.05**	(0.03)	0.05*	(0.03)	0.04	(0.02)	0.03	(0.02)
Other knowledge sourcing activities								
Universities and other HEIs within a firm's region					0.00	(0.02)	0.00	(0.02)
Universities and other HEIs elsewhere in the UK					–0.05*	(0.02)	–0.04*	(0.02)
Universities and other HEIs overseas					0.16***	(0.04)	0.16***	(0.04)
Trade fairs, exhibitions, and conferences within a firm's region							–0.01	(0.03)
Trade fairs, exhibitions, and conferences elsewhere in the UK							0.01	(0.02)
Trade fairs, exhibitions, and conferences overseas							–0.01	(0.02)
Firm profiles								
Log employees	0.11*	(0.06)	0.12**	(0.06)	0.14**	(0.06)	0.13**	(0.06)
Subsidiary	–0.06	(0.16)	–0.09	(0.16)	–0.12	(0.15)	–0.12	(0.15)
Exports	0.12	(0.20)	0.10	(0.19)	–0.11	(0.19)	–0.09	(0.20)
Constant	–0.21	(0.20)	–0.20	(0.20)	–0.41*	(0.21)	–0.36*	(0.21)
Partial effect of research-based sources within a firm's region								
Firms in economically advantaged regions			0.67***	(0.21)	0.66***	(0.20)	0.66***	(0.20)
Firms in economically disadvantaged regions			–0.09	(0.13)	–0.02	(0.11)	–0.01	(0.12)
Industry dummies (6 groups)	Yes		Yes		Yes		Yes	
Observations	299		299		299		299	
R^2	0.589		0.612		0.654		0.655	

Notes: * (**) (***) denote significance at the 10 (5) (1) % level respectively. Standard errors are given in parentheses. The null hypothesis of homoscedasticity is rejected in Breusch-Pagan/ Cook-Weisberg tests.