Network Structure, Knowledge Governance and Firm Performance: Evidence from Innovation Networks and SMEs in the UK

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Abstract

Universities are typically encouraged by policymakers at all levels to take a leading role in economic development, particularly through innovation. Simultaneously, economic development policy is increasingly focused on Small and Medium sized Enterprises (SMEs), creating a clear research issue in terms of the roles and interactions of government policy, universities, SMEs, and the creation and dissemination of innovation. This paper analyses the contribution of a range of actors in an SME innovation creation and dissemination framework, reviewing the role of universities and other institutions therein, exploring the contribution of networks, and identifying the mechanisms required to operationalise such a framework. Bivariate and multivariate (regression) analyses are employed to investigate innovation and growth outcomes in relation to these structures; data is derived from the survey responses of over 450 SMEs in the UK. Results are complex, dependent upon the nature of institutions involved, type of knowledge sought, and the spatial level of the linkages in place, but overall highlight the value of cross-locality networks, network governance structures, and spillover effects from universities. In general, we find less support for the factors predicting SME growth outcomes than is the case for innovation. Finally, we outline an agenda for further research in the area.

Key words: SMEs, Growth, Innovation, Universities, Governance, Networks.

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Introduction

Innovation is now seen as a cornerstone of modern economic activity (particularly, but by no means exclusively, within those sectors termed part of the 'knowledge economy'), and thus economic policymakers have increasingly sought ways to encourage this value adding activity, at both national and regional levels. Whilst conventional processes for fostering organisational learning and innovation were based primarily on individual behaviour and linear models (Weick, 1990), there is however now an increasing understanding that learning and therefore innovation occurs through highly interactive, iterative, networked approaches (Weick, 1990; Lundvall, 1992; Cooke, 1998; Gulati, 2007). Moreover, universities[1] have been encouraged to take an increasing interest in local economic development, innovation being an obvious area where they can play an important role, both directly and indirectly (Cooke *et al.*, 2000; Boucher *et al.,* 2003*)*.

Simultaneously, an increased importance has been placed on Small and Medium sized Enterprises (SMEs) and entrepreneurship generally, as a way of helping to alleviate economic problems. Research has acknowledged that due to rapidly changing and highly competitive markets, growth oriented small firms exert a growing influence on national economies around the world (Westhead and Birley, 1995; European Commission, 1996; Yeh-Yun-Lin 1998). These high growth firms are typically more prevalent in more dynamic industries and regions, and there also appear to be positive relationships between growth, use of innovation, and the use of external relationships of various kinds (Carroll and Hannan, 2000), though this is not without controversy. For example Roper (1997) found that the output of innovative small firms in the UK, Ireland and Germany grew significantly faster than non-innovators; in Germany this output growth was achieved through product innovation which led to productivity gains and thus reduced employment, whereas in the UK and Ireland both output and employment were positively related to innovation. In a more recent study Cooke *et al* (2005) found only a weak (though still positive) statistical correlation between growth and measures of new product and incremental innovation amongst UK SMEs. Conversely, knowledge networking activities may sometimes actually be negatively associated with growth outcomes (Huggins and Johnston, 2009). More generally, Freel and Robson (2004) describe the often complex nature of the linkage between innovation and growth performance of within small firms,

[1] In the UK, both Further (post age 16) and Higher (post 18) Education Institutions are included in broad policies in this area, but with the main focus upon the latter, i.e. the Universities

influenced for example by sector of activity, the nature of the innovation (incremental vs. radical), and the timeframe over which results are observed.

There is thus a clear research issue here, regarding the roles and interactions of government policy, universities, SMEs, and the creation and dissemination of innovation, as evidenced by Kitagawa's (2004) analysis of the English situation, for example. This study undertakes a wide-ranging examination of these issues. The paper briefly reviews the broad literature related to universities and SMEs in innovation, and networks for regional economic development generally. A basic framework for the processes that may be necessary to facilitate successful innovation and dissemination to SMEs is then developed. The methodology is outlined, and results generated utilising a quantitative analysis of a survey of over 450 SMEs in the UK. The conclusions discuss these results in terms of the consequent potential of universities in assisting the provision of a range of supporting mechanisms to facilitate successful innovation outcomes, and areas for further research into enabling mechanisms and further development of the framework.

Networks, Universities and SMEs in Processes for Innovation and Regional Economic Development

Network arrangements are increasingly seen as a foundation for economic development, particularly at the level of the regional economy (see for example Cooke, 1997; Morgan, 1997; Huggins, 2001; Gulati, 2007) where government, business and labour networks can all promote the agendas of economic development organisations. Morgan (2002) for example highlighted the ability of some sub-national governances (in his example, Baden-Wurttemberg) to develop appropriate 'institutional thickness' (Amin and Thrift, 1995; Amin, 1999) which allowed them to mobilise resources and provide important elements of social capital infrastructure to support networked economies with strong technology transfer and innovation systems. More specifically, Gordon and McCann (2000) identify three sets of advantages in geographically based clusters and networks, derived from agglomeration (external economies of scale, scope, and complexity), industrial complex advantages (reducing transactions costs through location) and, of most relevance here, social networks (in particular the easing of knowledge flows).

Recent literature on firm level R&D has also emphasised both the knowledge creating and absorbing role of in-house R&D (Veugelers and Cassiman, 1999), suggesting a strongly complementary role between in-house and external research. By analogy, a university may play a dual role within a region, both creating

(or co-creating) knowledge, and absorbing knowledge from outside the region. In general terms, spillovers and productivity benefits are probably greatest from publicly funded basic research which contributes to the public knowledge stock (Guellec and van Pottelsberghe, 2004). Optimising the potential contribution to regional development of a university's knowledge stock, however, will require complementarity between the university knowledge base and the requirements of regional firms. Research by Rodriguez-Pose (1999), Fernandez *et al.* (1996) and Jensen & Tragardh (2004), suggests that, in an economy dominated by small and medium-sized firms with an intermediate technological and industrial base, the returns may be greater from more applied research which is more easily absorbed by local firms (e.g. Oughton *et al*., 2002). Thus, the nature of university knowledge cannot be considered in isolation. Instead a more contextualised, systemic view is necessary reflecting both the supply of knowledge and its characteristics, the capabilities of knowledge users and the effectiveness of knowledge transfer (e.g. Cooke *et al.,* 1997; Braczyk *et al.,* 1998). The nature of the region itself may also be a factor in this process, Cooke *et al.* (2003) highlighting for example that core regions tend to have 'entrepreneurial' innovation systems, whilst more peripheral regions typically have 'institutional' ones. Therefore, the importance of creating, maintaining, and developing appropriate networks has also increased for the public sector, making it more important than ever to understand the processes involved.

The potential importance of universities in regional economic development is thus reflected in the research worldwide that considers this role (e.g. Susman 1990; Huggins and Cooke, 1996; Sargeant *et al.*, 1998; Lawton-Smith, 2003; Goldstein and Renault, 2004; Benneworth and Charles, 2004; Charles and Benneworth, 2005; Munday *et al.*, 2005; Harman, 2005; O'Shea *et al*., 2006; Huggins *et al*., 2008), identifying a wide range of positive impacts. Munday *et al.* (2005) focus on the direct impacts of universities on the local economy, through multiplier effects, whilst Lawton-Smith (2003) adds the role of universities in regional governance, and Charles and Benneworth (2005) also discuss the wider regional social and cultural role. Goldstein and Renault (2004), importantly, highlight that universities impact on the regional economy through their contribution to human capital development, research creation and dissemination, technology development and transfer, and assistance in creating a favourable milieu. This role has also been influenced by shifts in industry and government policy around the world, to a more entrepreneurial and commercial focus (Harman, 2005; O'Shea *et al*., 2006), university knowledge increasingly seen as needing to be both created, but also disseminated, beyond the narrow confines of academe into communities, and influencing practice (Branscomb *et al.*, 1999). Developing this further, Richard Florida describes universities as part of the 'basic infrastructure of the creative economy', and highlights the multifaceted role they now play in the social structure of creativity; not just in terms of

traditional spin-outs or linear knowledge flows, but also in their broader impact upon the 'quality of place' of the communities in which they are located (2002: p 292).

There may, however, also be issues related to goal ambiguities which characterise many universities, such as tensions between international reputation and regional role (e.g. Cohen and March, 1986; Jarzabkowski, 2005). Gunasakera (2006) highlights the problems that many individual academics have with regional engagement, due to issues such as lack of internal university management coordination, relatively small internal (e.g. promotional) incentives compared with more traditional academic activities, and poor alignment of policy with competitive research grant schemes. Lawton-Smith (2003) also indicates that university missions are likely to depend upon size, catchment area and context; similarly Boucher *et al.* (2003) focus on the importance of place (including the extent of competition between universities in the same geographic area) in determining university roles in regional development. Evidence from Goldstein and Renault (2004) also suggests that in general, universities in smaller, less urbanised areas, with proactive regional development policies, do have positive impacts capable of counteracting at least some of the disadvantages of a lack of agglomeration. Correspondingly, Boucher *et al.* (2003) suggest that the larger more traditional universities in core regions (e.g. capital cities) are less regionally engaged than large single universities in more peripheral regions where they are typically the only university. Additionally, newer technically-focused universities in core areas are also inhibited in their regional impact by the competition effects from other universities in the region, perhaps suggesting the need for more networking and cooperation and less competition, in order to focus university missions and activities into mutually beneficial regional development. On this, Anders (1992) has highlighted the importance of networking between universities within regions to increase their beneficial impacts on the economy, something supported in the UK context by Pickernell *et al* (2008).

Kitagawa's (2004) analysis of Higher Education and Innovation Policies in the English Regions highlighted a range of government initiatives that have been put into place. These include encouragement of inter-university collaboration to combine expertise and resources in generating knowledge creation, exploitation and innovation. Linking higher education and regional economic development policy through effective connections was also identified as a way of generating better delivery mechanisms. However, tensions were seen because overall policy regarding Higher Education tended to promote competitive rather than collaborative relationships, and because of resource limitations in lagging regions (such as demand-side, firm-level, and absorptive capacity problems).

Using Wales (UK) as the example, Morgan (2002) also argued that too much emphasis has been placed on university activities akin to the 'elite model', and not enough on skills and social capital development inherent within the 'outreach model' more suited to many of that region's universities; similar issues have also been described in the context of the USA (see for example Cherwitz and Sullivan, 2002; Reilly, 2003). Morgan concluded that this had led to an over-emphasis (in terms of resources) into elite universities, with consequent under-funding of education and training, and a focus on research deemed irrelevant to local and regional economic needs. In addition, Taylor *et al.* (2004) found that the institutions which had become universities in the post 1992 period in the UK (having previously been 'Polytechnics') were generally more embedded in their regions and thus better able to develop entrepreneurial, social capital, and practical learning outcomes for businesses.

Further evidence presented by Pickernell *et al.* (2008) suggests that relationships between universities in Wales are often too hierarchical to allow these types of interaction to occur. In particular their findings suggest that there is a clear need to develop and strengthen the structures and processes that fit into a Social Network cluster type, and focusing on knowledge sharing, long-term network development, and learning which promotes 'doing different things' and 'doing things differently'.

Kitagawa (2004) further argues that understanding the mechanisms and processes for inter-organisational network management between universities and other innovation support organisations seems to be key in constructing innovation systems within regions. Lagendijk and Rutten (2003) found that universities were often difficult to integrate into regional strategies; this highlighted a question for Kitagawa- namely the extent to which universities could be utilised in assisting the creation and dissemination of innovation in less favoured regions (i.e. the ones that could typically most benefit from it), given that much of the evidence concerning the positive impact of universities on regions focused on successful regional economies such as Silicon Valley, Boston, Cambridge UK, and Barcelona.

Kitagawa (2004) goes on to suggest that universities also need to utilise their non-local networks to generate additional resources for use in local economies, but also highlighted Rutten and Boekema's (2004) view that universities often have better links to other universities worldwide (and multinational companies) than with local SMEs. Kitagawa (2004) argues therefore that there is a need to examine the complementarity between university institutions, policy initiatives, and other support organisations. This brief discussion thus highlights the crucial role of suitably designed networks within this, particularly between universities and their local economies.

The need for linkages within the local economy as described above can be seen, in particular, in relation to the role of SMEs. Whilst conventional models of national economic growth imply that SMEs essentially play a secondary role in the economy supporting the activities of larger more established firms, more contemporary models afford entrepreneurship a more active and direct role in generating economic prosperity (Reynolds *et al.,* 1999). In the early 1980s in a number of EU countries, particularly the United Kingdom, the major strategic policy emphasis was placed upon stimulating new firm formation (Storey 1999). This emphasis was due in part to evidence that suggested the smallest firms were disproportionately responsible for innovation and employment creation (European Commission 1998). Knowledge spillover theories of entrepreneurship also argue that knowledge developed in certain institutions might be commercialized by others, and that entrepreneurship is one way that the 'economic agent with a given endowment of new knowledge' can best appropriate the returns from that knowledge. For example, Audretsch and Lehmann (2005) have demonstrated that the number of new firms located close to a university is positively influenced by the knowledge capacity (as measured by spending on R&D and technological innovations) of the region, and the knowledge output of the university. This leads them to argue that investment in the creation of new knowledge will tend to generate opportunities for entrepreneurs, but that if those with market information or other resources are not aware of the new knowledge, they may fail to invest (or under-invest) in that knowledge, or in new firms.

Questions clearly highlighted, therefore, concern the nature of appropriate networking both *between* universities and *between* universities *and* SMEs to enable beneficial innovation activities to be generated. This is manifested in the university role of creating human capital, where economic change has increased the importance of decentralised clusters of businesses and SMEs as suppliers and franchisers (Charles, 2003). The role of universities can however be seen more widely than this, given the increasing importance of networking within the innovation context.

Defining an Innovation Creation and Utilisation Framework

Current paradigms thus emphasize the need for multi-disciplinary and interactive knowledge production among governments, universities and research institutions, and firms in relevant industries; the 'Triple Helix' for innovation presented by Leydesdorff and Etzkowitz (1998). As a consequence, increasingly over the past decade cooperative and collaborative research and development arrangements, based on the formation of inter-organisational networks, have emerged as key strategies to meet the challenge of

fostering both the development and uptake of the innovative techniques and practices necessary to raise performance across a range of sectors (Powell *et al.,* 1996; Swan *et al.,* 2003).

Within the literature (see Clifton *et al.*, 2005, for a comprehensive review) there exist a set of concepts which overlap and connect networks and cluster-related theories, indicating eight basic types of clusters (Marshallian, Italianate, Hub and Spoke, Satellite, Industrial Complex, Urban Hierarchy, Social Networks, and Virtual organisation). Structure can be classified and related to performance by horizontal attributes (either internalised activities within the firm or across industries linkage) and vertical attributes (external and within-industry linkage), formal and informal modes, transactions, and agglomeration-related properties. A review of the disparate literature on innovation-based networks (discussed in more detail in Christie *et al.,* 2005) produces the following additional elements in the network classification scheme which together provide a framework for analysis — namely structures involved, returns sought, participant goals and conduct, participant basis, network mode and types of learning. It is thus possible to synthesise cluster types, structures and attributes (and cluster and network differences) based on the above literature. In particular, this highlights the need for appropriate enabling mechanisms to facilitate innovation activity between networks of participants, in terms of structures for knowledge creation and dissemination, management (and governance), and learning (including education and training). If the 'elite' university model is thus defined, loosely, as encompassing 'triple-helix' elements of Leyesdorff's (2000) model, then it would seem logical to also consider in more detail the 'diffusion' elements as factors universities may also be able to assist in through stimulating, managing and dispersing innovation to SMEs, as part of an overall innovation management framework. There is thus also a need to examine in more detail the three identified interrelated 'enabler' areas of education training and learning, management and governance, and conduits and fora, to effectively facilitate the creation, transfer and diffusion of innovation.

Research indicates, for example, that skills deficiencies exist in smaller enterprises in areas such as strategy, planning, marketing and sales (Welsh 1996; Greig 1997), whilst Holden and Hamblett (2001) point out that SMEs are notoriously weak in the infrastructure required to deliver training and development, all factors that reduce firms' knowledge and innovation creation and absorption capacity. Innovation management also often requires managers to match 'hard' expertise, in areas such as technology and project management, with 'soft' skills in people management, to promote creativity. Few managers have been educated in both of these areas (Goffin and Mitchell, 2005). Kirby (2004) thus advocates the use of universities in promoting and reinforcing the development of entrepreneurial skills in communication, creativity, critical thinking and assessment, leadership, negotiation, problem-solving,

social networking skills, and time-management. Frenz and Oughton (2006) also argue that the most consistent finding of regional total factor productivity growth studies is that the stock of human capital enhances the absorptive capacity of firms, facilitating local technology transfer and local and regional knowledge spillovers, and thus ultimately growth. Moreover, these authors found evidence of a positive and significant effect of both inter-firm and firm-university cooperation on innovation, but also that the level of UK firm-university cooperation is very low. They also concluded that firms must have a certain level of absorptive capacity (defined by the proportion of science and engineering graduates in the workforce, level of firm R&D expenditure, and organizational capability) before entering into cooperation with a university. Encouraging take-up through education and training will therefore involve all parties being provided with knowledge about the innovation itself and convinced of the possibilities for mutual gain (Goffin and Mitchell, 2005), and should assist in building appropriate governance structures.

The question then becomes which structures (i.e. conduits and fora) can be used. As noted, the literature suggests a range of relationships and structures in which knowledge creation and dissemination can occur, the choices including direct spinouts of companies, and collaborations with various stakeholder groupings from industry, government and institutions such as universities. Conduits that could exist for this interaction may include supply chains, but cluster and network theory suggests a range of other formal and informal ways in which these activities can occur. Related to this, appropriate management processes for innovation creation and diffusion networks are also vital; the three basic modes or mechanisms of social integration potentially of use are the hierarchy (either state or corporation based) (Griffiths & Zammuto, 2005), the market, and social networks (Lowndes and Skelcker, 1998; Thompson *et al*., 1991). Markets are sometimes perceived as being unable to adequately bundle the relevant resources and capacities between science and industry, while the complete vertical integration of the hierarchy restricts flexibility and incentives (Menard, 2002). Conversely pure networks of relationships based on trust and reciprocity are often insufficient forces to secure desired outcomes (Rhodes, 1997; Keast and Brown, 2002). Hybrid arrangements, however, can exhibit a number of possible combinations and recombinations of contact, authority, and trust to form new types of organizational entities ranging from strategic partnerships to multi-organizational arrangements constituted as corporate entities (Schaeffer and Loveridge, 2002). A hybrid approach therefore has the ability to limit or balance out the negative effects of an over-reliance on any one governance mode (Menard, 2002). A mix of governance modes will therefore often be required, depending on the industry in question and its clustering / networking relationships both internally and with other stakeholders. This means that stakeholder activity needs to be closely coordinated, to ensure that the governance structures are in place which will facilitate

the type of learning processes required to produce desired outcomes. Learning is thus the key process through which the performance outcomes of networks (defined in terms of returns sought) in general and cross-locality networks in particular are derived; the relationship between learning, and structures and governance modes, providing the mechanisms to bring participants and stakeholders together in order to share resources and knowledge not occurring internally or individually.

Thus, an ideal scenario might see an array of key stakeholders in collaboration from industry, government, and institutions (including universities and government research departments), utilising these interconnected mechanisms to generate and disseminate knowledge, innovation, skills, and training, and to operate management and governance structures appropriate to their own particular circumstances. It is such a model that we attempt to operationalise in this research; this conceptual framework explicitly places the SME at the centre of the innovation generation / diffusion and utilisation interface, given that it is they who will ultimately realise the benefits of innovation and for whom the enabling mechanisms will need to be put in place. Within this a two-way flow of information may be necessary; the precise nature of these relationships depending on the type of industry and the clustering / networking required. The successful creation and diffusion of innovation thus involves considerably more than just technical competence. In addition, it requires the development of the skills and networks able to facilitate it- encompassing the diffusion element of a university's potential role.

Innovation: Cross-Locality Considerations

There is however also evidence, much of it from the Regional Innovation Systems literature, that the collaborations described above can often be cross-local in nature. Frenz and Oughton's (2006) review suggests that the borders of innovation systems can be fuzzy (see also Narula, 2003), particularly as the growing importance of trade, economic openness (Simmie *et al.,* 2002) and multinational enterprise creates innovation processes spanning across countries. These overlapping geographical relationships can occur at the level of:

- National innovation systems, including infrastructure, institutions, education and training governances system and the inter-linkages and networks between them.
- Regional systems of innovation then have boundaries determined by elements such as the geographical spread of clusters, administration, infrastructure, amount of skilled labour, training structures, institutions, the degree of networks and linkages, and industry and firm specificities.

- Sectoral systems may also span across regions and countries; similarly generic or platform technologies (ICT for example) may apply across a range of sectors, regions and countries (Malerba, 2002).

While local and regional systems may provide internal economies, the degree of openness to national and global systems is also important. Indeed, Granovetter (1985) noted the effectiveness of weak ties and loose couplings over the weakness of strong ties between network contacts; this emphasises the 'strength of weak ties', in that although less strong than contacts used on a daily basis, these connections can reach outside an immediate network (or social circle), and into new areas of information and opportunity. Grabher (1993) warns similarly of the negative impact of social capital arising from 'lock-in' relationships caused by over-dependence on a too-narrow range of business or social contacts.

Cooke *et al.* (2005) also highlight the positive association between social capital related to trust in relationships, and the way in which the untraded interdependencies involved may then create *traded* interdependencies within networked arrangements. This can be seen as related to Boschma's (2005) identification of five dimensions of proximity that can have an impact on learning and knowledge, and which do not necessarily require *geographical* proximity, namely: cognitive (competence and reliability), organizational, social, institutional and finally geographical itself. He argues, for example, that the need for geographical proximity in order that learning should occur is weak when there is a clear division of precise tasks that are coordinated by a strong central authority—organizational proximity—and the partners share the same cognitive experience—cognitive proximity (Boschma, 2005: p69). He further suggests that spatial lock-in may be solved or even avoided by establishing non-local linkages. Findings from empirical studies also suggest that non-local as well as local relationships are important sources for interactive learning, and thus effective process and product innovation (see Asheim and Coenen, 2006; Asheim and Isaksen, 2002). In this way, institutional structures can reflect a kind of balance between stability (reducing uncertainty and opportunism) openness (providing opportunities for newcomers) and flexibility (experimenting with new institutions). With regard to universities specifically, Lambert (2003) found that for business-university collaborations, physical proximity is important for SMEs. However, whilst firms whose main market was local cooperated predominately with their local university (88 per cent of such firms), those whose market was international cooperated much more widely with national (48 per cent) and international universities (26 per cent). However, a quarter of these firms also had linkages with their local university. Conversely, no firms whose market was primarily local or regional reported cooperative links with overseas universities. This suggests that in general these cross-locality

networks are somewhat asymmetric, in that locally focused firms do not tend to use non-local knowledge, while firms with wider markets often use a range of sources- perhaps in ways that echo Boschma above. It is worth noting that smaller firms will, typically, be the ones with the primarily local markets. This of course does not mean they cannot be successful in this context; the Lambert study does not go into this area directly, i.e. the pattern of linkages observed may or may not be one that actually optimises performance (however defined). This is an issue worth investigating further, something that is attempted in the present research. The precise importance of each of the factors within the system will vary with the organisation of processes and relationships for individual firms and industries. It may not be the case, therefore, that all the factors will be applicable in every situation, and the strength and nature of the relationships (and their geography) will vary by context (for example industry to industry).

Methodology and Research Questions

In order to begin the evaluation of the framework, the role of the individual elements involved in the innovative activities of SMEs was examined in some detail, with particular focus on universities. This was done utilising data from SMEs in the UK; as such it inevitably reflects to a degree a specific socio-economic and institutional context, but the model itself is intended to have wider relevance such that it can be applied generally. Due to the exploratory nature of the research, a wide variety of variables arising from the literature review were tested using both bivariate techniques and regression analysis (see below for more detail on this). For reasons discussed earlier (e.g. Freel and Robson, 2004), innovation and growth are treated as discrete outcome variables within this research. The following basic hypotheses are posited in terms of the role of universities within this framework, both directly and indirectly in assisting the creation of enabling and/or diffusing mechanisms:

H1 Because of the typically easier access to local stakeholders than non-local, there will in general be a greater number of local links than non-local, including those of universities.

H2 Collaborative relationships between SMEs and the range of knowledge-generating /disseminating stakeholders (other firms, government and other agencies, research institutions and universities) will be positively related to both innovation specifically, and more general measures of growth.

H3 Because of the role of cross-locational networks in accessing enhanced resources for innovation and growth, there will be a stronger relationship between linkage with non-local stakeholders and innovation and growth than between more local stakeholders and innovation and growth.

H4 Due to the importance of the knowledge and innovation diffusion mechanisms highlighted in the framework, a positive relationship is expected between capacity to innovate (and growth

measures more generally) and levels of management and governance, education, training and learning, and use of structures / fora.

H5 With specific regard universities, because of the broader spillover benefits in accessing knowledge, in general a stronger relationship is expected between innovation and more locally based measures of management, education, training and learning, and structures / fora. Context-specific factors (e.g. sector, type of knowledge involved) are likely to be important.

H6 More generally, as the pursuit of innovation vs. growth outcomes is likely to involve potentially conflicting priorities for SMEs in terms of the utilisation and management of network resources, significant differences in results across these dependant variables are expected.

Measurable responses on SME innovation performance through standard indicators, notably inquiry regarding the introduction of products and services either new to the market or substantially modified, were gathered by means of a postal questionnaire. A self-rating of each SMEs capacity for innovation (on a scale of 1 to 10) was also obtained, as were measures of performance by turnover and employment during the 3 years prior to the survey. Of central importance were a range of questions relating to collaboration. These sought judgements from respondents, through use of the Likert scale and other quantitative indicators, concerning linkages with a range of stakeholders, enabling elements in terms of relationship types (e.g. formal and informal, associational club or network). Related management, education and training issues where also investigated, as was the geographical spread of linkages (between local, regional, national, and international) and the relative importance ascribed to enabling factors.

The survey was mailed to 3,600 firms, comprising 300 SMEs (defined as those with fewer than 200 employees) for each of the 12 standard UK regions. Ultimately 455 usable responses were received, representing a response rate of just over 14% (when firms that have ceased trading or have otherwise been identified as not applicable to this research are removed from the equation),[2] after the use of follow up letters, telephone calls, and the like. Whilst relatively low, this is in line with response rates experienced in other postal surveys of the general SME population in the UK (e.g. Brooksbank *et al.*, 2001). The survey was targeted at SMEs in industries likely to utilise innovations and knowledge management most extensively (as defined by OECD, 1999). Activities such as agriculture, retail, and

[2] Volatility within the business stock is a well-documented problem for SME research (e.g. Storey, 1999). Firms may also have simply moved, become part of a larger organisation, or have grown above the limit of 200 employees organically. A significant proportion of recorded non-response is therefore almost certainly due to questionnaires failing to reach valid targets, despite recipients being encouraged to inform researchers if this was the case. It was decided that such firms would not be replaced within the sample, due to the adverse effect this would have on the make-up of thereof.

public services were excluded because of low growth (agriculture), data reliability (retail) and absence of SMEs (public sector).

There was some small bias in responses towards larger firms, away from 'other business services' and towards knowledge-based services; there was no systematic bias in regional response and overall the authors are confident that the data is broadly representative of SMEs in the chosen sectors across the UK. In particular, there was no evidence that more 'successful' firms replied to the survey, the respondents representing a range of both negative and positive growth and innovation outcomes.

As mentioned above, statistical analysis of the data generated from the questionnaire survey took the form of both bivariate and regression techniques. The former was largely through correlations, which utilised the most appropriate statistic (pearsons or tau) for the data type in question (i.e. nominal, ordinal, or continuous), with 1-tailed significance tests undertaken at the 5% and 1% levels. Where applicable, difference of means tests were also used. Results are presented such that a positive association indicates a relationship consistent with the hypotheses outlined above, whilst a negative result indicates a relationship opposite to that predicted. We then build upon these preliminary results to construct appropriate regression models relating SME innovation and growth performance to structures for knowledge creation and dissemination, management, governance, and learning. Two regression analyses from the family of generalised linear models (McCullagh and Nelder, 1989) are thus used- one for innovation and one with growth as the dependant variable.[3] For the latter analysis linear regression is used because the dependent variable is measured as the percentage change in employment, with 65 firms having declining employment (thus negative percentages), 107 firms with no change in employment and 134 firms increasing employment. For the first analysis, the dependent variable is a count of the number of new products or services, with some firms returning zero values. Linear regression is therefore an inappropriate method here as it cannot guarantee that the predicted number of new products or services will be non-negative. Use of Poisson regression was also ruled out as the mean number of new products and services (4.45) is much smaller than the variance (232.5). Hence, negative binomial regression was chosen and implemented using the generalized linear modelling options in SPSS16.

[3] As noted, the dataset we use includes three potential measures of innovation- a count of new products and services introduced during the preceding three years , a count of modified products and services introduced, and a self-rating of innovative capacity. Growth is measured by percentage change in employment, and percentage change in turnover. Regression models (i.e. 5 in total) were constructed for each of these dependant variables, the 2 presented in full here being the best performing. Both analyses use as predictor variables the collaboration indicators (except "research institutes international" which is moderately correlated with some other predictor variables) and the "fora", "education and training" and "management and governance" variables (except "business social capital" which is also moderately correlated with some other predictor variables).

Results & Discussion

In terms of numbers of collaborative links between SMEs and stakeholders, Table 1 shows that the modal number of connections between SMEs and universities is one, compared to between 4 and 8 for SMEs and other companies, depending upon the spatial level involved. Most basically, this would suggest that when SMEs do have links with individual universities, these tend to be more concentrated and focused relative to their interactions with other firms, simply because the number of collaborative relationships is that much smaller.

Table 1: SMEs and Collaboration with other organisations, actors (Modal Number of Relationships)

For linkages with knowledge generating stakeholders (institutions, government, and industry), Table 2 results illustrate further that it is other companies that are most likely to be collaborated with, followed by financial advisors, with business support agencies and universities taking third position. Geography is important in terms of the intensity of linkages; generally with the more local the collaborator, the higher the percentage of SMEs collaborating. For universities specifically, this result confirms the evidence from Lambert (2003) concerning the use of local linkages, and is thus supportive of hypothesis 1. However, whilst local linkages are usually the more prevalent, it is the UK and international-level collaborators that are typically rated as being more important by the SMEs. This would appear to suggest the relatively high value for the SME of cross-locality networks and linkages; it should be noted though that for inter-company collaboration there is little variation in the importance ratings. One interpretation of this result is that, unlike other types of linkage, inter-company ones are essentially the same regardless of the level of geography over which they occur. This may be related to being predominantly economic / trade-related, rather than motivated by learning or the exchange of information.

Table 2: % of SMEs Collaborating with other organisations, institutions, etc. (Mean Importance 1-5 where 5 is greatest importance)

Whilst collaboration with universities and business support organisations rated lowest in terms of overall importance to firm performance, when collaboration was correlated to innovation measured in a variety of ways (in Table 3), there were strong, positive, and significant differences between the means of those

collaborating with universities (as for business support), compared with those not doing so, particularly in terms of the self-rated capacity to innovate (which was also the case for collaboration with other companies), as well as changes in products, though not the number of new products introduced. As noted above this may be because these linkages were more focused on innovation related activities directly, compared with other types of relationships, for example purely commercial.

Moreover, Table 3 shows a positive correlation between collaboration and innovation measures more generally (though statistically significant in only a relatively small number of cases). Conversely, whilst innovation measures are positively related to collaborations with universities and other research institutions, the relationship is negative for growth measures (excluding universities and employment growth) suggesting different types of knowledge and innovation flows in these relationships (i.e. supportive of H6). It should be noted however that none of the growth measures show any significant differences with respect to collaboration with actors of any kind. Thus, there is some support for the second hypothesis (H2), but this differs by stakeholder and performance measurement used. None of these relationships are particularly strong, however, suggesting the need to examine further the role of geography therein.

Table 3: Collaboration with Stakeholders against Measures of SME Innovation (Comparison of Means)

This is shown in some detail in Table 4. These results indicate, at a general level, greater positive and statistically significant correlation between the use of cross-locational networks and innovation and growth outcomes. In particular Table 4 seems to indicate the possibility that SMEs are obtaining limited but significant benefit (in terms of knowledge, innovation, and employment growth measures) from collaborations at wider than local levels, and particularly at the UK level. This is also supported by the final result which indicates that the greater the linkages with non-local networks, the stronger the positive relationship with measures of innovation and (employment) growth. There are also positive and statistically significant relationships for local and regional collaborations (particularly between company collaboration and innovation, financial advisors and employment growth, regional universities and product change and growth, other research institutions and innovation, business support and innovation and growth, business consultants and product change and output growth), but these relationships do not tend to be as strong as for wider collaborations.

Overall, this suggests that whilst local and regional links are more prevalent, there are stronger relationships between cross-locational collaborations (linked to a wider range of knowledge available at these higher geographical levels) and innovation and growth measures, thus supporting the third hypothesis (H3). Specifically, comparing involvement with universities across different levels (in Table 5) seems to indicate that SMEs are interacting with universities from outside their local and regional areas, particularly in terms of new product development and changes to products. The stronger relative showing of local universities in terms of general capacity to innovate and also in relation to employment growth may however also be suggestive of the use of local universities in more wide-ranging knowledge enhancing activities, as per H5 (and in parts of the literature, e.g. Oughton et al., 2002). Overall, the preliminary analysis presented suggests therefore that those SMEs undertaking relationships with universities (as well as with government business support and also other companies) may be gaining some advantage in terms of product innovation and growth from doing so. Moreover, there is also the possibility that less-formal knowledge flow methods are possible at more local levels than are formal collaborations, suggesting the need for more in-depth analysis regarding the issue of knowledge diffusion / enabling mechanisms.

Table 4: Correlation of Total, Local and Non-Local Knowledge-Creating Linkages against Measures of Innovation and Growth

Table 5 also shows how many of the enabling mechanisms are significantly and positively correlated with innovation-related outcomes for SMEs, though with varying degrees of strength and significance depending on the variable in question. Due to the benefits of proximity in accessing knowledge generally (i.e. in ways other than specifically through innovations and formal collaborations), one would expect a relatively strong relationship between capacity to innovate (and growth measures more generally) and linkages that are easier at a local level, in terms of measures of management, education, training and learning, and fora. The available data suggests that informal fora (including indirect relationships and information obtained outside of buyer-supplier relations) are indeed important, more particularly to innovation measures (both new products and changes to products), than to firm growth. Skills and knowledge related factors were positively, though only weakly, correlated with growth and innovation. If processes of management and governance are viewed in terms of 'business social capital', benefits from collaboration and trust of collaborators, a strong link can see between the building up of social capital and innovation and output growth, with measures of benefit and trust positively related to innovation capacity and new product development in particular. There is also evidence that managing knowledge through

face-to-face, telephone, and particularly IT-based interactions is positively related to innovation and (for IT) growth. Thus, support for hypothesis four (H4) is strong, but varies by the specific enabling factor in question.

The issues around IT-based interaction are probably related to the greater importance of cross-locational linkages in knowledge generation, but possibly also highlight the importance of utilising new technologies in the management of all knowledge interactions regardless of geography, (which may in turn make utilisation in ways that benefit growth outcomes easier). The *general* ability to gather external information is, however, positively linked to innovation measures, but again not growth.

Table 5: Correlations of Innovation and Growth related Measures against Enabling Mechanisms

The final research question focuses upon if and how universities can impact beneficially upon these knowledge diffusing factors, and thus where different types of university might focus their efforts. The results in Table 6 (which compare local, regional, UK and International University-SME collaboration) seem to highlight that for local universities, it is informal collaborations, and irregular, one-off transactions where most benefit is derived, with face-to-face interaction of most importance in those relationships. This suggests that it is in general milieu terms (and linked to agglomeration effects) that local universities are currently of most benefit to the innovation process. In comparison, SME relationships on a wider scale seem to be driven by the need to obtain information, requiring trust based (strategic) relationships, with much more importance necessarily placed on telecommunications technology as a way of conducting these relationships. For possibly similar reasons there is also increased importance placed on more formal fora (such as business clubs) and transactions (though not statistically significant) in these relationships. Finally, there is a much higher perceived importance of workforce knowledge and management skills within those SMEs conducting collaborations with international universities, though this might also be because they are typically in an early phase of the innovation/collaboration relationship. This suggests therefore that the support for hypothesis five (H5) may very much depend upon the type of knowledge and innovation being sought- i.e. the transfer of informal knowledge / milieu effects being associated with interactions at the local level, in contrast to more strategic information gathering.

Table 6: Universities against Enabling factors (comparison of means)

Table 7 summarises the hypotheses that we construct and test using the data and analysis we have presented. These are largely supported, but there is some considerable variation by type of performance measure in question, and by the nature and spatial distribution of collaborations and network structures employed.

Table 7: Summary of Hypotheses and Results

To conclude our analysis of the impact of collaboration and network governance structures on innovation and growth outcomes for SMEs, we construct 2 regression models as described in the methodology section above. Results from these are presented in table 8, and discussed below. Noticeably, collaboration with other non-local companies is a positive and significant factor for innovation (indeed, linkage with other firms below the UK level is a *negative* predictor of innovation). This result echoes that of Cooke *et al* 2005, and in part those of Asheim and Coenen (2006), and Asheim and Isaksen (2002) who also stress the value of balanced network relationships. Conversely, inter-firm collaboration is not significant for SME growth. The negative result for UK level financial investors and innovation is somewhat counter-intuitive; in contrast, the finding that growth is strongly linked to international investors is as might be expected given the typical focus of these relationships around employment creation rather than innovation (see for example Driffield, 2004). The observed outcomes for interaction with financial advisors are also broadly in line with expectations (i.e. the local particularly negative for growth, the international positive for innovation, again suggesting the value of cross-locality networks). There is moderate support for the role of universities- results are positive for both innovation and growth across all spatial levels, but only the coefficient for UK level collaboration in the innovation model is significant. This is a somewhat worrying result given the consensus around the potential role of universities in regional economic development (e.g. Susman 1990; Huggins and Cooke, 1996; Sargeant *et al.*, 1998; Lawton-Smith, 2003; Goldstein and Renault, 2004; Benneworth and Charles, 2004; Charles and Benneworth, 2005; Munday *et al.*, 2005; Harman, 2005; O'Shea *et al.*, 2006; Huggins *et al.*, 2008), and offers support to Frenz and Oughton's (2006) finding of very low levels of actual firm-university cooperation in the UK.

Results for interaction with business support intuitions are particularly interesting; working with local support services is important for SME growth, while it is UK-level activity that is significant for innovation. This is suggests that collaboration with national bodies is a course of action that is more effective for SMEs seeking innovation outcomes, while support from one of the Regional Development Agencies

(RDAs) is a good strategy for those firms attempting to grow. A plausible explanation for this result is that science and technology policy in the UK is largely level designed and implemented at the national level by the Department of Business Innovation and Skills, while more 'hands-on' business support (and grants for employment creation) is typically channelled via the RDAs. In fairly stark contrast to this finding, interaction with business consultants is a generally negative predictor- significantly so for innovation. We can only speculate on the possible reasons for this; it could be that firms which are struggling in some way will be the ones more likely to seek the services of consultants (i.e. the causation in fact runs in the opposite direction), though a similar argument could of course be made for firms making use of (largely public) business support services. In addition it could be that sector effects play a role, for example service firms making greater use of consultants, while on average introduce fewer new 'products' than their manufacturing counterparts.

Turning attention to findings relating to use of conduits and fora and network governance structures, a key result here is the importance for innovation of information obtained outwith 'normal' buyer-supplier relationships (including the importance of external information in general). This suggests that non-market based interactions (institutional, professional, but less so informal or social- see below) are indeed important predictors of SME innovation, as per Cooke *et al* (2005). Conversely, no significant results were obtained in relation to growth outcomes. Management and governance structures is the area that sees the greatest contrast between innovation and growth results for SMEs; face to face interaction and the importance of social contacts are significant predictors of firm growth, whereas the use of social contacts to gather business information is actually negatively associated with innovation- innovative firms rank tele-based interaction as an important factor. These results suggest caution should be exercised in over-emphasising the spatial proximity aspects of clusters at the expense of institutional or cognitive proximity (after Boschma, 2005). Moreover, these results confirm the findings of Freel and Robson (2004) and offer further support for H6 (i.e. that innovation and growth outcomes for SMEs are likely to be associated with differing usage of support structures) and indeed for Huggins and Johnston (2009) who show that 'knowledge networking' activities are sometimes negatively associated with SME growth. Finally, as might be expected, and supportive of the knowledge network paradigm in general, for both models the development of what respondents consider to be 'strategic contacts' was positive and significant.

Table 8: Regression Models for Innovation and Growth

Concluding Statement; Implications for Further Research

This paper has analysed the contribution of a range of actors in an SME innovation creation and dissemination framework by reviewing the role of universities and other institutions therein, exploring the role of networking and identifying the mechanisms required to operationalise such a framework. Results from the quantitative analyses are quite complex and uneven, dependent upon the nature of institutions involved, type of knowledge sought, and the spatial level of the linkages in place, but overall they highlight the value of cross-locality networks, network governance structures, and spillover effects from universities. In general, we find less support for the factors we specify in predicting SME growth outcomes than is the case for innovation, suggesting, at least in part, that different processes may be involved; The r-squared value of 0.22 obtained in the linear regression indicates that 22% of the variation between firms in percentage employment growth is explained by the included predictor variables. This is a relatively low value given the large number of variables used- the r-squared value implies there may well be other significant variables missing, at least for explaining employment growth. This is unsurprising, given that the majority of included variables are for various types and scales of collaboration and network interaction, but it does suggest some possible courses of action for further research; for example controlling for the possible differential effects of firm sector (e.g. Malerba, 2002), indeed it may be possible to extend such an approach to take supply chain or cluster membership into account; for example our finding regarding the negative impact on innovation of linkage with other firms based in the host region is, prima facie, somewhat at odds with the view of localised combinations of competition and cooperation driving economic performance (Porter, 1998). It is however possible that this finding could be reconciled by analysis which can effectively take into account whether any given firm is a member of a cluster or not.

Analogously, factoring regional effects into the model may also prove fruitful- it may well be that any kind of regional effect per se is less important than the observed variations in distribution of type of firm (or other institution) from region to region; there are (for example) certainly innovative firms with non-local networks in lagging regions (i.e. the host region itself does not preclude this), they are typically just less densely concentrated than in more successful regions. Further research in this area could confirm (or indeed reject) this supposition. Moreover, such a categorisation of regions could impact upon assumptions made regarding the qualities of local vs. non-local linkages; for example it is reasonable to hypothesise that for an SME located in London or the South East of England, local or regional linkages might provide access to a knowledge infrastructure that would not be available via similar structures in

more lagging regions. More generally, it is worth reiterating here that much of the literature around the role of networks, institutions and regional innovation systems is derived from the study of how these structures operate within certain exemplar regions- it is particularly important therefore for any framework operationalised to be able to deal with the differing nature of relationships within 'ordinary' regions. This is something that regional policy makers need to keep in mind if they are to avoid falling into the trap of pursuing cluster strategies that build up 'hard' infrastructure while neglecting the necessary softer factors we examine here (or similarly which are skewed towards upgrading internal firm resources at the expense of external i.e. network ones).

At the opposite end of the scale, differences created by internal firm-level factors also need to be explored. For example, an analysis examining (or at least controlling for) the impact of firm size upon collaborative behaviour could prove worthwhile. The framework as it stands does not explicitly link knowledge and innovation creation and dissemination with firm-level processes that commercialise innovation, and improve firm capacity and growth more generally. Individuals may fail to commercialise new knowledge (obtained for example via knowledge spillovers) through entrepreneurship if they under-invest in commercialization activities, or simply due to a lack of market knowledge (Audretsch, 2004). In order to exploit knowledge that is created and disseminated, entrepreneurs therefore also require appropriate personal 'knowledge' resources and management abilities, suggesting a need for evaluation of these internal individual / firm-level factors in addition to the external factors examined in the present study. Different types of university also play different roles in the knowledge generation and diffusion process. In particular there may be a key supporting role for local / regional universities in developing 'enabling factors', in addition to the knowledge creating role that seems more associated with universities at national and international levels. Moreover, potential mis-matches between the knowledge generating role of a given region's universities and the utilisation of this knowledge by the indigenous SME stock need to be understood better, and policy priorities addressed accordingly. This suggests the need for more coordination between universities, particularly at the regional level, if they are to play these dual roles (i.e. generation and diffusion) effectively. As highlighted for example by Gunasakera (2006), to play a full role in regional economic development, universities generally must participate in a number of fields, while still addressing the challenge of promoting and developing the enabling mechanisms necessary to generate and disseminate innovation.

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References

Amin, A., 1999. An institutionalist perspective on regional economic development. *International Journal of Urban and Regional Research* 23: 365-378.

Amin, A., and N. Thrift. 1995. Globalisation, institutional 'thickness' and the local economy, in P. Healey, S. Cameron, S. Davoudi, S. Graham, and A. Madani-Pour, eds. *Managing Cities: The New Urban Context*. Chichester, Sussex: John Wiley.

Anders, G. 1992. The changing role of the public university in local economic development. *Economic Development Review,* Fall: 76-79.

Asheim, B. T., and T. Coenen. 2006. Contextualising Regional innovation Systems in a Globalising Learning Economy: On Knowledge Bases and Institutional Frameworks. *Journal of Technology Transfer* 31: 163-173.

Asheim, B.T., and A. Isaksen. 2002. Regional Innovation Systems: The integration of local 'sticky' and global 'ubiquitous' knowledge. *Journal of Technology Transfer* 27: 77-86.

Audretsch, D. 2004. Sustaining Innovation and Growth: Public Policy Support for Entrepreneurship. *Industry and Innovation* 11(3): 167-191.

Audretsch D., and E. Lehmann. 2005. Does the Knowledge Spillover Theory of Entrepreneurship hold for regions? *Research Policy* 34: 1191-1202.

Benneworth, P., and D. Charles. 2004. University Spin-off policies and Economic Development in Less Successful Regions: Learning from two decades of policy practice. *European Planning Studies* 13 (4): 537-556.

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

Boucher, G., C. Conway, and E. Van Der Meer. 2003. Tiers of engagement by universities in their region's development. *Regional Studies* 37 (9): 887-897.

Braczyk, H-J., P. Cooke, and M. Heidenreich, eds. 1998. *Regional innovation systems: the role of governance in a globalised world*. London and Pennsylvania: UCL.

Branscomb, L.M., F. Kodama, and R. Florida. 1999. *Industrializing Knowledge: University-Industry Links in Japan and the United States.* Cambridge, MA.: MIT Press.

Brooksbank, D., L. Morse, B. Thomas, and N. Clifton. 2001. An Assessment of the management and practice of training for businesses in South East Wales, *International Journal of Applied Management* 2: 79–106.

Carroll, G. R., and M.T. Hannan. 2000. *The Demography of Corporations and Industries.* Princeton, NJ: Princeton University Press.

Charles, D. 2003. Universities and territorial development: reshaping the regional role of English universities. *Local Economy* 18 (1): 7-20.

Charles, D., and P. Benneworth. 2005. *The regional mission: The regional contribution of higher education*, London: Universities UK / Higher Education Funding Council for England.

Cherwitz, R., and C. Sullivan. 2002. Intellectual Entrepreneurship and Outreach: Uniting Expertise and Passion, *Journal of Higher Education Outreach and Engagement* 7 (3): 223-233.

Christie, M., P. Rowe and D. Pickernell. 2005. Economic Development: A Framework for Entrepreneurial Networks and Clusters. Paper presented at the *ICSB 50th World Conference*. Washington. D.C. June 15-18.

Clifton, N., R. David, and D. Pickernell. 2005. *Auditing Welsh Industry: A clusters based approach*. Cardiff: Welsh Assembly Government.

Cohen, M. D., and J.G. March. 1986. *Leadership and Ambiguity.* New York: McGraw-Hill.

Cooke, P. 1997. Regions in a Global Market: The experiences of Wales and Baden Wurttemburg. *Review of International Political Economy* 4 (2): 349-381.

Cooke, P. 1998. Introduction: Origins of the concept. In H.J. Braczyk, P. Cooke and M. Heidenreich eds. *Regional Innovation Systems – The Role of Governance in a Globalized World*. London: UCL.

Cooke, P., P. Boekholt, and F. Todtling. 2000. *The Governance of Innovation in Europe*, *Regional Perspectives on Global Competitiveness*. London: Pinter.

Cooke, P., N. Clifton, and M. Oleaga. 2005. Social capital, firm embeddedness and regional development. *Regional Studies* 39 (8): 1065–1077.

Cooke, P., M. Gomez Uranga, and G. Etxebarria. 1997. Regional Systems of Innovation: Institutional and Organisational Dimensions, *Research Policy* 26: 475-491.

Cooke, P., S. Roper and P. Wylie. 2003. The golden thread of innovation' and Northern Ireland's evolving regional innovation system. *Regional Studies* 37 (4): 365-379.

Davies, J., M. Hides, and J. Powell. 2002. Defining the development needs of entrepreneurs in SMEs. *Education and Training*, 44 (8/9): 406-412.

Driffield, N. 2004. Regional policy and spillovers from FDI in the UK. *Annals of Regional Science* 38 (4): 579–594.

European Commission. 1996. *Review Of Studies Into Innovative Fast Growing SMEs*, EIMS No. 42. Brussels: European Commission.

European Commission. 1998. A Common Definition of European SMEs. *Euro-Info* March. Brussels: European Commission.

Fernandez, E., B. Junquera and C.J. Vazquez. 1996. Government Support for R&D: The Spanish Case. *Technovation* 16: 59-66.

Florida, R. 2002. *The Rise of the Creative Class*. New York: Basic Books.

Freel, M.S., and Robson, P. 2004. Small Firm Innovation, Growth and Performance: Evidence from Scotland and Northern England. *International Small Business Journal* 22 (6): 561-575.

Frenz, M., and C. Oughton. 2006. *Innovation in the UK Regions and Devolved Administrations: A Review of the Literature*. Final Report for the Department of Trade and Industry and the Office of the Deputy Prime Minister. London: DTI.

Goffin, K., and R. Mitchell. 2005. *Innovation Management: Strategy and Implementation Using the Pentathlon Framework.* Basingstoke: Palgrave Macmillan Ltd.

Goldstein, H., and C. Renault. 2004. Contributions of Universities to Regional Economic Development: A Quasi Experimental Approach. *Regional Studies* 38 (7): 733-746.

Gordon, I.R., and P. McCann. 2000. Industrial Clusters: Complexes, Agglomeration and /or Social Networks. *Urban Studies* 37 (3): 513-532.

Grabher, G., ed. 1993. *The Embedded Firm: On the Socio-Economics of Inter-Firm Networks*. London: Routledge.

Granovetter, M. 1985. Economic action and social structure: the problem of embeddedness. *American Journal of Sociology* 91: 481–510.

Greig, F. 1997. Enterprise Training. *International Journal of Manpower*. 18(1/2): 185-205.

Griffiths, A., and R.F. Zammuto. 2005. Institutional Governance Systems and Variations in National Competitive Advantage: An Integrative Framework. *Academy of Management Review.* 30 (4): 823-842.

Guellec, D., and B. van Pottelsberghe. 2004. From R&D to productivity growth: do the institutional settings and the source of funds matter? *Oxford Bulletin of Economics and Statistics* 66: 353-378.

Gulati, R. 2007. *Managing Network Resources: alliances, affiliations and other relational assets*. Oxford: Oxford University Press.

Gunasekara, C. 2006. Leading the horses to water: The dilemmas of academics and university managers in regional engagement. *Journal of Sociology* 42(2): 145-163.

Harman, G. 2005. Australian Social Scientists and transition to a more commercial university environment. *Higher Education Research & Development 24*(1): 79-94.

Holden, R., and J. Hamblett. 2001. The Learning society and small and medium sized enterprises: empowering the individual? *Journal of Vocational Education and Training* 53 (1): 121-140.

Huggins, R., and P. Cooke. 1996. The economic impact of Cardiff University: innovation, learning and job generation. *Conference on Urban Universities and Cities*, Amsterdam, 27-29 March.

Huggins, R. 2001. Inter-firm network policies and firm performance: Evaluating the impact of initiatives in the UK. *Research Policy* 30 (3): 443-458.

Huggins, R., Johnston, A. and Steffenson, R. 2008. Universities, knowledge networks and regional policy. *Cambridge Journal of Regions, Economy and Society* 1: 321-340.

Huggins, R., and Johnston, A. 2009. Knowledge Networks in an Uncompetitive Region: SME Innovation and Growth. *Growth and Change* 40 (2): 227-259.

Jarzabkowski, P. 2005. *Strategy as practice: An activity-based approach*. London: Sage.

Jensen, C., and B. Tragardh. 2004. Narrating the Triple Helix Concept in Weak Regions: Lessons from Sweden. *International Journal of Technology Management* 27: 515-528.

Keast, R., and K. Brown. 2002. The Government Service Delivery Network: A Case Study of the Push and Pull of Central Government Coordination. *Public Management Review* 4 (4): 439-459.

Kirby, D.A. 2004. Entrepreneurship education: can business schools meet the challenge? *Education and Training*. 46 (8/9): 510-519.

Kitagawa, F. 2004. Universities and Regional Advantage: Higher Education and Innovation Policies in English Regions. *European Planning Studies*, 12 (6): 835-852.

Lagendijk, A., and R. Rutten. 2003. Associational dilemmas in regional innovation strategy development. E. Kuppers, R.Rutten, and F. Boekma. Eds. *Economic Geography of Higher Education: Knowledge Infrastructure and Learning Regions.* London: Routledge.

Lambert, R. 2003. *Lambert Review of Business-University Collaboration: Final Report.* London: HM Treasury, HMSO.

Lawton-Smith, H. 2003. Universities and Local Economic Development: An appraisal of the Issues and Practices, *Local Economy,* 18 (1): 2-6.

Leydesdorff, L. 2000. The Triple Helix: An Evolutionary Model of Innovation. *Research Policy* 29(2): 243-255.

Lowndes, V., and C. Skelcher. 1998. The dynamics of multi-organisational partnerships: An analysis of changing modes of governance. *Public Administration* 76(2): 313-333.

Lundvall, B-A. 1992. *National Systems of Innovation*: *Towards a Theory of Innovation and Interactive Learning.* London: Pinter.

McCullagh, P., and J. A. Nelder. 1989. *Generalized Linear Models*. 2nd edition. London: Chapman & Hall.

Malerba, F. 2002. Sectoral systems of innovation and production. *Research Policy* 31: 247-264.

Menard, C. 2002. *The economics of Hybrid organisations*. Presidential Address ISNIE 2002, MIT, September 29. Available at www.isnie.org.

Morgan, B. 2002. Higher Education and regional economic development in Wales: An opportunity for demonstrating the efficacy of devolution in economic development. *Regional Studies* 36 (1): 65-73.

Morgan, K. 1997. The learning region: Institutions innovation and regional renewal. *Regional Studies* 31(5): 491-503.

Munday, M., C. Jones, U. Kelly, D. McClellan, and I. McNicoll. 2005. *Aspects of the impact of Welsh Higher Education Institutions on the economy of Wales, Final Report*, London: Universities UK.

Narula, R. 2003. *Globalization and Technology: Interdependence, Innovation Systems and Industrial Policy,* Cambridge, UK: Policy Press.

OECD. 1999. *Science, Technology and Industry Scoreboard 1999: Benchmarking Knowledge-based Economies*. Paris: OECD.

Oughton C., M. Landabaso, and K. Morgan. 2002. The regional innovation paradox: innovation policy and industrial policy. *Journal of Technology Transfer* 27: 97-110.

O'Shea, R. P., T.J. Allen, A. Chevalier, and F. Roche F. 2006. Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities. *Research Policy 34*: 994–1009.

Pickernell, D., G. Packham, B. Thomas, and R. Keast. 2008. University Challenge? Innovation Policy and SMEs in Welsh Economic Development Policy: Towards a New Framework. *The International Journal of Entrepreneurship and Innovation* 9 (1): 51-62.

Porter, M. 1998. *On Competition*. Boston: Harvard Business School.

Powell, W.W., K.W. Koput, and L. Smith-Doer. 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Sciences Quarterly* 41(1): 116-145.

Reilly, K. 2003. The Engaged Institution, the Twenty-First Century, and the New University Extension. *Journal of Higher Education Outreach and Engagement* 8 (1): 29-36.

Reynolds, P.D., M. Hay, S.M. Camp. 1999. *Global Entrepreneurship Monitor*. Wellesley MA: Ewing M Kauffman Foundation Babson College.

Rhodes, R.A.W. 1997. From Marketisation to Diplomacy: It's the Mix that Matters. *Public Policy and Administration* 12: 31-50.

Rodriguez-Pose, A., 1999. Convergence or divergence? Types of regional responses to socio-economic change in Western Europe, *Tijdschrift vooor Economische en Sociale Geografie*. 90: 363-378.

Roper, S. 1997. Product Innovation and Small Business Growth: A comparison of the strategies of Irish, UK and German Companies. *Small Business Economics* 9: 523-537.

Rutten, R., and F. Boekma. 2004. 2004. The spatial dimension of inter-firm learning: case study and conceptualization, in P.Cooke and A. Piccaluga, eds. *Regional Economies as Knowledge Laboratories* Cheltenham: Edward Elgar.

Sargeant, A., E. Sadler-Smith, and A. Dawson. 1998. University Collaboration and Regional Economic Development– exploiting the potential. *Local Economy* 13(3): 257-266.

Simmie, J, J. Sennet, P. Wood, and D. Hart. 2002. Innovation in Europe: A Tale of Networks, Knowledge and Trade in Five Cities, *Regional Studies* 36(1): 47-64.

Schaeffer, P. and S. Loveridge. 2002. Towards and Understanding of Types of Public Private Cooperation. *Public Performance and Management Review* 26(2): 169-189.

Storey, D.J. 1999. *Understanding the small business sector*, London: Routledge.

Susman, N. 1990. The role of the technical university in area economic development: A review and appraisal, *Economic Development Review,* 8(Winter): 25-29.

Swan, J., H. Scarbrough, and M. Robertson 2003. The construction of 'communities of practice' in the management of innovation. *Management Learning* 33(4): 477-496.

Taylor, D.W., O. Jones, and K. Boles 2004. Building social capital through action learning: an insight into the entrepreneur. *Education and Training* 46(5): 226-235.

Thompson, G., J. Frances, R. Levacic, and J. Mitchell, eds. 1991. *Markets, hierarchies and networks: The coordination of social life.* London: Sage.

Veugelers, R., and B. Cassiman. 1999. Make and buy in innovation strategies: evidence from Belgian manufacturing firms. *Research Policy* 28: 63-80.

Weick, K.E. 1990. Organizational culture as a source of high reliability. *Californian Management Review* 29(2): 112–127.

Welsh, B. 1996. *Developing Managers for the Smaller Business: A Report on Training Development.* London: Institute of Management.

Westhead, P. and S. Birley. 1995. Employment Growth In New Independent Owner-Managed Firms In Great Britain. *International Small Business Journal* 13(3): 11-34.

Yeh-Yun-Lin, C. 1998. Success Factors Of Small and Medium Sized Enterprises In Taiwan: An Analysis Of Cases. *Journal of Small Business Management* 36(4): 43-56.

Table 1: SMEs and Collaboration with other organisations, institutions, etc. (Modal Number of Relationships)

	Universit-ies	Other Research Institut-ions	Other Compan-ies	Financial Invest-ors	Financial Advisors	Business Support	Business Consult-ant
Any Collaboration	1	2	8	1	2	1	1
Local Collaboration	1	1	5	1	2	1	1
Regional Collaboration	1	1	5	1	1	1	1
UK Collaboration	1	2	6	1	1	1	1
International Collaboration	1	2	4	1	1	1	1

Table 2: % of SMEs Collaborating with other organisations, institutions, etc. (Mean Importance 1-5 where 5 is greatest importance)

	Universit-ies	Other Research Institut-ions	Other Compan-ies	Financial Invest-ors	Financial Advisors	Business Support	Business Consul-tants
Any Collaboration	36.7 (2.71)	19.4 (2.94)	83.7 (3.91)	24.9 (3.14)	80.9 (3.51)	36.9 (2.66)	26.2 (2.99)
Local Collaboration	25.8 (2.53)	6.3 (2.76)	51.8 (3.80)	13.1 (3.14)	62.4 (3.52)	22.5 (2.68)	16.9 (2.90)
Regional Collaboration	12.2 (2.86)	5.4 (3.04)	42.8 (3.73)	6.6 (2.68)	19.5 (3.30)	17.4 (2.69)	7.0 (3.08)
UK Collaboration	7.7 (3.36)	11.5 (2.98)	51.5 (3.98)	8.2 (3.58)	13.6 (3.56)	6.1 (2.80)	7.0 (3.40)
International Collaboration	3.1 (3.0)	4.9 (3.29)	27.1 (3.89)	3.5 (3.70)	2.6 (3.27)	2.3 (3.0)	2.8 (3.33)

Table 3: Collaboration with Stakeholders against Measures of SME Innovation (Comparison of Means)

	Collab-orate with:	Universit-ies	Other Research instit-utions	Other Comp-anies	Finan-cial Invest-ors	Finan-cial Advis-ors	Busin-ess Support	Busin-ess Consul-tants
Number of New Products / Services	Yes	3.93	4.52	4.56	5.17	4.82**	5.68	5.32
	No	4.54	4.27	3.11	4.02	2.17	3.56	3.97
Number of Changes in Products / Services	Yes	2.93**	4.49**	2.35	2.47	2.31	2.72	3.06
	No	1.77	1.65	1.45	2.10	1.71	1.91	1.90
Capacity to Introduce New Products / Services	Yes	5.94**	6.32*	5.79*	5.88	5.70	5.91**	5.83
	No	5.50	5.50	5.05	5.58	5.46	5.52	5.61
Output Growth	Yes	0.7759	0.4066	1.1148	0.4681	0.6039	0.7937	0.4695
	No	1.2304	1.2215	0.8717	1.2726	2.8613	1.2298	1.2688
Employ-ment Growth	Yes	0.4217	0.3016	0.3677	0.5489	0.3401	0.4235	0.4150
	No	0.2893	0.3422	0.1724	0.2712	0.3200	0.2901	0.3116

**** = Significant at 1% 1-tailed level; * =significant at 5% 1-tailed level**

Table 4: Correlation of Total, Local and Non-Local Knowledge-Generating Linkages against Measures of Innovation and Growth

	Capacity to introduce New Products/ Services	New Products/ Services (Actual)	Change in products/ Services (Actual)	Output Growth	Employ-ment Growth
Knowledge Generating Factors					
Collaborate with other companies (any)	**0.105****	**0.165****	**0.084***	**0.002**	**0.085**
Collaborate with other companies (local)	0.01	0.077	0.038	-0.102*	0.004
Collaborate with other companies (regional)	0.053	0.158**	0.087*	0.010	0.076
Collaborate with other companies (national)	0.121**	0.22**	0.160**	0.014	0.102*
Collaborate with other companies (international)	0.202**	0.22**	0.208**	-0.012	0.137**
Collaborate with financial investors (any)	**0.049**	**0.081***	**-0.11**	**0.048**	**0.135**
Collaborate with financial investors (local)	0.053	0.061	-0.004	-0.023	-0.009
Collaborate with financial investors (regional)	0.003	0.001	-0.003	-0.018	-0.013
Collaborate with financial investors (national)	0.038	0.031	0.061	0.053	0.150**
Collaborate with financial investors (international)	0.013	0.043	-0.008	-0.033	-0.065
Collaborate with financial advisors (any)	**0.021**	**0.016**	**0.059**	**0.044**	**0**
Collaborate with financial advisors (local)	0.007	0.038	0.037	-0.035	-0.107*
Collaborate with financial advisors (regional)	0.045	0.002	0.051	-0.009	0.040
Collaborate with financial advisors (national)	0.166**	0.122**	0.127**	0.065	0.176**
Collaborate with financial advisors (international)	0.051	0.009	0.005	0.012	0.168**
Collaborate with university (any)	**0.076***	**0.045**	**0.091***	**0.121***	**0.087***
Collaborate with university (local)	0.085*	0.025	0.06	0.069	0.009
Collaborate with university (regional)	0.025	0.056	0.084*	0.113*	0.085*
Collaborate with university (national)	0.049	0.149**	0.226**	0.090	0.110**
Collaborate with university (international)	0.074*	0.082*	0.158**	0.051	0.087*
Collaborate with other research institutions (any)	**0.130****	**0.159****	**0.155****	**0.020**	**0.128****
Collaborate with other research institutions (local)	0.045	0.076	0.127**	0.047	0.006
Collaborate with other research institutions (regional)	0.068	0.10*	0.102*	0.048	0.080
Collaborate with other research institutions (national)	0.107**	0.123**	0.116**	0.064	0.145**
Collaborate with other research institutions (international)	0.081*	0.057	0.142**	-0.027	0.053
Collaborate with business support (any)	**0.057**	**0.086***	**0.088***	**0.017**	**0.186****
Collaborate with business support (local)	0.049	0.077	0.066	0.027	0.139**
Collaborate with business support (regional)	0.052	0.086*	0.159**	-0.17	0.118*
Collaborate with business support (national)	0.131**	0.091*	0.078	-0.020	0.106*
Collaborate with business support (international)	0.076*	0.057	0.099*	-0.019	0.10

…Table 4 (cont.)

Collaborate with business consultant (any)	**0.038**	**0.001**	**0.070**	**0.073**	**0.128****
Collaborate with business consultant (local)	0.052	0.035	0.108*	0.112*	0.038
Collaborate with business consultant (regional)	0.004	-0.012	0.026	0.048	0.092*
Collaborate with business consultant (national)	-0.003	0.003	0.025	0.073	0.080
Collaborate with business consultant (international)	0.001	0.033	0.085*	0.024	-0.001
Geography- based Measure:					
Overall linkage with non-local networks	0.094*	0.11*	0.111*	0.090	0.143*

*** = statistically significant correlation at the 5% one tailed level**

**** = statistically significant correlation at the 1% one tailed level**

Table 5: Correlations of Innovation and Growth related Measures against Enabling Mechanisms

Enabling Mechanisms:	**Innovation / Growth Measures**				
Conduits and Fora:	**Capacity to introduce New Products/ Services**	**New Products/ Services (Actual)**	**Change in products/ Services (Actual)**	**Output Growth**	**Employ-ment Growth**
Information exchange outside the buyer-supplier relationship	0.173*	0.204**	0.193**	0.081*	0.135*
Importance to performance of relationships-informal	0.047	0.093*	0.02	0.047	0.054
Importance- to performance of relationships - contractual	0.112**	0.077*	0.108**	0.026	-0.005
Importance to performance of relationships – arms length	0.079*	0.092*	0.054	-0.043	0.045
Importance to performance of relationships - indirect	0.053	0.101**	0.128**	0.022	0.075
Education and Training:	**Capacity to introduce New Products/ Services**	**New Products/ Services (Actual)**	**Change in products/ Services (Actual)**	**Output Growth**	**Employ-ment Growth**
Skills and Knowledge-rating	0.110**	0.024	0.067	0.079	0.063
External information Rating	0.128**	0.181**	0.207**	0.083	0.059
Technical Capacity Rating	0.162**	0.162**	0.199**	0.064	0.006

...Table 5 (cont.)

Management and Governance:	**Capacity to introduce New Products/ Services**	**New Products/ Services (Actual)**	**Change in products/ Services (Actual)**	**Output Growth**	**Employ-ment Growth**
Importance of Interaction-face-to-face	0.166**	0.128**	0.079*	0.127	0.043
Importance of interaction-telephone based	0.099**	0.100**	0.109**	0.021	0.033
Importance of interaction- IT based	0.099**	0.223**	0.246**	0.126*	0.115**
Develop Strategic Contacts	0.119**	0.174**	0.149**	0.086*	0.129**
Social Contact Rating	-0.05	0.063	0.014	0.180**	0.017
To what extent do you trust collaborators ?	0.079*	0.031	0.017	0.082	-0.04
To what extent collaborators benefited ?	0.139**	0.113**	0.106	0.058	0.067
To what extent has your company benefited (from collaboration)	0.155**	0.104**	0.119**	0.081	0.027
Business Social Capital	0.139**	0.155**	0.141**	0.132**	0.073

*** *= Significant at 1% 1-tailed level; * =significant at 5% 1-tailed level**

Table 6: Universities and Enabling factors (comparison of means)

	Firm Collab-orates with:	Any Univers-ity	Local Univers-ity	Regional Univers-ity	UK Univers-ity	Inter-national Univers-ity
Conduits and Fora:						
Information exchange with customers and suppliers outside the buyer-supplier relationship	Yes	6.30*	6.09	6.88**	7.64**	9.21**
	No	5.8	5.94	5.85	5.84	5.87
Importance to performance of relationships- informal business & social relationships	Yes	5.12*	5.13*	5.18	5.06	5.86
	No	4.59	4.67	4.73	4.76	4.75
Importance to performance of relationships- contractual as a regular customer or supplier	Yes	7.50	7.29	7.45	7.82	7.86
	No	7.39	7.48	7.42	7.39	7.41
Importance to performance of relationships- irregular or one-off transactions	Yes	5.05**	5.04*	5.59**	5.18	4.14
	No	4.34	4.45	4.47	4.55	4.62
Importance to performance of relationships- indirect via a third party intermediary	Yes	4.95	5.01	5.29**	5.58**	4.29
	No	4.25**	4.34	4.40	4.42	4.52
Education, Training and Learning:						
Performance- skills & knowledge rating	Yes	8.51	8.50	8.55	8.94	9.57*
	No	8.52	8.52	8.51	8.48	8.48
Performance- external info rating	Yes	7.31	7.18	7.78*	8.25**	8.71**
	No	7.05	7.13	7.05	7.05	7.09
Management / Governance Issues:						
Importance of interaction- face to face	Yes	7.57**	7.61**	7.58	7.82*	7.86
	No	6.91	6.99	7.09	7.09	7.13
Importance of interaction- tele based	Yes	7.39	7.43	7.67	8.15**	8.36*
	No	7.19	7.20	7.20	7.19	7.22
Importance of interaction- IT based	Yes	6.52**	6.39**	6.87**	8.21*	8.36*
	No	5.30	5.51	5.58	5.53	5.65
Develop strategic contacts?	Yes	6.12**	6.33	5.63	7.03**	8.07*
	No	4.91	5.04	5.33	5.23	5.27
Importance of professional and business clubs	Yes	4.34**	4.19	4.57*	4.69*	5.00*
	No	3.51	3.69	3.72	3.75	3.78
To what extent trust collaborators?	Yes	6.92	6.88	7.00	7.33*	7.79*
	No	6.85	6.87	6.85	6.83	6.84
How often in contact with key collaborators?	Yes	2.42	2.41	2.41	2.06*	2.14
	No	2.40	2.41	2.41	2.44	2.42

**** = Significant at 1% 1-tailed level; * =significant at 5% 1-tailed level**

Table 7: Summary of Hypotheses and Results

Hypothesis	Result summary
H1: greater use of local linkages	Supported
H2: collaboration associated with innovation and growth	Partially supported: differs by stakeholder and performance measure (more support for innovation than growth)
H3: non-local collaboration associated with innovation and growth more strongly	Supported: non-local linkages rated as of higher importance
H4: use of network governance structures associated with capacity to innovate	Supported: but varies by enabling factor in question
H5: local spillovers from universities associated with innovation	Partially supported: for general innovative capacity rather than specific innovations, dependent upon the type of knowledge sought
H6: divergence between innovation and growth results	Partially supported: more so for network governance structures than by type of institution collaborated with

Table 8: Regression Models for Innovation and Growth

	Model 1: innovation	Model 2: growth
(constant)	1.019	21.163
Knowledge Generating Factors:		
collaborate other companies local	-.012	8.922
collaborate other companies regional	-.389*	-30.688
collaborate other companies UK	-.029	17.256
collaborate other companies international	.601**	-8.595
collaborate financial investors local	.334	-8.052
collaborate financial investors regional	.528	-72.448*
collaborate financial investors UK	-.636*	-50.417
collaborate financial investors international	-.473	264.320**
collaborate financial advisors local	.233	-50.470**
collaborate financial advisors regional	.289	-17.693
collaborate financial advisors UK	.588*	44.074*
collaborate financial advisors international	.681**	-79.864
collaborate university local	.145	14.579
collaborate university regional	.148	15.322
collaborate university UK	.065*	13.083
collaborate university international	.075	0.027
collaborate other research institution local	-.073	-32.083
collaborate other research institution regional	.872	-18.926
collaborate other research institution UK	.304	-18.547
collaborate business support local	.024	31.434**
collaborate business support regional	-.281	-18.635
collaborate business support UK	1.046**	20.008
collaborate business support international	-.003	-42.680
collaborate business consultant local	.336	-2.324
collaborate business consultant regional	-.901*	-38.328
collaborate business consultant UK	-.879*	43.935
collaborate business	-.026	-140.404

consultant international		
Conduits and Fora:		
info outside buyer-supplier	.073**	-29.407
importance to performance of relationships-informal	-.006	-48.557
importance to performance of relationships-contractual	-.083	33.404
importance to performance of relationships- arm's length	.101*	-15.574
importance to performance of relationships-indirect	-.057	-10.301
Education and Training:		
performance- skills & knowledge rating	.080	36.817
performance-external info rating	.142**	10.634
performance- tech capacity rating	.045	3.591
Management and Governance:		
importance of interaction- face to face	.033	9.766*
importance of interaction- tele based	.097*	30.882
importance of interaction- IT based	.057	-32.346
develop strategic contacts	.100**	68.471**
performance- social contact rating	-.109**	8.168*
to what extent trust collaborators	-.079	-15.657

Summary stats: Likelihood Ratio Chi-Square = 108.411 at 43 degrees of freedom; significant at <0.001, n= 362 R squared = .22, n= 306

**** = Significant at 1% level; * =significant at 5% level**