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The effect of external knowledge sources and their geography on innovation in Knowledge Intensive Business Services (KIBS) SMEs; some Implications for de-industrialised regions in the UK

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ABSTRACT

The paper explores the effect of external knowledge sources and their geography on innovation activity in small Knowledge Intensive Business Services (KIBS). It draws on results from a survey conducted in 2010 of 342 small and medium (SME) KIBS in the UK's North East and West Midlands. It is shown that innovation is supported by knowledge gained from frequent interaction with regional and UK customers as well as more frequent interaction with local business networks, including informal contacts as well as national licensing arrangements, regional and UK commercial networks and UK public and professional infrastructure. Innovation capability is also enhanced by internationalisation through both traded and untraded relationships. Various industry-specific business networks and regional government agencies also act as important sources of knowledge and networking in de-industrialised regions. No support is found for benefits arising from the clustering of firms in similar line of business or with regional universities or public sector organisations. Also, while we acknowledge positive effect of R&D on KIBS innovativeness we argue that its' effect is much less important compared to regional and extra regional knowledge sources.

Key words: knowledge intensive business services, de-industrialised regions, innovation, policy

JEL 014, R11, R12, R 58

INTRODUCTION

Knowledge Intensive Business Services (KIBS)[1] are playing ever more important role in the UK economy. From 2000 to 2011, for example, employment in KIBS rose from 13.6% to 15.1% as a percentage of total UK employment (OECD SCIENCE, TECHNOLOGY AND INDUSTRY SCOREBOARD, 2013). Reflecting on this structural change and given that innovation has been recognised in the UK and internationally as one of the key drivers of productivity and growth, it is service industries innovation and KIBS in particular which is attracting significant attention (GALLOUJ AND DJELLAL, 2010). Services innovation may have a direct effect on the economy via growth in employment and enhanced productivity (MANSURY AND LOVE, 2008) as well as exports (BRYSON, 2007). However, indirect benefits from services innovation may be felt through their enabling role in supporting innovation in other sectors including public sector (MULLER AND ZENKER, 2001; CZARNITZKI AND SPIELKAMP, 2003; WOOD, 2005; BRYSON, 2010). The role of KIBS seems to be of particular significance in advanced regions where manufacturing competitiveness depends on knowledge provided by KIBS (CORROCHER ET AL, 2009). Much less is known, however, about KIBS innovativeness in less advanced regions in the UK.

Over the last decade, the economics business literature has been discussing competitive strategies and innovation in KIBS both from the theoretical perspective and empirically (CORROCHER ET AL, 2009, 175). In the empirical literature, a particular line within service innovation literature, largely drawing results from the Community Innovation Survey (CIS) investigates specific characteristics of KIBS innovativeness (see for example,

[1] There are a number of definitions of KIBS. For example, Bettencourt *et al.,* (2002, 100–1) define KIBS as "enterprises whose primary value-added activities consist of the accumulation, creation, or dissemination of knowledge for the purpose of developing a customized service or product solution to satisfy the client's needs." Miles *et al.,* (1995) distinguish between professional services (P-KIBS) and technological services (T-KIBS). P-KIBS are professional services, which are users of technology (business and management services, legal and accounting, market research, management consulting etc.). T-KIBS focus on information and communication technologies and other technical activities (IT-related services, engineering, technical testing and analysis, R&D consulting, etc.). Our analysis excludes legal and accountancy firms as they are perceived as routine service providers rather than knowledge providers.

EVANGELISTA 2000; EVANGELISTA and SAVONA 2003; CAMACHO and RODRIGUEZ, 2005). This literature has brought some important insights into the nature of services innovation largely emphasising what differentiates innovation in services compared to manufacturing. Other KIBS studies which draw conclusions from primary survey data conclude that external sources important for KIBS innovativeness are suppliers and customers (for example, TETHER and METCALFE, 2004). Public organisations and universities, however, play a negligible role (for example, DJELLAL and GALLOUJ, 2001). TETHER (2005) moreover argues that innovation in services, unlike manufacturing, is more likely to entail and be orientated towards organisational change rather than product/process innovation.

In summary, conceptualisation and empirical analysis of KIBS' innovative efforts have largely focused on what differentiates such services from manufacturing and other services (CORROCHER ET AL, 2009). However, the impact of the external environment on KIBS innovativeness in different geographical locations remains under-researched and is also largely neglected in policy circles. Although studies of KIBS innovation which draw from CIS provide important insights into the nature of KIBS innovation, therefore, they pay insufficient attention to the level of localisation of KIBS' external links. To a certain degree this shortcoming is due to the nature of CIS data collection which does not include both geographical and industry stratification (EVANGELISTA et at., 2001, SHROLEC, 2010) [2]. There is therefore a need for regional surveys to address this issue. This paper aims to make a contribution towards filling this gap in empirical evidence by using regional survey data of KIBS located in North East and West Midlands.

A number of KIBS papers which draw evidence from primary surveys and case studies do take into account the level of localisation of external links (see for example,

[2] For example, while many CIS studies attempt to measure the impact of various internal and external factors on firm innovativeness, statistically plausible analysis can be conducted on either: (a) country level for particular industries or (b) regional level for all available industries. In other words, CIS does not accommodate analysis of particular sectors within their regional (local) settings. This is because CIS sampling procedures do not include both geographical and industry stratification.

ASLESEN and JAKOBSEN, 2007). However, they largely neglect the diversity of these links. For example, much literature on KIBS innovation concentrates on the relation between KIBS and customers and the importance of geographical proximity in these links (see for example, KOSCHATZKY, 1999; MULLER and ZENKER, 2001; KEEBLE and NACHUM, 2002; KOCH and STAHLECKER, 2006). The territorial innovation literature does take the geographical characteristics of inter-organisational ties into consideration, and has shown that local links may enhance the innovativeness of firms. At the same time an emerging body of work also argues that ties with organisations outside the home region also matter for innovation (BATHELT *et al.,* 2004; BOSCHMA, 2005). Many studies, directed to both KIBS and territorial innovation focus on dyadic relationships between a focal actor and for example, a single supplier or university (KNOBEN and OERLEMANS, 2012, 1006). Often evidence is also drawn from more successful regions. This is not surprising given that the evidence points to benefits derived from high concentrations of knowledge based activities in such regions.

The empirical research regarding KIBS innovation which takes into account the diversity of types of knowledge links would benefit from more examination of the level of localization of these links. At the same time, territorial innovation literature and KIBS location literature would benefit from research that takes into account diversity of the types of knowledge and their level of localisation. Both lines of literature would benefit further from empirical evidence from less successful regions. In this context, this study emphasises both the geographical variety and diversity of KIBS' inter-organisational networks in de-industrialised regions.

External knowledge networks for learning and innovation are particularly important for SMEs as they are often faced with limited in-house resources. One of the characteristics of the KIBS sector is the prevalence of SMEs hence this paper concentrates on KIBS SMEs. It acknowledges the importance both of firms' internal and external knowledge for learning and innovation. The research questions are: (i) which identified types of external knowledge

networks are conducive to the innovativeness of KIBS SMEs in de-industrial regions, and on which geographical scale do these function, and (ii) in this context, what is the role of R&D in KIBS innovativeness.

This paper draws from results of a survey conducted in 2010 of 342 small and medium (SME) KIBS in the UK's North East and West Midlands. This study does not provide any conclusions about the driving forces behind innovation in KIBS across all de-industrialised regions. It aims to contribute to the ongoing policy debate and provide insights into the direction of further research. The paper initially presents a review of relevant earlier research relating to the role of firms' absorptive capacity and of external networks in KIBS innovation, as well as on localised and non localised learning in facilitating innovation. Experience in two de-industrialised regions, the North East and the West Midlands of England, is later presented and the main issues facing their development identified. The choice of data, data collection processes and data analysis techniques are then presented, followed by the main results and their discussion.

ABSORPTIVE CAPACITY, R&D AND EXTERNAL KNOWLEDGE SOURCES AND INNOVATION IN KIBS

Role of R&D and absorptive capacity in KIBS innovativeness

Various factors have been proposed that contribute to the innovative capability of firms. The first group includes factors internal to the firm, such as learning by doing and investment in R&D (COHEN and LEVINTHAL, 1990). The ability to utilise external knowledge, which is to a great extent a function of the level of prior knowledge i.e. the firm's absorptive capacity (COHEN and LEVINTHAL, 1990; ZAHRA and GEORGE; 2002, FREEL, 2010) is also a key factor. A measure of absorptive capacity is accumulated R&D (COHEN

and LEVINTHAL, 1990; FREEL, 2006). METCALFE (1998), however, emphasises the role of knowledge sharing and cooperation for innovation and downplays the role of R&D.

Even though the scale of R&D activity in KIBS seems to be smaller than in manufacturing (for example TETHER, 2004), FREEL (2006) argues that commentators by and large continue to support the positive effect of R&D on KIBS innovativeness. TETHER (2005), however, finds that while manufacturing firms are more likely to innovate through using in-house R&D and collaborations with universities and research institutes, service firms are more likely to collaborate with customers and suppliers. In a survey of Finnish KIBS firms (LEIPONEN, 2005) also finds that external knowledge sources, especially customers and competitors, positively affect innovation while in house R&D had no significant effect. In a study of US business service firms MANSURY AND LOWE (2008) find that external linkages have positive effect on a number of measures of innovation performance. Similar results are found on a sample of KIBS in Northern Ireland (LOVE ET AL, 2010). TETHER and METCALFE (2004) argue that cooperation with customers and suppliers represents the main source of knowledge and technology for services, “soft” sources which define their innovation strategy more clearly than traditional “hard” sources such as R&D activity.

This suggests that the role of external openness through partners and linkages is of particular importance in service sector innovation, whereas the role of R&D is less important. This paper provides some empirical evidence regarding both scale and the effect of R&D and external knowledge on KIBS innovativeness in de-industrialised regions in the UK. In this sense our data goes beyond existing surveys such as Community Innovation Survey (CIS) which contains questions on the involvement of external knowledge sourcing but does not allow statistically plausible analysis by both sector and region.

Role of external sources of knowledge in KIBS innovativeness

The analytical framework applied in this paper relates to the role of various types of knowledge networks in knowledge sharing, learning and innovation by small and medium KIBS in de-industrialised regions. This is because firms can enhance their competitive position through cooperation, knowledge sharing and by engaging in networking. Such an approach recognises the possibilities of market failure in knowledge sharing and provision particularly in old industrial regions which are often perceived as institutionally thin (TODTLING and TRIPPL, 2005). Moreover, interaction with suppliers, customers, public agencies, business networks, industry associations, informal contacts, competitors, universities etc. in any type of region can provide missing inputs into the learning process which the firm alone may not be able to provide (ROMIJN and ALBALADEIO, 2002). Interaction may serve the purpose of gathering information about markets, technologies, availability of government support and grants, HR practices, taxing and accounting rules and legislation etc.

Some authors claim that KIBS are not extensively linked to wider innovation systems and institutions (see for example MILES, 2005). However, evidence shows that KIBS are involved in interactive learning processes both with their customers and with other organizations within the *local* innovation system (STRAMBACH, 1998; DEN HERTOG, 2000). The importance of geographical proximity for knowledge sharing and innovation between KIBS and clients has been noted in a number of studies (KOSCHATZKY, 1999; MULLER and ZENKER, 2001; KEEBLE and NACHUM, 2002; KOCH and STAHLECKER, 2006). However, it has also been acknowledged that in peripheral regions KIBS may be constrained by a low quality of local demand compared to their core counterparts (for example O'FARRELL *et al.*, 1992). In addition, there is conflicting evidence regarding the importance of collaboration with universities, and whether universities, public research

institutes and trade organisations function on a predominantly local or national level. DJELLAL and GALLOUJ (2001) note a negligible role of universities and other public organisations as sources of innovation for KIBS. However, HOWELLS (2000) argues that the similarities between T-KIBS and high tech manufacturing imply a higher incidence of T-KIBS collaboration with universities relative to P-KIBS.

Cooperation with other service firms is seen as another potential source of innovation for KIBS (BRYSON AND MONNOYER, 2004). However, this type of cooperation seems to be constrained given the appropriability concerns, in other words, the weakness of IPR protection (FREEL, 2006).

Localised learning and global knowledge

Many research studies put emphasis on learning by interacting, concentrating on intra-regional relationships between firms and other economic actors, enhanced by regional clustering and geographical proximity. In this respect both traded and untraded interdependencies (STORPER, 1997) are seen as pivotal to regional success. Related concepts have been developed to capture the importance of geographical proximity and innovation. In studies on clusters as well as other extensive literature on industrial districts, innovative millieux, regional innovation systems and learning region, spatially bounded knowledge is perceived as a most important source. ASHEIM and ISAKSEN (2002) argue that many studies on clusters often imply that knowledge from sources external to a cluster is of inferior importance for firms' competitiveness. This literature, which puts emphasis on the importance of the region as a scale of economic organisation coupled with associated policy developments often draws evidence from exemplar regions such as Silicon Valley, Boston, London, Oxford and Grenoble. These regions have a high concentration of service related industries and high technology sectors such as biotech and high tech electronics (see LAWTON SMITH, 2003).

A variety of explanations have been offered with regards to the positive role of clustering in space. Some of these explanations relate to the tacitness of some types of knowledge, making its transfer across distances difficult. Others refer to the nature of personal relations and trust, lower communication costs and enhanced quality of interaction through of face-to-face contact (see GORDON AND MCCANN, 2005). Other literature, however, questions the supremacy of geographical proximity and the region. It has been argued that inter-firm interaction is not necessary local and that the effect of networks (being a a-spatial concept) seems underestimated (BOSCHMA and TER WAL, 2007, TER WAL and BOSCHMA, 2011). This argument acknowledges that firms also need extra-regional knowledge to avoid lock-in effects associated with outdated technology and decreasing market opportunities (BATHELT *et al.,* 2004; GERTLER and WOLFE 2006). Lock-in means that a particular technology or product is dominant (which is often the case in de-industrialised regions in relation to outdated industries and technologies), not because its inherent cost is low or performance is good, but because it enjoys the benefits of increasing returns to scale.

A number of empirical studies (see for example GRAF, 2011 and MORRISON, 2008) find that the role of "gatekeepers" ,who represent important firms or institutions in clusters, is to draw on local as well as external knowledge. Also, GIULIANI and BELL (2005) show that knowledge diffusion takes place mainly in a core group of firms with absorptive capacity whereas other firms with inferior absorptive capacity remain isolated from the knowledge network in their study of the Chilean wine cluster[3].

BATHELT *et al.* (2004), MALMBERG and MASKELL (2002), OINAS AND MALECKI, (2002) therefore emphasize that both local and global knowledge are important. Transfer of knowledge and ideas from global networks may mitigate the possible stagnation and lock-in effects of the regional knowledge base and may be particularly beneficial in de-industrialised

[3] For a comprehensive review of the empirical studies on innovation networks see BOSCHMA and TER WAL (2009).

regions. This may be enabled by advancements in information technology and falling costs of transport and communication. The role of KIBS in facilitating both internal and external networks for such regions may therefore be significant. External networks may take particular form of global traded relationships in market transactions and are less likely to be geographically bounded for KIBS (ASLESEN and ISAKSEN, 2007; WOOD, 2006). However, evidence regarding the importance of global traded relations for UK located KIBS comes mostly from the metropolitan regions and previous studies which investigated this issue in less developed regions, although indicative, are more than a decade old (see O'FARRELL et al 1996). Hence, this study aims to fill this gap in the literature by providing new empirical evidence from de-industrialised regions.

Even though international traded relationships seem to be important for KIBS there is little agreement in empirical studies regarding the relationship between exporting (international traded relationships), R&D and innovation, which appear to act in a complex relationship to each other (HARRIS and MOFFAT, 2011).[4]

Questions arise as to whether it necessarily follows that close geographic proximity to customers or to complementary knowledge plays equally important role for KIBS innovation in all geographical settings and whether there is a role for national or regional governments to bridge possible market failure in networking and knowledge provision in de-industrialised regions. In the UK's South East studies have found support for the importance of specific regional network relations. However, they also emphasise the importance of wider national and international networking for innovation (KEEBLE *et al.,* 1998; SIMMIE, 1997; ROMIJN and ALBALADEIO, 2002). Empirical evidence from different types of regions is

[4] It seems that undertaking R&D and/or innovating may or may nor impact on the firm's decision to export , and in turn to be influenced by the experience of exporting (i.e., through a "learning-by exporting" effect) (HARRIS and MOFFAT, 2011). It is, however, outside the scope of this paper to dismantle the complex relationship between R&D, innovation and exporting.

necessary to provide insights into the nature and effect of external knowledge on firms' innovativeness. The paper aims to bridge this gap.

The Regional context

In the UK, research on KIBS has emphasised the persistent uneven concentration of KIBS favouring London and the South East. In these regions KIBS benefit from sophisticated regional demand as well as a supply of knowledge networks, good soft and hard infrastructure, excellent transport links and a skilled work force, enabling them to function in international markets (WOOD, 2002). As a result, KIBS in such developed regions are successful on a much larger scale than their counterparts in more peripheral locations. These developments may emphasise and reinforce disadvantages that KIBS located in de-industrialised regions may face. They contribute to increased regional disparities, and the need for policies to ameliorate this trend has been recently emphasised by WOOD (2008).

In order to contribute to understanding on this issue, the focus of this paper is on SME KIBS in two de-industrialised regions in the UK, the North East and the West Midlands. Both were characterised by heavy industrialisation from the late 18th century onwards and a sharp decline in manufacturing sector during the late 20th century. The 18thcentury saw the emergence of Industrial Revolution which in the nineteenth century in the North East and the West Midlands gave rise to coal and related industries such as steel, iron and engineering production, including ships, railways, metal goods and particularly in the North East, chemicals. These regions represented the capitalist “workshop of the world”. Nowadays, the North East and the West Midlands are largely de-industrialised, with few remaining manufacturing growth industries . From the 1960s, production largely migrated to cheaper overseas locations (HUDSON, 2005) and both regions suffered sharp declines in manufacturing jobs.

According to HUDSON (2005), with the decline of Fordism and mass production, and the subsequent emphasis on post-Fordist high tech manufacturing, coupled with increased international competition, these regions became economically marginalised, leaving them with many problems of adaptation and lack of competitiveness. The decline in the West Midlands relates to more recent plant closures in the vehicle manufacturing industry, coupled with a decline in the many SMEs that served as component suppliers to the motor industry. Hence, the issue of regional economic development in these two regions has become of continuing importance, although in practice this has proven difficult to solve[5]. As old industries declined a weak re-industrialisation occurred, with an emphasis on automotive and consumer electronics, coupled with a rise of the "branch plant" economy, including more recently a proliferation of back offices and call centres, particularly in the North East.

There are both opportunities and problems of adjustment in relation to KIBS in de-industrialised regions. Such KIBS may be faced with unsophisticated demand compared to their counterparts located in core regions and metropolitan areas. Indeed, VAESSEN and KEEBLE (1995) point to limited market potential of firms located in non-core regions whereas O'FARRELL *et al.,* (1992) emphasise disadvantages associated with lower quality of market demand compared to that in core regions. Moreover, ASHEIM and ISAKSEN (2003) stress that there is a lack of interactive learning amongst SMEs in such regions.

However, (BOSCHMA and LAMBOOY, 1999, 21) emphasise that high–technology industries hardly need to establish specific linkages with their local environment in order to develop and expand. This may also hold for KIBS who can develop and expand in any type of region provided they posses sophisticated non-local linkages. However, evidence suggests that although geographical distance can be overcome in multiple ways with help of

[5] Before the second quarter of 2008, UK Gross Domestic Product (GDP) grew for almost 16 unbroken years. Much of this growth was concentrated in London and its neighbouring regions, and differences in economic performance between the regions persisted. GVA per head in the North East was only three-quarters that of England. The North East had the highest levels of unemployment in the period August to October 2011, and the South East the lowest. The percentage of people employed in the public sector also varies. It is highest in the North East (25 per cent) and lowest in the South East and East (17 per cent).

modern communications technology and better transport connections, long distance service relations are not commonly noted in KIBS (O'FARRELL *et al.,* 1996).

A traditional argument related to KIBS internationalisation has been that KIBS internationalise because their clients operate in foreign markets (O'FARREL *et at*, 1996). While this type of internationalisation is quite common in KIBS it is by no means the only way for KIBS to reach distant markets. GLUCKER (2004) and ROBERTS (1998) state that foreign direct investments represent the common form of internationalisation of KIBS but that partnerships are also quite typical due to a need for close KIBS client interaction. FDI types of foreign market entry, however, require high levels of resources and commitment, which most SMEs do not possess. It is more likely that the risks associated with foreign market entry, technology sharing and product/service development, and the barriers posed by foreign regulation, may be overcome by forming joint ventures and strategic alliances. These in turn may have a positive impact on KIBS innovativeness.

Empirical evidence is therefore needed to identify opportunities for KIBS innovativeness by investigating the effect of local and non-local linkages. Evidence based policies supporting innovativeness in KIBS SMEs in de-industrialised regions can then take effect first by directly supporting economic performance in KIBS while simultaneously enhancing the performance of KIBS' clients.

THE EMPIRICAL SPECIFICATION

Data collection

In this study, Data were collected through an outsourced telephone survey of KIBS SMEs in the North East and West Midlands. Information was collected on 342 SME KIBS' innovative

performance as well as on a measure of their absorptive capacity and a range of external factors that might contribute to or hinder KIBS innovative performance. The database used was One Source, available through the British Library. 342 usable responses were collected, representing a 5.27 confidence interval (margin of error) at 95% confidence level[6]. Of 888 contact records for the North East, 167 interviews were completed and 293 refused. The West Midlands contacts (1,900) were stratified into three geographical areas and random samples drawn, to yield 175 planned responses. A skewed sample for the West Midlands was enhanced by extra interviews from larger firms (more than 5 employees). The stratification procedure was not followed in the North East since the sampling frame was exhausted.

The profile of the sample is that the average size was small, 12 employees, with a median of 3. The largest employed 249 people. None of the firms are majority owned by another entity. Firms had been operating for an average of 17 years and had an average profit to sales ratio of 4.84%. Of 240 companies which recorded information on profits, 47.4 % claimed profits above 10% of the turnover and 6% reported zero profits in 2008. Of 340 companies that answered the question, 150 (44%) had introduced at least one product/service innovation in the previous three years. Of 339, 110 (44%) had introduced at least one process innovation and, out of 183 respondents, 130 (38%) introduced at least one market innovation.

Survey questions asked business owners and managers to identify how often they source knowledge from various networks located within the region, UK and abroad; whether their firms have introduced innovative products, services, processes and marketing methods in the past three years and how much they invest in R&D. The links between performance indices (innovation) and determining factors (investment in R&D, frequency of sourcing knowledge from various traded and untraded networks and obstacles to success) are

[6] According to the Interdepartmental Business Register, total population in 2010 is 33,280 firms for both regions. If for example 50% of survey participants invest in R&D then the actual population which invest in R&D could vary by +_ 5.27%. In other words we can be 95% certain that the actual population who invests in R&D can be as low as 45% (50-5.27) as well as high as 55% (50+5.27).

analysed statistically, although the relationship between innovation and economic performance is outside the scope of this paper[7]. The emphasis is not on analysing differences or similarities between the two regions but on providing statistically significant results which apply across de-industrialised regions.

The conceptual model and variables

Following from the proceeding literature review this paper aims to test four hypotheses:

H1: Knowledge from regional customers and regional informal business networks enhances KIBS innovativeness.

H2: Knowledge from international customers and other international untraded networks enhances KIBS innovativeness.

H3: Knowledge from regional public knowledge infrastructure i.e. universities, regional and national public sector organisations and regional competitors has positive impact on KIBS innovativeness.

H4: R&D activity is not amongst the most important predictors of KIBS innovation.

Hence, the analytical model presented here represents the innovation capability of firms arising from internal inputs, such as their absorptive capacity, and various external inputs. The measurement of innovation relates to product/service innovation and process innovation combined, using a simple binary variable indicating whether or not a firm had introduced at least one such innovation during the three years preceding the survey[8]. It should be noted that this measure does not account for the significance or the impact of any

[7] Previous research on KIBS in Northern Ireland (LOVE *et al.*,, 2010) shows that the link between innovation, exporting and productivity is complex. Findings from this study indicate that innovation assists both exporting and productivity, however, this link is materialised through formal commitment to R&D whereas innovation *per se* is not enough.

[8] Logistics regressions were also run for market/marketing innovation but did not yield satisfactory results.

particular innovation[9]. Our decision to combine product/service and process innovation relies on the previous literature which recognises that the traditional distinction between product/service and process innovation may be less meaningful in services (LOVE ET AL, 2010).

Measurement of the sources of internal and external capability is more straightforward. Internal capability or absorptive capacity is measured through investment in R&D. Following DORAN and O'LEARY (2011), R&D is defined as expenditure by the firm on creative work to increase its stock of knowledge for innovation. JORDAN and O'LEARY (2008) found that it is the effectiveness of R&D, rather than having a dedicated R&D department, that matters for product innovation. Investment in R&D is measured first as a simple binary variable reflecting whether firms invested in R&D or not and later by three binary variables, reflecting different levels of investment in R&D as a proportion of total turnover: a) investment greater than 10%; b) investment between 6%-10% and c) investment in the range from 1%-5%. Specification of R&D investment measured by three binary variables has also been employed in other studies (see for example, FREEL, 2006).

The external capability of firms is captured through intensity of networking measured by the frequency with which knowledge is sourced from various external agents. [10] These ranged from 1-10 on a Likert scale, representing managers' and business owners' assessments. The variables were classified into regional, national and international sources of knowledge and grouped using principal component analysis into thirteen significant factors, applied in probit regression models.

[9] Qualitative information from a survey points to a wide variation in the nature of innovation in firms, some being more radical than others.

[10] External sources of knowledge were classified into following relationships with: Customers, Suppliers, Rival firms, Employment, Licences, Consultants, Formal strategic alliances/joint ventures, Public sector organisations, Private sector organisations, such as private training or research providers and consultants, Literature/patents, Conferences, trade fairs, exhibitions, Professional and trade associations, Universities or other higher education institutes, Contract research, Research cooperation, Business networks, Informal contacts.

The other control variables used in the model include : firm size; firm age; a regional dummy, with 1 for North East and 0 for West Midlands and also a technology dummy, with 1 for Technology or T- KIBS and 0 for Professional or P- KIBS.

Analysis techniques

Principal component analysis was used to provide aggregation and normalisation of the external knowledge variables. Its aim was to provide a better understanding of the structure of the set of external knowledge variables and reduce the data to a more manageable size. Thirteen factors with Eigen values of greater than 1 were extracted by varimax rotation and used in regressions. The results are presented in the Appendix, Table 1. An interpretative description of the factors is provided below. Principal component analysis also tackles the potential problem with co-linearity between various external knowledge sources.

Description of Factors:

1) *International Formal Knowledge Sources* These include overseas public sector organisations, consultants, former employment, research cooperation, private sector organisations such as training or research providers, licences, contract research, universities or other higher education institutes, rival firms, professional and trade associations, formal strategic alliances/joint ventures and suppliers.
2) *National Public and Professional Knowledge Infrastructure elsewhere in the UK:* Universities or other higher education institutes, professional and trade associations, business networks.
3) *Regional and National Commercial Networks:* Consultants, both within the local region and elsewhere in the UK; private sector training or research providers and

consultants within the region; formal strategic alliances/joint ventures, both elsewhere in the UK and within the region.

4) *International Customer and Informal Networks:* Overseas business networks, conferences, trade fairs exhibitions, customers, informal contacts and formal strategic alliances and joint ventures.
5) *Regional Informal and Business Networks:* Regional business networks, informal contacts, conferences, trade fairs and exhibitions within the region.
6) *Regional and National Research Cooperation:* Contract research and research cooperation.
7) *Regional Public Knowledge Infrastructure* Regional public sector organisations and, Higher education institutes.
8) *Regional and National Patents and Literature*
9) *Regional and National Customers*
10) *Regional and National Employees.*
11) *Regional and National Rivals*
12) *Regional and National Suppliers*
13) *Regional and National Licences*

In the probit estimations, the dependent variable is defined as innovation (i.e. including both product-service and process innovation) and regressed on the following independent variables: (a) the thirteen types of external sources of knowledge identified by the principal component analysis, (b) investment in R&D as measured by the different ranges of the R&D to turnover ratio, and (c) standard control variables usually included in an innovation function. Tables 3 and 4 show the results from a linear Probit model. We acknowledge that the model is likely to be subject to endogeneity and omitted variables bias. This is because it may be equally plausible that the effect of R&D on innovation may be felt through some unobserved factor such as general level of firm's success(i.e. it is possible that more innovative firms are also more successful ones, which in turn increases their R&D

intensity). This consideration indicates that causation may run in the opposite direction whereby more innovative firms tend to invest in R&D and not vice versa. To address this issue we provide a sensitivity test by using a two stage estimation that enables us to control for any unobserved causality between innovation and R&D.

First, Table 3 presents results form one stage estimation in which R&D and innovation are treated as strictly exogenous variables. Table 4 presents results from a two stage estimation. The best approach to control for unobserved endogeneity is to use instrumental variable estimation. However, the present empirical context does not provide strictly exogenous instruments for R&D[11] and thus we slightly modified two stage estimation to test the robustness of our results in the presence of unobserved endogeneity. We implement the two stage estimation as follows: first we estimate a probit model for the determinants of an R&D active firm. In the first stage estimation, the dependent variable is a binary R&D indicator that takes value 1 if the firm invests in R&D and zero otherwise.

Results from the first stage estimation are shown in column 1 of Table 4. Apart from investment in R&D other control variables used at this stage are: region, age, type (T-KIBS vs P-KIBS) and size. Additionally we have included different degrees of profitability in order to capture whether or not firms' financial strength drives a firm's decision to invest in R&D. Once we have estimated the R&D probit model, we use the predicted values of this model as regressors in our second stage estimation which is the innovation probit model. Therefore the second stage model does not include the trichotomous R&D variable but only the predicted values from the R&D probit model of the first stage. By following this approach we reduce the potential endogeneity effect that might exist between R&D and innovation. The overall fit of the model as implied from the R-squared value remains low in both Table 3 and

[11] The current data are collected from a telephone survey. Although this method has certain advantages for investigating the importance of external knowledge sources for KIBS innovativeness we encounter two main constraints with regards to implementation of IV estimation. First, none of the variables can be considered as exogenous instruments for R&D and second most of the variables are not continuous which renders them as not suitable for use in IV estimation.

Table 4. This is somewhat an expected outcome given that this is only a cross section analysis with no time variation.

MAIN FINDINGS

Determinants of innovation capability

Our survey takes into account the geographical remit of various knowledge sources, and our results show that the relationship between "soft" knowledge sources such as interaction and learning from customers, suppliers and others and "hard" knowledge sources such as R&D is more complicated once we take into account frequency of interaction on one hand and its effect on innovativeness on the other. Prior descriptive analysis of our survey shows that the most frequently utilised sources of external knowledge are indeed clients (together with informal contacts) and suppliers. However, while higher frequency of networking with regional and UK clients confers innovation advantages this does not seem to apply to interaction with suppliers (Tables 3 and 4). In fact, more frequent interaction with local and UK suppliers seem to have negative effect on innovation (Tables 3 and 4).

Orientation towards local or national client/market exchange is therefore associated with higher innovation performance. This is in line with majority of KIBS studies which emphasise the importance of KIBS-client co-production of innovation. This finding is, however, somewhat contrary to findings of ROMIJIN and ALBALADEIO (2002), who found no positive effect of interaction with local customers among high tech firms in the South East of England. Another important result, in terms of both its statistical significance and its positive effect relates to the influence on firms' innovativeness of regional informal and business networks and attendance at conferences and trade fairs (Tables 3 and 4). Support networks within the region, through informal contacts and business networks, and ad hoc

networking, through conferences, trade fairs and exhibitions, therefore seem to have profoundly positive effect on firms' innovativeness[12]. Hence, we find support for hypothesis 1.

Our descriptive data supports findings from previous studies (for example, O'FARRELL *et al.,* 1996), which indicate that for KIBS international networks are much less common than regional and UK networks. However, the more KIBS engage in networking with international informal contacts, strategic alliances and joint ventures, attend conferences, trade fairs and exhibitions overseas, and interact with foreign customers, the greater the probability that they had introduced product/service innovation (Tables 3 and 4). The positive effect of engaging with international clients suggests that those KIBS that establish international exporting capabilities tend to benefit from more sophisticated international demand. This finding is in line with ROMIJN and ALBALADEIO (2002) who found that most innovative high tech firms from the South East operate in leading global markets. However, It can be concluded that it is not export orientation *per se* but learning through exporting, as proxied by frequency of interaction with international clients and market entry through joint ventures and strategic alliances, that significantly increases innovation capability (Tables 3 and 4). Hence, we find support for hypothesis 2.

Innovation capabilities of KIBS SMEs do not seem to be enhanced by frequency of interaction with firms in similar lines of business (Tables 3 and 4). However, more frequent interactions with the regional and national commercial networks, such as consultants and commercial training providers are significant predictors of KIBS innovation activity. Moreover, more intensive collaboration with national and regional universities and public sector organisations actually decreases the probability of KIBS innovation in our first model (Table 3). Other studies which found similar results state that this negative association may

[12] A caveat should be placed here concerning the causality bias that may exist in relation to the link between external knowledge sources and innovation. Our results suggest that the more innovative firms are more likely to take up learning from external sources. Nevertheless, in the current empirical context we are unable to provide further evidence about the validity of such hypothesis. We leave this idea for further empirical research.

be due to KIBS SMEs attempting to overcome competitive pressures by reaching out to universities and public sector organisations (KEEBLE *et al.,* 1998; HUGGINS and JOHNSTON, 2009). However, once we control for the possible effect of firms' general level of success in our two stage model, this significant and negative effect does not exist anymore but instead becomes positive but insignificant for regional public networks. For national public and professional knowledge infrastructure (universities and other higher education institutes, professional and trade associations and business networks) the sign in our two stage model is both positive and significant. Hence, the role of national public and professional knowledge infrastructure becomes a significant predictor of firms' innovativeness once we control for the general level of firms' success. This effect, however, does not apply for regional public knowledge infrastructure (regional public sector organisations and regional universities) even though we acknowledge the positive sign in our two stage model. Therefore, we find no support for hypothesis 3. It has been noted that successful transfer of the tacit component of knowledge which firms may draw from universities requires close and ongoing interaction between the inventor and purchaser (TEECE, 1985). It follows that firms' capacity and willingness to engage with universities will affect the potential of effectively transferring meaningful knowledge (BERCOVITZ AND FELDMAN, 2006). This is consistent with our findings which show that once we control for the general level of the firms' success the effect of knowledge transfer from universities and other public organisation becomes positive. In other words, our results indicate that the positive effect of knowledge firms draw from universities and other public institutions on firms' innovativeness largely depends on their own success and the ability to absorb this type of knowledge.

Only a small number (14.6%) of North East and West Midlands KIBS SMEs invested in R&D. The role of R&D in supporting KIBS innovation seems nevertheless both significant and positive in our first model. This effect applies to all levels of R&D expenditure (Table 3). This result holds true for both technological and professional KIBS (T-KIBS/P-KIBS dummy

controls were introduced in both regressions). This is in line with some other recent studies which apply an innovation production function to establish the sources of KIBS innovativeness (for example, LOVE *et al.,* 2010; LOVE and MANSURY, 2007; FREEL, 2006). However, once we have controlled for endogeneity, investment in R&D seizes to remain the significant predictor of innovation though the positive sign for R&D remains (column 2 in Table 4). This result does indicate that the R&D innovation nexus is subject to endogeneity bias. This does not mean that R&D does not matter for innovation but results indicate that there are also some other/unobserved factors which are associated with innovation which work in combination with various sources of external knowledge. Hence, we find support for hypothesis 4.

In our second model innovation also seem to depend on a firm size, with large firms more likely to introduce innovation. This finding is in line with previous studies, including ROPER *et al.,* (2008). Extensive knowledge sourcing from regional and national licences also improves product-service innovation capability (Tables 3 and 4). Licensing essentially permits the firm to use the property of the licensor, usually in the form of trademarks, patents and production techniques. Licensing has the potential for large return on investment due to the low initial investment required by the licensor, though some potential returns from manufacturing and marketing may be lost. However, it seems that benefits which KIBS SMEs accrue from licensing arrangements in North East and West Midlands outweigh the associated disadvantages, at least in the short term. Also, the probability of being an innovator increases for firms located in West Midlands rather than those who are located in the North East. In our first model T-KIBS are more likely to be innovators but once we control for the general level of firms' success this effect does not exist any longer even though the sign stays positive.

CONCLUSIONS

This paper has sought to analyse the knowledge networks which may be conducive to firms' innovativeness on a sample of KIBS SMEs in two de-industrialised regions in the UK, as well as to establish the level of localisation of these networks. The paper also investigates the role of R&D on KIBS innovativeness. The main empirical contribution of this paper and its novelty lies in the fact that this is empirical research regarding KIBS innovation which takes into account the diversity of the types of knowledge links as well as the level of localization of these links. At the same time, the paper contributes to territorial innovation literature by providing insights into the diversity of types of external knowledge and their level of localisation in de-industrialised regions. We have shown that KIBS firms which operate in high-technology and knowledge industries who establish more frequent specific linkages both with their local as well as global environments are able to avoid lock-in effects. We also acknowledge positive though not significant effect of R&D on KIBS innovativeness.

For some time UK SME policy has focused on building clusters of related firms. This initiative has mainly taken a form of building physical infrastructure such as science parks (HUGGINS *et al.,* 2010). Science parks have been largely created to promote linkages with scientific institutions and universities located close to industry. This policy direction draws its authority mainly from localised learning and cluster literature. Our results show that there are no benefits associated with more frequent interaction with firms in similar line of business and that relationships with scientific institutions and universities benefit firms from a distance rather than locally.

Our results also show that both regional and international networks are conducive of firms' innovativeness in de-industrialised regions. The results correspond to conclusions from developed regions which point to the importance of local and global ties (KEEBLE *et al.,* 1998; SIMMIE, 1997; ROMIJN and ALBALADEIO, 2002). In addition being an exporter and learning from international clients increases the chance of success but so does learning

from local and UK customers. Local and UK consultants also play a positive role. Despite the positive role of external informal contacts and business networks, both regional and global, the role of firms' internal R&D and their corresponding absorptive capacity should not be under estimated. Business and informal networking, attending business meetings, conferences and fairs seem to have positive effects through KIBS internal capacity to absorb knowledge and information available elsewhere.

In our survey, some institutions, such as the Chambers of Commerce, Business Link, the professional trade organisations, the former Regional Development Agencies and other regional and industry specific business networks, were listed as important networking partners, providing consultancy and financial assistance and in facilitating networking between firms and other organisations. In this respect, they play important role in de-industrialised regions as sources of knowledge for KIBS SMEs. This may well mean that in de-industrialised regions they act to ameliorate possible market failures related to insufficient commercial provision of support for SMEs as well as limited opportunities for networking. Their impact should therefore not be viewed only through their direct role in providing business, marketing and financial assistance to firms but also through their role as mediators between peripheral firms, local and international business networks, and potential distant markets.

We recognise that there are a number of limitations to our analysis. These include the utilisation of a binary response in the definition of dependent variables. A number of other studies (JORDAN and O'LEARY 2005; ROPER *et al.,* 2008 and DORAN and O'LEARY, 2011) have suggested that this may tend to overstate the importance of external interactions. Also, cross sectional analysis does not allow us to claim the direction of causality; however we tackle this problem with a two stage estimation in our second model. We emphasise, therefore, that important lines of future enquiry must include disentangling the relationships between the internal capability and external interactions of firms, and we

call for more empirical research related to both de-industrialised and current ‘core’ regions to enhance reliability of our conclusions.

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Table 1: Principal component analysis results Rotated Component Matrix[a]

	Component												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Public sector organisations overseas	.850												
Consultants overseas	.799												
Employment overseas	.797												
Research cooperation overseas	.770												
Private sector organisations, such as private training or research providers and consultants overseas	.696												
Licences overseas	.681												
Contract research overseas	.677												
Universities or other higher education institutes overseas	.677												
Rival firms overseas	.637												
Professional and trade associations overseas	.592												
Formal strategic alliances/joint ventures overseas	.592			.519									
Suppliers overseas													
Universities or other higher education institutes elsewhere in the UK		.692											
Professional and trade associations elsewhere in the UK		.626											
Business networks elsewhere in the UK		.575			.552								
Public sector organisations elsewhere in the UK													
Consultants elsewhere in the UK			.720										
Private sector organisations, such as private training or research providers and consultants elsewhere in the UK			.692										
Consultants within your region			.642										
Private sector organisations, such as private training or research providers and consultants within your region			.629										
Formal strategic alliances/joint ventures within your region			.530										
Formal strategic alliances/joint ventures elsewhere in the UK			.514										
Business networks overseas				.685									
Conferences, trade fairs, exhibitions overseas				.684									
Customers overseas				.589									
Informal contacts overseas				.547									
Literature/patents overseas													

Conferences, trade fairs, exhibitions elsewhere in the UK								
Business networks within your region	.680							
Informal contacts within your region	.644							
Conferences, trade fairs, exhibitions within your region	.644							
Informal contacts elsewhere in the UK								
Professional and trade associations within your region								
Contract research within your region		.848						
Contract research elsewhere in the UK		.815						
Research cooperation within your region		.587						
Research cooperation elsewhere in the UK		.521						
Public sector organisations within your region			.684					
Universities or other higher education institutes within your region			.581					
Literature/patents within your region				.771				
Literature/patents elsewhere in the UK				.650				
Customers elsewhere in the UK					.722			
Customers within your region					.694			
Employment elsewhere in the UK						.776		
Employment within your region						.768		
Rival firms within your region							.824	
Rival firms elsewhere in the UK							.805	
Suppliers within your region								.829
Suppliers elsewhere in the UK								.715
Licences elsewhere in the UK								.752
Licences within your region								.607

Notes: Explained variance= 71.057; Kaiser-Meyer-Olkin (KMO) test= 0.819; Bartlett's test of sphericity: X2=9855.969; p=0.000

Table 2: Correlation Matrix Innovation, R&D and firm specific Characteristics

	Innovation	Region	Age	Size	T KIBS/ P KIBS	R&D	RD>10	6<R&D<10	1<R&D<5
Innovation	1								
Region	-0.061	1							
Age	-0.001	0.09	1						
Size	0.161	0.048	0.295	1					
T KIBS/P KIBS	0.086	-0.002	-0.056	0.006	1				
R&D	0.221	0.037	0.021	0.242	-0.014	1			
RD>10	0.174	-0.052	-0.054	0.251	-0.154	0.67	1		
6<R&D<10	0.136	0.11	-0.038	-0.044	0.017	0.49	-0.075	1	
1<R&D<5	0.027	0.027	0.161	0.157	0.18	0.432	-0.066	-0.049	1

Table 3: Determinants of Innovation, Results from Probit Estimation

VARIABLES, **Pr(Y=1, innovation and 0 otherwise)**	Marginal Effects	Marginal Effects
Region	-0.080***	-0.099***
	[0.017]	[0.001]
Age	0	0
	[0.002]	[0.001]
Size	0.003	0.004
	[0.003]	[0.002]
T- KIBS vs P- KIBS	0.034***	0.037***
	[0.009]	[0.006]
R&D(1=R&D active, 0=R&D inactive)	0.259***	
	[0.008]	
R&D Expenditure>10%		0.260***
		[0.007]
R&D Expenditure 6-10%		0.375***
		[0.041]
R&D Expenditure 1-5%		0.031***
		[0.007]
International Formal	-0.047***	-0.043***
	[0.014]	[0.001]
National Public and Professional	-0.016***	-0.015
	[0.003]	[0.012]
Regional and National Commercial	0.069*	0.066
	[0.041]	[0.043]
International Customers and Informal	0.044***	0.034***
	[0.008]	[0.007]
Regional Informal and Business	0.132***	0.139***
	[0.026]	[0.031]
Regional and National Research Cooperation	-0.037***	-0.036***
	[0.002]	[0.012]
Regional Public Knowledge Infrastructure	-0.037	-0.038
	[0.047]	[0.083]
Regional and National Patents and Literature	0.001	0.005
	[0.009]	[0.012]
Regional and National Customers	0.056***	0.062***
	[0.006]	[0.003]
Regional and National Employees	-0.025	-0.026
	[0.083]	[0.081]
Regional and National Competitors	0.006	0.007
	[0.027]	[0.042]
Regional and National Suppliers	-0.036	-0.039
	[0.037]	[0.044]

Regional and National Licences	0.025***	0.027***
	[0.004]	[0.003]
Observations	237	235
Probability of positive outcome (Y=1)	0.565	0.569
Pseudo R-squared	0.128	0.14
Log-likelihood	-142.4	-139.3

Notes: Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

Table 4: Two Stages Probit Estimation for Innovation

	R&D	Innovation
	Marginal Effects	Marginal Effects
Region	0.029***	-0.093***
	[0.007]	[0.005]
Age	0	0
	[0.001]	[0.001]
T-KIBS vs P-KIBS	0.02	0.003
	[0.059]	[0.003]
Size	0.002**	0.033
	[0.001]	[0.050]
Profitability 0	0.187	
	[0.541]	
Profitability 0-1	0.594**	
	[0.240]	
Profitability 1-5	0.438***	
	[0.087]	
Profitability 5-10	0.539***	
	[0.118]	
Profitability>10	0.160**	
	[0.081]	
R&D predicted values		0.081
		[0.087]
International Formal		-0.037***
		[0.002]
National Public and Professional		0.039***
		[0.006]
Regional and National Commercial		0.102*
		[0.058]
International Customers and Informal		0.044**
		[0.018]
Regional Informal and Business		0.129***
		[0.025]
Regional and National Research Cooperation		-0.040***
		[0.007]
Regional Public Knowledge Infrastructure		0.001
		[0.031]
Regional and National Patents and Literature		0.023
		[0.020]
Regional and National Customers		0.058***

		[0.013]
Regional and National Employees		-0.045
		[0.091]
Regional and National Competitors		0.023
		[0.034]
Regional and National Suppliers		-0.011***
		[0.000]
Regional and National Licences		0.028*
		[0.016]
Observations	267	296
Probability of positive outcome	0.156	0.568
Pseudo R-squared	0.154	0.115
Log-likelihood	-108.9	-180.4

Notes: Standard errors in brackets with *** p<0.01, ** p<0.05, * p<0.1. Estimates refer to a two stages procedure. In the first stage, we estimate the probability of firm to invest in R&D. In the second stage, predicted values of the R&D equation are used as a determinant for the innovation decision equation. Further details about the two stage estimation can be found in the text.