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Business-to-Business Networking and its Impact on Innovation: Exploring the UK Evidence

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ABSTRACT
The paper reports the results of a systematic literature review that explored the evidence on networking and innovation. The review concentrated on articles published between 1980 and 2003 and from 628 it selected 179 that were rated highly. This paper explains the evidence as it relates to the United Kingdom and the implications for a country's innovation infrastructure more generally are highlighted. The study finds that firm's in the UK have a strong history of networking, that they are not as competent as competitors at leveraging value from networks and that the UK's network infrastructure requires further development.

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ABSTRACT

The paper reports the results of a systematic literature review that explored the evidence on networking and innovation. The review concentrated on articles published between 1980 and 2003 and from 628 it selected 179 that were rated highly. This paper explains the evidence as it relates to the United Kingdom and the implications for a country's innovation infrastructure more generally are highlighted. The study finds that firm's in the UK have a strong history of networking, that they are not as competent as competitors at leveraging value from networks and that the UK's network infrastructure requires further development.

EXECUTIVE SUMMARY

In 2003 the United Kingdom government began to explore how it could improve the country's ability to innovate. The paper outlines one study, a systematic literature review on networking and innovation, which contributed to this debate. Systematic literature reviews originate from medical sciences and are designed to improve the use of academic research in practice. They typically involve the adoption of repeatable, explicit methods for the collection, synthesis and application of empirical evidence relating to a particular problem. In the study reported the authors explore the evidence on business-to-business networks and seek to identify from prior empirical study how these contribute to forms of innovation. The evidence on which the study is based included 628 papers from which 179 were identified as having sufficiently strong empirical evidence on which to found conclusions. In this paper the data from 36 papers focusing on networking and innovation in the UK provide the main source of information. The evidence on the subject was found to be wanting in a number of respects. The majority of studies focused on high-technology industries with little focus on the service sector and study was spread out thinly across many disciplines and journals with little proof of critical mass.

The data on networking and innovation shows a number of conclusions that are valuable to practitioners. Diversity of collaborations across business systems (e.g. between industries or between science and industry) were found to provide a key source of innovation, the integration of suppliers during the early stages of product innovation was found to be essential for success and the role of customers early in the idea generation and development phase was confirmed. Third parties (e.g. professional associations) were found to play a crucial role in networked innovation acting as

neutral knowledge brokers and conduits for the diffusion of innovation between firms. In particular science partners were found to be essential when firms seek 'frame-breaking' innovation requiring detailed technical input. How firms manage and collaborate through networks was shown within the evidence to be crucial for successful innovation, as innovation has become more complex networks begin to hold greater strategic significance. The studies reviewed show that alliance structures, management competencies and strategic network management all have a bearing on the success of innovation within firms. It appears from the data that how firms are embedded in their locality and the links they have can also affect their capacity to innovate, however, current thinking on this issue is unclear.

As well as the general issues of significance to all firms the paper explored the specific networking practices in the United Kingdom (UK) and explored its network infrastructure. From the empirical evidence the paper concludes that firms in the UK have relatively strong relationships with firms in their direct market interface (e.g. suppliers). Likewise relationships between firms and science partners in the UK are considered to be strong comparatively to competitors. General weaknesses for UK firms revolve around the competencies of individuals and firms to leverage maximum value from networks and there was some concern over the extent to which finance networks work and how they support promising ventures. The overall networking infrastructure in the UK was also found to be limited in a number of respects. Many UK intermediaries had not acted in a neutral capacity and this had been found to be essential for the development of trust between parties and the formal infrastructure, such as incubators, was found to lack scale when compared to competitors. Based on these findings it was concluded that in the UK networking did contribute to innovation and UK employees and firms did engage within networks extensively. The paper found, however, that UK firms were not as competent as competitors at leveraging value from networks and that the UK infrastructure was not quite adequate to support networking activity.

INTRODUCTION

Policy makers, practitioners and academics in the United Kingdom (UK) have been engaged in a national debate about how to improve the country's innovation and productivity performance. In 2003 the debate focused on two initiatives, the Department of Trade and Industry's (DTI) Innovation Review and the Porter and Ketels' (2003) report. The Innovation Review, which was published in December 2003, involved a widespread consultation and sought to understand how the Government could act to increase innovation in the UK (DTI's Innovation Report, 2003). In addition to the Innovation Review, the DTI and the Economic and Social Research Council (ESRC) commissioned Professor Michael Porter and his team to conduct a review of the existing evidence on UK competitiveness. The resulting "UK Competitiveness Report" was published in May 2003. It argued that the UK had made progress in certain aspects of the economy over the past decade. Growth in labour force utilisation had been stronger than in Continental Europe, the UK's growth rate of GDP per capita had shown a rapid increase and trade and foreign direct investment levels had been high when compared to competitors. The Porter and Ketels' (2003) report, however, illustrated that there was still a large productivity gap between the UK and its major competitors such as the United States (US), France and Germany. In the study Porter argues that the UK economy is now in a transitional stage, and that the productivity and prosperity gap will widen if certain shortcomings are not addressed concluding that one of the major levers for change is to enhance the currently weak innovation capability of the UK (Porter and Ketels, 2003).

On 29th April 2003, leading academics, practitioners and policy-makers in the UK attended the first Advanced Institute of Management's (AIM) Management Research Forum titled 'Post Porter: Where Does The UK Go From Here? Delegates were presented a number of key questions about UK competitiveness. The report recommended a thorough review of all existing research relating to innovation and competitiveness in the UK. Nine AIM Scholars were selected to produce three 'evidence bases' on separate themes relating to innovation by conducting systematic reviews. This paper reports the results of one of these reviews, which was designed to analyse the extent to

which UK companies were engaged in networking activities and to explore how this contributed to their capacity to innovate (Pittaway et al. 2004a). The next section of the paper will explore how the systematic review was conducted before introducing the evidence base.

CONDUCTING SYSTEMATIC LITERATURE REVIEWS

The use of systematic literature reviews originated in medical research as a response to inadequate exploitation of academic research in practice, an experience shared by many disciplines (Trinder and Reynolds, 2000). The purpose of the approach was to avoid bias and error in making recommendations for practice by making explicit the assumptions underlying the review and by improving techniques for the inclusion of empirical evidence (Tranfield, Denyer and Smart, 2003). The method involves the collection, synthesis and application of empirical evidence relating to a problem being evaluated. By adopting a repeatable and clear approach to undertaking reviews systematic studies ensure comprehensive literature searches of published evidence and provide an *'audit trail of the reviewers decisions, procedures and conclusions'* (Tranfield et al., 2003). Such evidence-based approaches to literature reviews can now be found in many physical and social sciences (Petticrew, 2001). Although medical science has traditionally adopted a positivist orientation to systematic reviews, including for example meta-analysis of empirical data, other social sciences have adapted the approach in a way that takes into account different ontological and epistemological assumptions (Davis, Nutley and Smith, 1999).

Whilst differences between medical science and management research requires adaptation of the systematic review methodology, it can be applied to the management field in order to produce reliable studies, which can inform policy and practice (Tranfield et al., 2003). Until recently, however, the use of systematic literature reviews for informing policy in business and management research had been largely ignored. Cranfield Innovative Manufacturing Research Centre recently began to develop and adapt a methodology for evidence-informed management research using systematic literature reviews and their prototype was used to produce this study. The methodology

used for this study is, therefore, outlined in detail by Tranfield, Denyer and Smart (2003). Table 1 outlines the steps taken when conducting this particular study; these steps were both guided by the general methodology and adapted to the particular requirements of the subject (for further information see Pittaway et al., 2004a).

[Insert Table 1]

THE EVIDENCE BASE

In this paper a sub-set of the findings are presented exploring the relationship between networking and firms' propensity to innovate, focusing on the UK evidence. In the first stage of the review 628 papers were found by searching ABI Proquest, Science Direct and Web of Science citation indexes using the search strings developed (Pittaway et al., 2004a). From the broad data it is clear that networking and innovation have been studied in a number of fields within social science. The key journals contributing to the review illustrate the fields of study that have most to say about the subject. The top ten journals in terms of their coverage of this topic are reported in Table 2.

[Insert Table 2]

In addition to these journals the review sourced articles from another 47 journals. The papers reviewed were also analysed according to the countries that featured within studies. This analysis showed that 36 papers had empirical data based on the UK, 35 on the USA, 42 on other European Countries (Germany with 14 studies was the highest other European country included in the review), 11 were on Japan and 3 were on other countries (Australia; Brazil and Israel). The number of studies focusing on the UK is quite high providing a small but useful empirical base.

The thematic review of the papers presented in Table 3 shows that a large proportion of the articles reviewed focused on the firm level (micro) factors exploring how networks are managed and work in practice (57.7%), while a smaller proportion explore the macro or networking infrastructure that supports networking activity (42.3%). The evidence base is relatively recent, for example, from 1999-2003 93 papers were found on the subject while from 1981-1986 4 papers were

found. The analysis of the citations on networking and innovation also shows an upward trend between 1981 and 2003. The data illustrates that networking and its impact on innovation is a relatively new area of investigation and published work is, therefore, quite limited.

[Insert Table 3]

In summary, with regard to the overall sample of evidence, a number of key points can be made. The evidence base used in this study is somewhat dominated by a focus on technology and new technology industries and the research to date lacks some depth in terms of the limited number of studies that have been carried out. Research on the subject is also fragmented as it is spread across a large number of authors, journals and disciplines in social science, with only a small number of expert groupings, notably publishing in Regional Studies, Research Policy and the Journal of Business Venturing. The main conclusion drawn from the sample was that the subject area may require some prioritisation by a 'critical mass' of academics over a prolonged period if the evidence base is to be improved and expanded (Pittaway et al., 2004a).

The UK sample consisted of 36 empirical papers, which were supplemented by a further 15 articles. The overall picture of this data provides a useful way to assess the gaps in the UK evidence before introducing the detail. The key journals contributing to the UK evidence were Regional Studies (4); Journal of Business Venturing (3); Research Policy (3) and Technovation (3). The main key words were Innovations (10); Small Business (5); Research and Development (4); and, Technology Change (3). Table 4 presents the industrial analysis of papers comparing the overall evidence to that focusing specifically on the UK.

[Insert Table 4]

The base data highlighted here corresponds with the evidence overall. The top four journals are the same as those included in the overall sample and only one key word is different (Technology Change). The distribution of papers show that manufacturing industries have been studied more in the UK and high tech industries slightly less; neither difference is particularly profound and the high technology industries continue to dominate. There is some difference in the degree of study

focusing on electronics in the UK but this can be explained by the lower influence of the semi-conductor industry, which is perhaps less important in the UK than it is in Japan, Germany and the US. The UK evidence, similar to the evidence on networking and innovation overall, tends to be spread thinly across a large number of industries and lacks critical mass. In the following part of the paper the UK evidence is reviewed according to a number of key themes. The detailed implications are highlighted in the subsequent part of the paper. For the purposes of this study a network has been defined as: *"a firm's set of relationships with other organisations"* (Perez and Sanchez, 2002, p. 261) and innovation was defined using the DTI's definition; *"Innovation is the successful exploitation of ideas, into new products, processes, services or business practices, and is a critical process for achieving the two complementary business goals of performance and growth, which in turn will help to close the productivity gap" DTI's Innovation Report (2003, p. 8).*

NETWORKS IN THE UK MARKET INTERFACE

The general evidence on networks in the market interface shows that the involvement of suppliers in innovation efforts improves their chance of success, while including customers enables firms to identify opportunities for innovation (Pittaway et al. 2004b). The UK evidence on the subject is presented in Table 5 and shows the value of diverse partners and illustrates the importance of supplier and customer involvement during innovation.

[Insert Table 5]

Network and Partner Diversity

The importance of diverse partners within networks for innovation has been shown by a number of studies (Kaufmann and Tödtling, 2001; Romijn and Albu, 2002; Pittaway et al., 2004). In the UK Keeble et al's (1998) study shows how different types of technology-based firms in the Oxford and Cambridge regions benefit from international networks through the diversity of their relationships. Firms with an international technology orientation typically interact more with

research collaborators (23.5%) and research-led Universities (59.6%) when compared with firms that have a national orientation (11.8% and 45.7% respectively). Keeble et al's (1998) work illustrates that UK technology intensive firms that internationalise are particularly important in local regional networks and for the diffusion of innovation because they allow for the inward migration of new technologies from outside the UK.

Consequently, diverse partners and particularly international ones play a role in innovation networks (see Table 5). The current data on the diversity of partners shows that UK firms' networking capacity in this regard is as good, if not better, than other competing countries (particularly France and Germany). UK firms have been shown to engage customers in a variety of different ways, including marketing and research and development (R&D) collaborations (Bruce and Rodgus, 1991; Oakey, 1993). They have drawn in external contributors in key award-winning innovations (Conway, 1995) and have worked with suppliers extensively (Rothwell, 1991; Bruce and Moger, 1999; Romijn and Albaladejo, 2002). In conclusion the networking capacity of firms within the market interface is relatively strong in the UK but there are some variations between sectors (Bruce and Moger, 1999).

Supplier Involvement in Networked Innovation

The importance of networks between a firm and its suppliers has been shown to have important implications for innovation capacity, particularly where suppliers have direct engagement in projects from the outset (Ragatz et al., 1997; Perez and Sanchez, 2002; Pittaway et al., 2004). The involvement of suppliers has a direct impact on the likely technical success and market appropriateness of product innovations and it has been directly linked to firm's productivity performance (Conway, 1995). Supplier involvement in UK networks is generally positive Rothwell's (1991) study, for example, illustrates that innovative small manufacturing firms have obtained many technical inputs from other companies. Many of these firms have collaborated through joint R&D ventures and sub-contracted R&D. Other innovations and links have occurred that do not have any overt technical content. In the study firms gain access to market know-how via

marketing links and collaborations. Small firms were also shown to lessen the risks of product innovation by collaborating with other co-suppliers (Rothwell, 1991). Conway's (1995) and Romijn and Albaladejo's (2002) work support this view providing evidence of UK firms working extensively with suppliers when innovating. Bruce and Moger's (1999) study of the clothing industry does, however, suggest that the effective integration of suppliers in innovation in the UK might be lower in some industries than others.

Customer Involvement in Networked Innovation

The value of customer involvement in incremental innovation has been shown (Von Hippel, 1978; Freeman, 1982; Ragatz et al., 1997). Customer networks are important during the early stages of innovation when ideas and opportunities are first explored (Walsh, Roy and Bruce, 1988). For example, in Bruce and Rodgus' (1991) study of 48 suppliers in the UK enzyme industry, 73% of companies involved the customer in idea generation and problem solving, while 64% involved them in product testing. Conway's study (1995) of 35 successful innovations also found that customers were crucially important at the idea generation stage of the innovation process. UK companies that stated they received essential information from customers were more successful with technological innovation and had greater commercial success when the innovations came to market (Conway, 1995).

In Oakey's (1993) study the strong bonds between small UK biotechnology companies and principle customers was considered to be beneficial and supportive of innovation but risks were also identified. It was shown that a strong contribution to innovation and growth from small firms in this industry was unlikely due to its sophistication and cost base. Both small and large firm executives viewed the networking behaviour of large firms as a formal strategy for keeping a watching brief on their smaller suppliers for possible future acquisition. This was considered optimal for two reasons. Firstly, strong patronage or a small equity stake allowed the small firm to develop in an independent state during formation and growth which enabled it to gain the advantages of small size. Secondly, if the enterprise eventually proved to be a success the

technological and human assets could be obtained through acquisition at a lower cost than would be involved with developing the technology.

Consequently, the empirical evidence on the involvement of business customers in innovation in the UK shows a mixed picture. UK high technology industries appear to be good at involving customers in their innovation efforts particularly at the crucial stages of idea generation and opportunity recognition. Weakness in the UK revolves around the strategies of larger firms; particularly where collaboration is used purely as an acquisition strategy to avoid internal R&D expenditure. The evidence on UK biotechnology firms suggests that such network relationships can lead to lower R&D investment levels in larger firms reducing their capacity to innovate internally.

THE NETWORKING INFRASTRUCTURE

The Role of Third Parties

The role of third parties (e.g. professional associations) in network infrastructures shows that they can act as neutral knowledge brokers for the development of informal relationships (Pittaway et al. 2004b). Study in the UK confirms this general view suggesting that firms offering business services to other firms (e.g. accountants) and trade associations play the most important roles (Bryson, Keeble and Wood, 1992). Other intermediaries like consultants are important where problems emerge requiring process innovations and professional associations have had both positive and negative effects on innovation diffusion (Swan, Newell and Robertson, 1999). The studies reviewed suggest that intermediaries play a more important role in the UK's networking infrastructure than formal support mechanisms such as publicly funded business support (Curran et al. 1993). It must also be acknowledge, however, that such intermediaries rarely play a neutral role in network infrastructures and they may be less effective at network brokerage than other publicly sponsored organisations (Robertson, Swan and Newell, 1996).

One study examined the role of consultants as network participants and their influence over the innovation process (Bryson, Keeble and Wood, 1992). Detailed interviews were carried out

with 120 small business service firms including management consultancy and market research firms. In the study they analysed informal networks, including demand-related (those associated with clients and obtaining new business), supply-related (where firms are able to satisfy specific client demands) and networks associated with support functions (for example, links with the banks or business advisers). The findings of the study show that personal networking behaviour is essential in business services and these firms act as an important node in network infrastructures.

Trade associations are a key intermediary in many sectors undertaking conventions, providing members with resources and organising meetings. The UK evidence on the value of these intermediaries within networks is perhaps a little limited. One study examined the role of trade associations (Curran et al., 1993) in networks for smaller firms. It focused on printed circuit board manufacturers, computer services, tool hire, hotel and guest houses and hairdressing. Overall 110 business owners were interviewed, of these 60 were members of trade bodies. The research identified that membership of trade associations was high in some sectors, notably PCB manufacture and tool hire, while it was low in others. Trade associations in the UK had a varying degree of enthusiasm for the inclusion of small firms and did not always encourage networking benefits. Such associations, however, were identified as being more successful in the promotion of support networks in the UK than their formal counterparts.

Like their trade equivalent professional associations can play an important role in network infrastructures (Robertson et al. 1996). Much of the role played by such associations can be through the promotion of informal networking and the diffusion of innovation via events and continuous professional development. The evidence on the networking role of professional associations in the UK is relatively limited (Swan, Newell and Robertson, 1999). The study by Swan, Newell and Robertson (1999) examined the UK's approach to networking in professional associations by exploring the diffusion of Computer Aided Production Management (CAPM) technologies and compared this activity to the approach of professional associations in France, The Netherlands and Sweden. The study used a survey which explored various aspects of the adoption

of CAPM and the influence of professional associations on diffusion. The survey covered 1846 firms including 350 from the UK and the researchers conducted interviews in addition to the survey. UK firms tended to adopt more standardised packages than other nations but this did not link to adoption success. Adapting standard packages forced the UK firms to change their operational systems to fit the software, whereas firms elsewhere tended to take more time in implementation to adapt the systems to their particular operational requirements. This was explained by the different way in which the professional organisations in the countries operated. In both the UK and France firms adopted standardised packages but the French firms had more success. In France the professional association held formal events but invited fewer supplier-members and had more informal discussion and networking. In the UK there was more uncritical technology push from suppliers and the professional association, formal events were held; MRP2 was promoted as the 'best practice' CAPM design above alternatives. The use of the professional association to push the interests of suppliers was not tempered by informal discussion over practical problems implementing the technology. The UK professional association consequently tended to promote a 'fad or fashion' in 'best practice' without considering the difficulties associated with implementing the new technology. The association did not actively facilitate informal networking and learning that could have led to more effective implementation of the technology. In the study the UK professional association may also have played a key role in the moderate success of the technology in the UK when compared to other countries (Swan, Newell and Robertson, 1999). The evidence shows that the one professional association studied in the UK was less effective at supporting the diffusion of innovation through networks than its counter-parts in other countries but obviously further empirical research on the subject is needed before any major conclusion can be drawn.

In conclusion the role of third parties in the networking infrastructure in the UK has been under-researched for any general conclusions to be made. For example, there is little evidence in the review on the role of Chambers of Commerce, which is surprising, and not enough on associations, particularly on the role of trade conventions. The current evidence shows that these

intermediaries are considered to be important within the network infrastructure especially for small firms. The evidence also presents some concerns, both trade and professional associations have been seen to be 'exclusive' in someway. They have either not been welcoming of smaller firms or they have pushed the particular interests of one type of technology above another. Given that neutrality and trust have been found to be the key requirements for successful network brokerage, UK associations may need to be more careful about how they balance the interests of their members.

The Role of Science Partners

Science partners acting as intermediaries in networks contribute to innovation by assisting the development of informal-personal networks and by enabling firms to develop thinking that steps outside of existing business systems (Verspagen, 1999; Bougrain and Haudeville, 2002). Research focusing on relationships between UK firms and science partners is considerable and it has recently been the focus of a major policy review (Lambert Review, 2003). For example, Shaw's (1993) study shows that entrepreneurs have needed to link to a variety of science/public sector partners. As well as the 20 universities and hospital schools that were linked to the 34 innovations, the Medical Research Council (MRC), the Department of Health, the British Technology Group (BTG), the Department of Trade and Industry were all found to act as important intermediaries enabling the innovations to be commercialised. Likewise Rothwell's (1991) study shows that UK small firms in manufacturing have benefited greatly from links to science and technical partners. Many radical innovations in these firms have been derived from external sources and these were often associated with the employment of graduate engineers and scientists or via interaction with public sector R&D laboratories. Incremental innovations in contrast arose more frequently from inside the firm. The great majority of UK firms studied were proactive in seeking networks; although often the catalyst was problem-based.

The evidence in Rothwell's study is also supported by Collinson and Gregson's (2003) where they compared Connect Scotland, The Austin Technology Incubator (US) and the Canadian

Environmental Technology Advancement Corporation (Canada) showing that science partners have been making important contributions as intermediaries in networks in the UK, US and Canada. In the study it is suggested that these network forms should be further encouraged and can develop more in the UK context; both CETAC and ATI were more effective at nurturing new technology-based businesses than Connect. Consequently, the studies illustrate relationships between firms in the UK and science partners are relatively comprehensive, particularly within high-tech industries and this finding is confirmed by the Lambert Review (2003). Interactions based on student placements and projects have been beneficial to firms and these are viewed as effective methods for accessing the science base. Also within this section the role of personal networking and informal relationships was highlighted as crucial for assisting innovation within these forms of relationship (Ebadi and Utterback, 1984; Fritsch, 2001).

The Role of Venture Finance Partners

Finance networks are important for the commercialisation of innovation and co-investment has been shown to provide better quality investments and larger funds for high growth businesses (Bygrave, 1987; 1988). The current evidence does not support the existence of coordinated mechanisms and cooperation in UK finance networks. All regions have schemes to support informal venture capital, for example, through the National Business Angel Network (NBAN), Business Links and business angel syndicates. The British Venture Capital Association figures illustrate that the existence of business angels is increasing in the UK (Harding, 2000). Currently there are about 18,000 business angels across the UK investing over £500 million in approximately 3,500 companies (Harding, 2000). The importance of networks amongst the business angel population is highlighted (Mason and Harrison, 1995). Informal investors obtain most of their information on investment opportunities from friends and business associates. Business angel's networking opportunities can be raised by government agencies if they act as network brokers. Analysing the UK business angel networks Mason and Harrison (1997) conclude that syndicated deals with other registered angels account for around 25% of total investments, while a further 10%

were with other equity investors, which does not compare favourably with the US (Mason and Harrison, 1997). Where syndicated deals among business angels happen, levels of funds for expanding businesses have increased, but there is still a need for further public support for the establishment of such networks (Harding, 2000). A review of the DTI's projects on informal investment by Harrison and Mason (1996) did show that intervention in these networks can work. The study reviewed five informal investment demonstration projects undertaken by the DTI and found them to be successful. The findings show that the five projects facilitated 64 investments worth £3.7million and the projects were able to leverage other networks including finance from the banks, other business angels and helped create other networking opportunities between investors and entrepreneurs.

The key finding of the work on UK business angels when compared with US counterparts is that the UK can benefit by strengthening the role of business angel networks but that this must be done on a local (sub-regional) level. Further, that encouraging syndicated investments can improve the quality of the investment and the amount of funds available to entrepreneurial firms (Bygrave, 1988). Networks are viewed as essential for assisting syndicated approaches and therefore are essential in the investment infrastructure.

The UK evidence on the formal venture capital network infrastructure was rather more limited. The US data suggests that relationships between venture capital companies are essential for encouraging co-investment (Bygrave, 1987) and that co-investment can be linked to greater success in entrepreneurial businesses and for VCs themselves (Bygrave, 1988). It is clear that networked approaches to investment: spread risk; engage more people around the venture assisting learning; encourage larger funds to be invested in appropriate ventures; create greater network opportunities; and, enable entrepreneurial firms to grow more quickly. Consequently, this is a subject that requires further study in the UK.

The general evidence on how institutional mechanisms can assist the innovation process is inconclusive (Staber, 2001). It does show that these mechanisms can assist innovation via networks

but how they do so remains unclear (Phillimore, 1999). The UK data, for example, illustrates some successful attempts at creating clusters via networks in Tyneside but there has been less success in Leeds (Shutt and Pellow, 1998). The UK operates approximately 50% fewer regional incubation units than France and Germany (Albert, Bernasconi and Gaynor, 2002) and the evidence base illustrated that in South London the support infrastructure had failed to create links between engineering firms (Kitching and Blackburn, 1999).

Industrial Districts and Clusters

The concept of industrial districts or clusters featured strongly in the Porter and Ketels' (2003) report and it was argued that the UK had a relatively weak set of clusters. None of the data in this study was designed to directly address this question, however, examples of UK attempts to create clusters via networking were found. Shutt and Pellow's (1998) study, for example, explores the developments of three urban regions in the north of England and the attempts of economic development agencies to promote business networking. In north Tyneside the study examined the work of the 'Real Service Centre', a partnership between local authorities, business links, Training and Enterprise Councils (TECs) and Newcastle University, which was designed to create services for specific industries. In Sheffield attention was focused on the 'cultural industries' where promotion of the sector brought together 140 businesses. In Leeds the study focused on the Leeds Financial Services Initiative which in the 1990s bought together firms from engineering, printing and the media. The results of the study were mixed; it showed that in north Tyneside some networking and innovation benefits had accrued to the marine technology sector. In Sheffield the clustering appears to have been successful but in Leeds clustering success in the engineering sector was disappointing. The value of clusters for promoting innovation via networks, in this study, was consequently rather limited.

Incubators

The UK in recent years has made considerable effort to improve the incubation infrastructure for start-up firms. The policy has been supported by the Regional Development

Agencies who have made large investments in new incubation facilities. The main role of these incubators has been to provide dedicated space and support services for start-ups particularly high-tech ones, however, they also play an important role in networks. The quality of an incubator, however, largely depends on the quality of the network it can mobilise and consequently offer to prospective clients (Albert, Bernasconi and Gaynor, 2002) and this has not been widely acknowledged or addressed within the UK. A study carried out by Albert, Bernasconi and Gaynor (2002) shows that incubation does not contribute at the same level to the UK's networking infrastructure as it does in France and Germany. The report published by the United Kingdom Business Incubation (Small Business Service, 2001) confirms this view and illustrates that the UK has some way to go if it is to create a policy that promotes the development of sufficient incubation space. The management of such space is also identified as essential, if an incubator does not utilise local networks and encourage the establishment of further networks, as well as, providing space and support services they may not be as effective as they could be for supporting innovation (Albert, Bernasconi and Gaynor, 2002). However, there was no evidence found in this review that focused on the role of incubators in the creation and maintenance of local networks and this would appear to be a priority for future research.

THE MANAGEMENT OF NETWORKS

The evidence on the management of networks shows that a firm's experience and competence when managing its networks can have a direct impact on its innovation and productivity performance (Coles et al. 2003; Ritter and Gemünden, 2003). The general evidence highlighted the role of network management in translating activity into innovation outcomes but the UK evidence on the subject is limited. Overall it tends to focus on links between small and large firms than on the management of networks within firms (Rothwell, 1989; Curran and Blackburn, 1992). Consequently, the current findings need to be considered cautiously. They do show, however, that UK firms have tended to rely on the networking capabilities of too few individuals in

their relationships with other firms and that contacts have been too short-term being one-off and intermittent (Curran et al., 1993). This is of concern within the UK because the general evidence supports the view that networks are more effective at leading to innovation where they are relatively stable and long-term (Gemünden, Ritter and Heydebreck, 1996; Pittaway et al. 2004b).

The Management of the Small Firm – Large Firm Interface

Studies exploring the links between small and large firms confirm the general impression that collaboration between firms in the UK tends to lack stability being driven by short-term decision-making (Rothwell, 1989). An investigation into the economic and social networks of small firms, for example, with a particular focus on their links with large firms and public sector organisations was carried out by Curran et al. (1993). Owner-managers from 60 small printing and electronics firms were interviewed, as well as, 8 representatives from local large organisations. Relations between firms depended on personal links and were often broken because of changes in personnel. Although word-of-mouth was the most common way in which small firms obtained business from large firms in the UK such contacts tended to be haphazardly activated rather than being embedded in existing local networks. Latent networks existed but firms put little effort into promoting and maintaining them.

Rothwell's (1989) earlier study of inter-firm relationships supports this view of network relationships in the UK. The work shows that large and small firms play complementary roles in the innovation process and that there is considerable variation between sectors in these relationships in the UK context. Rothwell (1989) highlights that public sector organisations can play an important role in brokering relationships that are essential if innovation is to occur and that in the UK this does not happen particularly well[†]. Rothwell's (1991) subsequent study examining the UK manufacturing industry finds that small firms collaborate with large firms in a variety of different ways, including for example, subcontracting relationships, licensing agreements and joint-ventures, but that these practices are not as widespread in the UK as elsewhere, particularly the US.

[†] With the exception of particular industries notably medical equipment manufacturers, pharmaceuticals and defence technologies

The UK evidence on small-large firm inter-relationships needs to be developed further. For example, the study of corporate venturing is well covered in the literature but there is only limited empirical evidence relating to the UK (Miles and Covin, 2002). Larger firms can have considerable impact on a locality through their relationships with other firms, especially ones based on venturing and the UK's performance in this regard is unclear although current evidence does suggest it might be weak.

Network Configuration and Behaviour

Once again the UK evidence on this subject is relatively limited, firms are equally involved in networks as their US counterparts but the relationships tend to be more focused on fewer individuals and are not 'leveraged' for business purposes to the same extent.

The size of entrepreneurs' direct contact networks in Northern Ireland was found to be less broad than the US (Birley, Cromie and Myers, 1991). The evidence suggests that the more informal approach to decision-making in businesses in the US have contributed to the creation of more extensive personal contact networks. Although personal contact networks were smaller in Northern Ireland entrepreneurs tended to spend equal amounts of time maintaining the contact network as US entrepreneurs. Networking activity did, however, occupy a significant place in the working lives of Northern Ireland entrepreneurs. Entrepreneurs made contact with each of their 5 most widely used contacts about 11 times per month and had known them on average for about 8 years. The study concluded that policy makers should aim to increase the size of contact networks in the UK and help improve the knowledge and skills of entrepreneurs in operating them (Birley, Cromie and Myers, 1991).

Ostgaard and Birley's (1994) study examined the personal networks of entrepreneurs and their links to the strategic makeup of the business. The study was carried out in two English Counties, Cambridgeshire and Avon and focused on three industries: manufacturing, engineering and software. It initially examined 317 firms in Cambridge and 232 in Avon but worked on a sample of 159 firms. The study showed a number of different networking strategies in UK small

firms including, marketing differentiation, product innovation, market segmentation, distribution, growth through outside capital and differentiation through quality. Drakopoulou Dodd (1997) further explores the relationship between personal networks and entrepreneurial behaviour by examining data from the British Household Panel Survey. The data show that membership of social groups is higher for business owners (8.19) than for wage and salary earners (7.8). The study further illustrates that 8 out of 10 owner-managers have high levels of involvement in social networks in the UK and exhibit higher levels of participation (7.93) than the employed (6.7).

Overall the evidence on network configuration concentrates mainly on UK entrepreneurs and their personal networking strategies. Wider studies on network configuration, however, have been more far reaching examining: innovation pathways; alliance structures; information diffusion; network trajectories; and, structural issues associated with network change (Grandori and Soda, 1995; Coles, Harris and Dickson, 2003). There is consequently a need for further UK research on these issues**.** The UK evidence does suggest, however, that entrepreneurs tend to have less wide and less dense personal networks than their US counterparts and some studies do suggest that further educational support might be required; although how this could be achieved practically is unclear (Birley, Cromie and Myers, 1991). It is just as possible that because there are fewer opportunities for useful commercially applicable networking UK entrepreneurs tend to engage less.

LOCAL AND REGIONAL EMBEDDEDNESS OF NETWORKS

The embeddedness of networks in localities is important for the establishment and maintenance of informal networking behaviour; which itself has been shown to be essential for innovation (Love and Roper, 2001). There is little agreement about how regions might support such embeddedness, although inward investment has been identified as being an important factor (Grabher, 2001).

The evidence on local support and the local embeddedness of networking in the UK is reasonably extensive when compared with evidence on other themes. It shows that certain industries in the UK such as the advertising industry have had significant success as a consequence of innovation within networks (Grabher, 2001). The evidence confirms the role of the formal support infrastructure for promoting and establishing networking behaviour; although some of the data show that it has not been particularly successful at supporting informal networking activity (Smallbone, North and Leigh, 1992).

The Business Support Infrastructure

Smallbone, North and Leigh's (1992) investigation into the business support infrastructure and its impact on networking examined a panel of firms from 1979-1990 in 8 manufacturing sectors; interviews were carried out with 306 firms. Work was also been carried out by Bennett and McGoshan (1993). Some of the key findings show that 55% of firms had received some substantial form of external assistance; paid consultants were the main form used (52%) while 17% received help from banks (Smallbone et al. 1991). Trade associations (8%) had a relatively low use, while 21% of firms had received assistance from public agencies (Smallbone et al. 1991). The study highlighted the case for strengthening support networks, 25% of firms were able to point to examples of problems where external assistance would have been useful but was not available (Smallbone et al. 1991; Bennett and McGoshan, 1993). Likewise Atkinson's (1994) study of 3,289 firms in Cornwell, Shrewsbury, Brighton, Manchester, Newport and Slough shows that that formal and informal support networks are used extensively by small firms when seeking information about employment-related concerns.

The importance of local business-to-business networks for business support in the UK is also highlighted by Gibb (1993) in his review of policy support for small businesses. The author places particular emphasis on networking between small businesses themselves and between the agencies supporting them and illustrates the UK's relative poor performance in this area. Bennett and McGoshan (1993) examine national surveys conducted with 84 Chambers of Commerce and

244 enterprise agencies and suggest the gaps include an uneven distribution of support agents reflecting a wide range in the quality of support networks and considerable overlap between agents in the delivery of services whilst leaving strategic gaps.

These studies show that in the UK the public sector support infrastructure under-represents certain firms (especially those employing less than 10 employees) in networks and that the role of banks and accountants is essential because they act as a node of entry into some business-to-business networks. Kitching and Blackburn (1999), for example, study small mechanical engineering firms in Stuttgart (Germany), Aarhus (Denmark), and South London (England) and show that the limited networking between small-business owners and training providers in South London can be explained by a lack of embeddedness of UK small engineering firms in the institutional framework supporting business. The absence of a critical mass of engineering businesses, the limited experiences of business owners and the weak business-support network in South London are mutually reinforcing.

The data on formal support highlighted here is perhaps too out-of-date to draw any general conclusions on UK business support in 2004. A number of major changes have occurred including the foundation of the Small Business Service and the dissolution of Training and Enterprise Councils (TECs) since these studies were undertaken. The data do illustrate, however, that business support in the UK has generally underperformed when seeking to create and support informal networks.

The Importance and Performance of Regions

The UK's disparity in regional economic performance featured strongly in the Porter and Ketels' (2003) report on UK competitiveness. The study illustrated that the persistence of prosperity differentials across the UK indicated a failure to overcome the differences in the quality of the business environment across regions. This is illustrated effectively in the data from Cantwell and Iammarino's (1998) study. In terms of networking it appears that UK regions differ

substantially and this can in part be explained by the effectiveness of networking infrastructures in regions and the part played by larger firms including the role of foreign inward investment.

Cantwell and Iammarino (2000), for example, show that the effects of foreign inward investment is positive at both the national and regional level but highlight that it is dominated in the UK by one region the South East. They examine the regional differentials affecting the networking infrastructure and find considerable disparities. For example, Multinational R&D expenditure is dominated by the South East which is 3.4 times the nearest other UK region (North West). Multinational R&D personnel are dominated in the South East which is 3.5 times the nearest other UK region (North West) and the UK Government spend on research grants in higher education institutions by region (1994-1997) also indicates the dominance of the South East (39.9%) which is 3.2 times the nearest other UK region (Scotland). Cantwell and Iammarino (2000) conclude, in agreement with Porter, that UK policy needs to be rebalanced if strong regional concentration on the South East is not to be compounded further. They conclude that UK policy needs to adjust regional and industrial policies to develop and improve local technological competence. It needs to attract and retain development efforts that contribute to locally specific innovation while creating strategies that diffuse knowledge and innovation from the centre of strength (the South East) to other regions of the UK. Finally, that UK policy should create a more even distribution of publicly funded research and development across regions.

Love and Roper (2001) provide further evidence of problems for some UK regions. They show that structural weaknesses in regions particularly a preponderance of low value added industry and low productivity small firms lead to low levels of R&D, networking and technology transfer activity. Unfortunately these circumstances lead to low innovative activity and consequently limit the growth potential of firms preventing regional firms from creating positive local spillovers.

From the UK evidence on regional disparities and business support the proposed shift of economic development to the Regional Development Agencies appears sensible for the improved performance of regions. In certain regions there may be a need to continue to develop regional

strategies for inward investment, strategies for retaining talent through entrepreneurial activity and policies for building more effective regional network infrastructures. Based on this review these appear to be three of the most effective areas for regional policy where it is seeking to build sustainable patterns of innovation through networking.

CONCLUSIONS

This systematic review identified 628 relevant papers on networking and innovation and reviewed 174 papers that were ranked highly for the quality of their empirical work. The empirical evidence on which this review is based should, therefore, be considered comprehensive but not exhaustive. The evidence derived from the review is considered to be fairly limited, covering a large number of subjects, in many disciplines. There is not a clear critical mass of research in any given area and the study of networking and innovation was found to be overly weighted toward the high technology industries with only limited focus on other areas like manufacturing and service industries.

The evidence reviewed confirms that networks and networking amongst firms plays a pivotal role in innovation and that this has become more relevant as technologies have become more complex. Networking should not be viewed as a panacea for innovation, however, as there are many other factors that contribute to innovation performance (for example, R&D and foreign direct investment). Network forms are typically dynamic and complex and there is little evidence to explain which forms of network most contribute to innovation. Much of the evidence did highlight, however, that the use of networks was important for venture creation and for small growing firms. When examining the formation of networks this study concludes that there are many factors that promote and prevent their formation and that government intervention plays an important role creating institutional mechanisms that support the development of network infrastructures.

The wider evidence shows that relationships with multiple but diverse organisations can have a positive impact on innovation within firms. Typically the more diverse the relationships a

firm hold the greater chance they have of innovating. The integration of suppliers, co-suppliers and distributors in innovation projects also has a positive impact on the innovation process and innovation success rates. Third parties, science partners and institutional mechanisms all play instrumental roles by creating a network infrastructure that encourages the development of relationships. Likewise effective venture finance networks can enable better opportunities for commercial success when firms innovate by improving the quality of investment decisions. How networks are managed, therefore, can be viewed as essential to a firm's capacity to innovate but their ability to manage such relationships depends on their prior experience within a network and their network management competencies. There are many different forms of network configuration and these differ depending on the form of innovation, industry and the purpose of the network, however, some networks can prevent innovation and be anti-competitive. Networks fail for a variety of reasons and government intervention can act as both a positive and negative force affecting the sustainability of particular networks and network infrastructures. Although institutional and infrastructural mechanisms play an important role in the networking capacity of a country the effectiveness of networking between firms is often driven by personal and informal relations. As a consequence a nation's cultural and historical milieu plays a principle role in the way networking is undertaken and how it contributes to business-to-business relationships.

Like the general evidence, data on networking in the UK was limited and spread across a number of subjects. Firms appear to have strong network relationships with suppliers and business customers in the UK although there are variations between sectors. Some UK trade associations need to play a more active role encouraging the involvement of small firms in their activities and UK associations (both trade and professional) need to be more careful to protect their neutrality as network intermediaries. The role of science partners in radical innovation was confirmed in the UK context and some current mechanisms (e.g. student placements and projects) had been effective at encouraging relationships. UK venture finance networks appeared to be less well developed than the US and there is value in further promoting co-investment. Within the networking infrastructure

the UK needs to continue and expand its regional incubation capacity and improve the amount of networking activities led from incubators. Network relationships between UK firms tended to be intermittent and driven by short-term decision-making undermining the stable relationships that are required for innovation and formal business support activities need to do more to promote informal networks. The evidence confirmed that large disparities between regions in the UK have an extreme effect on their network infrastructures and, therefore, there is considerable variation in innovation capacity between regions in the UK.

Based on the conclusions of this study it can be demonstrated that the UK's performance in networking for innovation is quite strong. In the key areas linked to innovation, such as, supplier and customer engagement and links with science partners the UK performs well. In other areas, for example, the development of networking infrastructures and firms' management of networks there is some cause for concern. In the UK policy intervention needs to help firms learn how to leverage networks more effectively and encourage the development of longer term more stable relationships between firms. The UK networking infrastructure requires more neutral intermediaries and while it operates adequately has limited impact in promoting networking and innovation because it lacks scale. "*Overall in the UK we do a lot of networking, we do not perhaps do enough to capitalise on it and our general infrastructure is not quite adequate to support it".*

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TABLE 1
The Systematic Review Methodology

Stage	Name	Results	Description
1	DATABASE ANALSIS:	628 Citations	During the first stage of the review citations from ABI Proquest; Science Direct; the Web of Science were identified using the search strings outlined (Pittaway et al., 2004) and applying the automatic exclusion search strings outlined.
2	TITLE ANALYSIS:	375 citations included 157 excluded and 96 duplicates	During the second stage the review applied the manual inclusion and exclusion criteria identified to the titles of the 628 citations found in stage one. During this stage the focus of the researchers was to remove duplicate items and any citations that obviously contravened the inclusion criteria set out prior to the database searches.
3	ABSTRACT ANALYSIS:	332 citations included 43 excluded	During the third stage the reviewers analysed in detail each of the abstracts. The inclusion and exclusion criteria were again applied and a more rigorous assessment of articles was undertaken. During this phase the citations were organised into an A, B and C list to reduce the number of articles to manageable level.
	A ranked 179	179 Citations	The A list of citations for the review included only articles which appeared to fully meet the inclusion criteria, which could contribute to understanding UK networks compared to key competing countries. Articles were only included in the A-list if it was clear that they had sound empirical contributions. The researcher's judgments on inclusion in the A list applied the quality criteria and was balanced to include quantitative, qualitative and ethnographic forms of primary research.
	B ranked	76 Citations	The B list of citations included articles that appeared to have some relevance to the inclusion criteria but where some ambiguity existed about how they would contribute to the subject. These articles also included studies that did not meet the higher order quality criteria for inclusion.
	C ranked	77 Citations	The C list included articles of two types. Firstly, there were a number of articles that were relevant to the subject and made sound theoretical contributions. These were excluded because they did not meet the criteria associated with providing empirical evidence on which policy could be based. The second category included articles where the contribution to the subject either appeared somewhat tenuous or the empirical evidence appeared to be relatively weak.
4	POST ABSTRACT CODING:	174 Citations 5 Duplicates	Following stage three 5 further duplicates were found when reviewing articles.
5	NARRATIVE INCLUSIONS	20	During the review phase and the report writing phase further citations were identified using a narrative approach which clearly contributed to the subject in discussion. Some of these came from expert recommendation and others from articles reference lists.

TABLE 2

Key Journals Contributing to the Subject

Rank	Journal	Field	A List Citations	First Stage Inclusion
1	Research Policy	Economic Geography	20	43
2	Journal of Business Venturing	Entrepreneurship and Small Business	18	33
3	Regional Studies	Regional and Economic Geography	16	20
4	Technovation	Technology Management	12	29
5	International Journal of Technology Management	Technology Management	11	22
6	Technology Analysis and Strategic Management	Strategic Management; Technology Management	10	17
7	Small Business Economics	Entrepreneurship and Small Business	7	11
8=	Journal of Product Innovation Management	Operations Management	6	9
8=	Organization Studies	Organisational Behaviour	6	9
8=	Strategic Management Journal	Strategic Management	6	7

TABLE 3

Thematic Analysis of Papers used in the Systematic Literature Review

Theme	Description	No. of Papers	% of Papers	Coding Density	% Density	Ranking
Network Behaviour	How different behaviours within networks lead to different forms of benefits.	27	16.6%	8687	18.8%	1
Network Management	Studies which look at the effective management of networks by firms	37	22.7%	6020	13.1%	2
Institutional Factors	Research which explores the value and contribution of institutional mechanisms for promoting networking.	6	3.7%	4729	10.3%	3
Finance Partners	Focusing on studies which explain the important role of equity finance networks in the innovation process	9	5.5%	4680	10.2%	4
Suppliers	Articles which focus on the importance of supply networks within the innovation process	12	7.4%	4347	9.4%	5
Third Parties	These papers focus on the role of third party networks e.g. professional and trade associations and consultants.	11	6.8%	4305	9.3%	6
Network Governance	Papers that explore the role of governance within networks	13	8.0%	3717	8.1%	7
Science Partners	Research papers focusing on science partners as network brokers within business networks	14	8.6%	2745	5.6%	8
Network Formation	Studies that focus on how networks form and what factors inhibit of assist their formation.	8	4.9%	2502	5.4%	9
Network Configuration	Research examining the makeup of networks and how these can be formed to benefit strategic goals	17	10.2%	1602	3.8%	10
Diversity of Partners	These papers focus on the importance of diverse partners in networks.	5	3.1%	1466	3.2%	11
Customers	Studies which explore the important role of customer business-to-business networks in the innovation process	4	2.5%	1308	2.8%	12
TOTAL		**163**	**100%**	**46,108**	**100%**	

TABLE 4

Industrial Analysis of the Papers Reviewed (UK Analysis)

Industry	No. of Papers	% of Sample	No. of Papers UK	% of UK Sample	Change
Primary Industries	4	5.7%	1	4.6%	-1.1
Energy Industry	1		0		
Agriculture	1		0		
Oil and Gas	2		1		
Manufacturing Industries	12	17.1%	5	22.7%	+5.6
Automobile Components	3		0		
Ceramics	1		0		
Mechanical Engineering	2		0		
Medical Equipment	3		2		
Clothing	2		1		
Packaging Machine	1		0		
Service Industries	2	2.9%	1	4.6%	+1.7
Food Industry	1		0		
Financial Services	1		1		
High Technology Industries	52	74.3%	15	68.2%	-6.1
Chemicals					
Plastics	6	8.6%	3	13.6%	+5.0
Petrochemicals	1		0		
Enzymes	1		0		
Defense Industries	1		1		
Electronics	3	4.3%	2	9.1%	+4.8
Software	23	32.9%	5	22.7%	-10.2
Semiconductors	3		3		
Robotics	7		0		
Home Automation	2		0		
Telecommunications	1		0		
Pharmaceutical	3		0		
Biotechnology	20	28.6%	5	22.7%	-5.9
Embryonic	11		2		
	1		0		

TABLE 5

The UK Evidence on Networks in the Market Interface

Authors	Data used in the Study	Date	Summary
Romijn and Albaladejo	Detailed empirical model of internal innovation used to assess 33 companies in small electronics and software firms	2002	Analysed in detail the innovation performance of firms. Found that suppliers played a key role in product innovation in the UK. Used Spearman correlation co-efficients and found significant relationships (at 0.05 and 0.01 levels) with suppliers. Proximity of suppliers to the innovating firm had a direct impact on the incidence of product innovation (0.343) and with the product innovation index (0.412).
Bruce and Moger	Semi-structured interviews with 10 senior managers in retail multiples including manufacturers and fibre suppliers	1999	An empirical study exploring innovation supporting and blocking factors in the UK clothing industry supply chain. Three types of supply relationships identified co-partnerships; ad-hoc relationships; and, small networks of independents. Found that networks of independents had difficulty engaging in existing co-partnerships and that the other two forms limited innovation to an incremental process. UK clothing manufacture was relatively lacking in innovation capacity as a consequence.
Conway	Studied firms who received the Queens Award for Technological Achievement and the British Design Award using a sample of 35 interviews	1995	External inputs sourced informally played a critical role in 8 (23%) of the innovations. 19 (54%) of the projects drew on important inputs from external sources only 11 (33%) of the projects were considered not to have benefited (or to a minor extent) from external networks. The establishment of a project supported by the Ministry of Defense to work on Liquid Crystal Display is highlighted. Although the consortium was formal the informal friendships guided innovation. 9 (26%) projects were stimulated by a formal need; 4 (11%) from a science-technology project; 22 (63%) from various internal processes. The innovation concept was defined by external sources in only 5 (14%) of the cases. External inputs were less important during problem-solving than field testing.
Oakey	Survey interview with 43 new biotechnology firms	1993	In common with many high technology industries biotechnology firms rely heavily on one single large customer in their customer networks. Incidence of single customer purchasing in South East (67%) – Rest of UK (33%). The high South East total was seen as a precursor to acquisition.
Bruce and Rodgus	Survey to senior marketing personnel of 48 suppliers in the Enzyme Industry	1991	The main factors for competitiveness were 'effective product marketing' 7.28; 'maintaining links with customers' 7.00; and, new product R&D 6.92 (on a 1-10 scale). A majority of firms involved customers (73%) and customers were involved in idea generation and problem solving (73%) and product testing (64%). The survey showed that manufacturers dominated the innovation process but used customer involvement and this was a significant competitive issue in the Enzyme Industry.
Rothwell	Survey of 400 small manufacturing firms	1991	69% of firms had marketing links with other firms; 47.5% had a technical link; 39% of firms had contracted out R&D; 26% engaged in some form of collaborative R&D; 37% of firms were engaged in collaborative marketing. A large proportion of firms subcontracted some of their manufacturing (68%) but only a small number manufactured under license (16%).