Cambridge Journal of Regions, Economy and Society 2008, **1,** 165–173
doi:10.1093/cjres/rsn015

Innovation, networks and knowledge exchange

Susan Christopherson[a], Michael Kitson[b] and Jonathan Michie[c]

[a]*Department of City and Regional Planning, Cornell University, 129 Sibley Dome, Ithaca, NY 14853, USA. smc23@cornell.edu*
[b]*Judge Business School, University of Cambridge, Cambridge CB2 1AG, UK. m.kitson@jbs.cam.ac.uk*
[c]*Kellogg College, University of Oxford, 62 Banbury Road, Oxford, OX2 6PN, UK. jonathan.michie@kellogg.ox.ac.uk*

Introduction

A number of recent developments across the global economy have combined to put increasing emphasis on economic activity based on knowledge and innovation. This has been reflected not only in public policy towards universities but also in the approach of government—at national, regional and international level—towards both innovation policy and the formulation and promotion of national and regional economic strategies. These developments have included:

(i) the evolution of an 'information economy',
(ii) the increased variety and scope of innovation,
(iii) the development of 'open innovation',
(iv) the need for companies to become 'learning organisations' and for regions that wish to prosper on the basis of high-technology economic activity to become 'learning regions' and
(v) the globalization of economic activities which has intensified competitive pressures to be 'first to market' with innovations.

Such developments have been analysed across a range of academic research areas, including those related to national systems of innovation and regional systems of innovation, the 'globalization of technology' and 'regional innovation networks'. This academic research has helped to inform various public policy debates across the globe over the past few years. What is apparent, however, is that much of the current policy discussion remains narrow in focus and fails to fully embrace the complexity of the innovation process and the variety of impacts of institutions such as universities.

This current issue contributes to that academic literature, reporting the results of several original research projects. It also engages with the public policy debates on appropriate action for government—at regional, national and international levels—to pursue and for other bodies such as universities to adopt.

Varieties of innovation

At its simplest, innovation is 'the successful exploitation of new ideas' (DIUS, 2008, 12). But such innovation can vary in terms of products, services, processes and business practices. It can take place in the private, public and third sectors. And importantly, the impact of innovations can be highly variable and in some cases negative.

Much of the current focus of innovation policy remains rooted in the application of technology in manufacturing. Thus, it focuses on support for R&D and on mechanisms to support technology transfer from the science base. Furthermore, there is a myopic focus on the production of technologies—such as information technology (IT), biotechnology and nanotechnology—rather than the diffusion and use of such technologies (Abreu et al., 2008b). These are important elements of an innovation strategy but together they are partial and incomplete as they fail to address many aspects of 'hidden innovation' (NESTA, 2007), and in particular much of innovation in services.

The innovation type with potential to have the greatest economic impact involves the development of new general purpose technologies (GPTs) which are major advances in innovation which may have profound impacts on the economy and society. The development of IT is considered as a recent example of a GPT and earlier examples include the steam engine, railroad, electricity and the internal combustion engine. Much of public policy, at both national and regional scales, has focussed on technologies that may have the potential to become GPTs. This makes some sense as the development of such technologies is highly uncertain, risky and expensive, and to the extent that such technologies may generate positive externalities, there is a sound case for policy intervention. The question of how GPTs impact upon the economy and society is, however, often absent from the policy discourse.

First, the 'development' of such technologies themselves will have only a small economic impact. Simply, such technology-producing sectors are small in terms of both employment and shares of national income. This is particularly important when considered at the regional or local level, as the development and encouragement of 'high-technology clusters' are unlikely to have a major impact on many local economies. And to the extent that local economies attempt to foster similar 'clusters' there may be unfortunate 'place competition' with an adverse impact on the development of such technologies.

Second, it is the *use* of GPTs that has the biggest impact on the economy. Thus, it is the use (not the development) of IT that has had a major impact on the growth in many advanced countries, such as the USA. As Solow (2001) observed: the three industries which contributed to the productivity surge in the USA from 1995 to 2000 were, in order, wholesale trade, retail trade and security and commodity brokers. These were sectors that were both large (in terms of employment and shares of national income) and who used IT to improve business processes and increase productivity. It is therefore the diffusion of technology that is crucial to economic growth. And this diffusion takes time—Solow had observed a paradox in 1987, in that: 'you can see the computer age everywhere but in the productivity statistics' (Solow, 1987). It was at least another 10 years before this paradox was resolved. Other GPTs have taken longer to have a major economic impact: Watt completed the development of the steam engine in 1775 but according to Crafts (2004) steam contributed little to economic growth before 1830 and had its peak impact about a hundred years after Watt's invention.

Further distinctions can be made between radical and incremental innovations. Radical innovations, which may evolve from GPTs, involve the development of a new product or service which incorporates major technological process or organizational changes. Radical innovation may involve major disruptions or 'gales of creative destruction' (Schumpeter, 1942). Incremental innovations involve development along an existing technology or innovation trajectory. Incremental innovations can also be disaggregated according to whether they are new to the industry or the operating market of the firm, or just new to the firm. What is important to emphasize is that the drivers, impact and policy implications of different types of innovation will vary across sectors and across geographies.

'Open' innovation

A recent development within both the research literature and the corporate world has been the recognition that much innovation involves interactions between different research teams and corporate entities, as opposed to being developed by a single

research team or in one corporate laboratory (Chesbrough, 2003). In most sectors of the economy, for even the most research-intensive companies, more than 90% of the world's researchers will be working for competitor companies and other organizations rather than in that company's own R&D department. Thus, tapping into the research being conducted outside the company is vital: 'The open innovation model that Chesbrough describes shows the necessity of letting ideas both flow out of the corporation in order to find better sites for their monetization, and flow into the corporation as new offerings and new business models' (Brown, 2003). The importance of customers has been stressed in von Hippel (1988, 2005) who has posited the notion of user-led innovation. This notion has been taken and pushed to breaking point by Tapscott and Williams (2007) who have coined the term 'wikinomics' to describe the power of mass collaborations and open source technology.

Although the recent emphasis on open and user-led innovation provides interesting insights, a number of caveats need to be made. First, collaboration with others is not a recent phenomenon—although its extent may be increasing. Second, accessing external knowledge may be difficult and costly. Third, the use of external knowledge does not alleviate the need for internal capacity to absorb, assimilate and exploit such knowledge. Fourth, although the role of users is increasing, this tends to be concentrated in the IT sector: in other sectors, increasing feedback from consumers is important but this should be distinguished from the co-production of innovations by firms and users.

This emphasis on open innovation has geographic implications, although these are not straightforward. On the one hand, the argument is that it has become increasingly important to tap ideas from outside your own organization on a global scale. On the other hand, proximity and human interaction may be important conduits of learning and innovation, such that clusters of high-tech activity and regional innovation systems can facilitate knowledge exchange and foster economic dynamism within discrete geographical regions. What is apparent is that such innovation processes will be highly varied, and will depend on the historical path of development (see Driver and Oughton, this issue), local industrial structures and other institutional and policy factors. As Martin and Sunley (2003, 28) argue: 'there are now so many different varieties of clusters and so many confusing claims about their theoretical basis, form, identification and significance that the concept is peculiarly elusive and hard to pin down'. The spatial dimension of knowledge flows is analysed by Boisot, Canals and Macmillan (this issue) who find that knowledge structuring and spatial agglomeration co-evolve and that the development of IT is significantly altering such co-evolution.

University–business interactions

There is an increasing pressure from governments across the world on universities to engage more actively with the corporate sector (see, for example, Lambert, 2003; Sainsbury, 2007). This is driven by the belief that such engagement will have positive economic outcomes, enhancing innovation and economic growth. The role of Stanford University in contributing towards the 'Silicon Valley' phenomenon and of Massachusetts Institute of Technology (MIT) and the other Boston universities towards the economic dynamism of Route 128 are well documented (see, for example, Saxenian, 1994). Likewise in Europe, the 'Cambridge phenomenon' refers to the growth of the high-tech economy in Cambridgeshire, UK, which has been fostered in various ways by the presence of a world-class university—from licensing Intellectual Property (IP) and creating spin-out companies, through to providing well-educated graduates and undertaking commissioned research and consultancy work for commercial clients (Keeble et al., 1999; Segal Quince and Partners, 1985). However, it should be stressed that the Cambridge phenomenon started when the university had little active interest in business engagement and adopted a laissez-faire approach to what academics did.

Arguably, the technology phenomenon has been even more significant in the case of Oxford, which is one of Europe's leading centres of innovation-led

economic development (Lawton-Smith, Glasson and Chadwick, 2007, 2). In their analysis of the Oxford biomedical cluster, Lawton Smith, Romeo and BaGchi-Sen (this issue) argue that path dependence and co-evolution of the scientific and entrepreneurial systems are important in understanding the dynamics of growth. They also argue that internationalization of markets and networks are important drivers of growth—and, as argued by Suorsa and Jauhiainen (this issue), this may be particularly problematic for firms in peripheral regions.

The role of community formation in the development of an emerging technology cluster is considered by Feldman and Lowe (this issue) in their analysis of the Cambridge (Massachusetts) biotechnology industry. Community involvement can help to construct a shared understanding and appreciation of an emerging technology and can therefore foster regional economic development. Much of the conventional wisdom has stressed that innovation is fostered by unfettered markets, risk taking and low levels of regulation. Feldman and Lowe show the inadequacy of this approach and hark back to the older view of regulation where it acts as a form of public stewardship that advances community interests. Thus, emerging technology clusters may benefit if regulation turns uncertainty into calculable risk, provides standards and legitimizes the technology.

Clearly, one needs to be cautious in drawing policy conclusions from such cases. Harvard, MIT, Stanford, Oxford and Cambridge are five of the world's leading universities. One might conclude that having one of the world's 'top 10' universities in an economic region that also has other conditions in place necessary for encouraging and fostering the growth of high-tech companies will likely contribute to that region being innovative and economically successful. (Better still if you can have two of the world's 'top 10' universities in your region, as Route 128 enjoys with Harvard as well as MIT in the vicinity.) But by definition, not all of the world's universities can be in the 'top 10' and not every region can host a 'top 10' university. Of course, it may be the absolute rather than relative excellence of the university that is important. In which case, emulating the aforementioned universities might well provide some benefits. Equally, the relative—rather than absolute—excellence of the university may be significant. 'To those that have will be given', and being one of the world's leading universities may attract the best faculty, students and research projects away from other universities to the higher ranked ones—and hence away from other economic regions towards the regions containing the top universities. More useful, then, may be to analyse the various ways in which knowledge is transferred from universities to the regional economy, to see if there are lessons beyond the generic one of wanting a world-class university in the region.

It is important to recognize the different roles that individual universities play in their local and regional economies (Asheim and Gertler, 2005; Cook and Morgan, 1998). The diversity will reflect a university's particular strengths and local economic trajectories (Lester, 2005a, 2005b). As Rutherford and Holmes (this issue) argue, the form and nature of university–industry relationships and their impact on regional economies show that place and institutionally specific actors are important and they need to be considered within a wider context of the innovation and supply chain strategies of businesses. Furthermore, they stress the importance of power relationships in shaping university–industry networks. The importance of geographical and industrial variety is also stressed by Suorsa and Jauhiainen (this issue) in their analysis of innovation in peripheral regions. Their analysis also suggests that there may be a problem of cooperative lock-in, as high-technology enterprises rely on cooperation with the nearest higher education institute which has only limited skills and competences.

Knowledge exchange mechanisms

In the USA, the process of transferring IP from the university sector to the corporate sector was given a major boost in 1980 when the Bayh-Dole legislation permitted universities to claim title to the discoveries of faculty, staff and students resulting from government-funded research (Fearn, 2008, 32). In

1985, the UK followed suit, transferred the ownership of IP generated by publicly funded research in universities to those universities (Hague and Holmes, 2006, 11). These legislative changes allowed universities to license the IP to companies or create new companies to commercialize the innovations, thus speeding up the time to market. There has been a good deal of focus in public policy debate on company spin-outs from universities as a means of commercializing the results of university research. However, in many instances, it may be more productive to license that IP to an existing company that is already expert and experienced at commercializing such IP, rather than creating and spinning out a new company.

Warren, Hanke and Trotzer (this issue) show that differences in local innovation systems influence the performance and impact of university technology transfer offices. They find that universities that are geographically isolated from supportive innovation systems suffer a reduction in their efficiency in transferring technology. Much of the current focus on technology transfer implies a 'one size fits all' approach which is considered inappropriate by Warren et al. as each case needs to take account of local resources, infrastructure, social limitations, and so on.

Although patents, licenses and spin-outs are often at the centre of the policy discourse, they are only some of the range of mechanisms through which universities can influence innovation and business performance. According to Lester (2005a, 2005b) and Lester and Piore (2004), increasing the stock of codified knowledge is only one type of interaction at the university–industry interface. Others include the traditional role of educating people: problem-solving such as contract and cooperative research and public space functions such as informal social interactions, meetings and conferences. A survey of innovation activity in the UK and the USA (Cosh et al., 2006) indicated a similar pattern of university–business linkages in the two countries, with informal contacts being the most frequently cited interactions and licensing and patenting among the least frequently cited. Cosh et al. (2006) also find that the recruitment of graduates is an important interaction, which is supported by the analysis of university–business networks in automotive clusters in Southern Ontario by Rutherford and Holmes (this issue).

Another challenge to the conventional wisdom is whether university–business interactions should be considered as forms of 'knowledge transfer' or 'knowledge exchange'. Knowledge transfer implies a linear process, from the university researcher to the corporate recipient (whether this be to an existing corporate entity or a new one). We argue that 'knowledge exchange' will in many cases be a more appropriate and apposite term. It will often be the knowledge within the corporate sector that gives rise to the research in the first place: 'necessity is the mother of invention'. This shift from the concept of transfer to exchange itself has parallels with the move within the research literature from thinking of innovation as a linear process from research to development, instead to a 'systems' approach with all the feedback loops and synergistic relations that systems involve and develop.

The narrow view of university–business interactions—where the focus is on technology transfer increasing local or regional innovation—fails to capture the reality of the complexities and varieties of such interactions and their impacts. As Huggins, Johnston and Steffenson (this issue) argue, the use of university knowledge is not uniform across firms, with not all firms benefiting equally. Also, as argued by Rutherford and Holmes (this issue), there is a tension with much regional innovation policy as many of the economic gains from new knowledge will be realized outside the originating locality.

Huggins, Johnston and Steffenson (this issue) also argue that many firms do not acquire their knowledge from within a geographically proximate area. Many highly innovative firms are often connected to global networks, suggesting that non-proximate actors are able to transfer complex knowledge across such spatial boundaries, providing that the appropriate knowledge exchange or network structures are in place (see also Abreu et al., 2008a). Similarly, many of the activities and outputs of universities are not spatially

constrained. Power and Malmberg (this issue) argue that universities play a number of roles at local, regional and global scales, and how to best harness university research for the purpose of social and economic development might not primarily be a regional problem. Instead, they argue that the impact of a university on regional economic development is related to the material and immaterial advantages it will bring to the host region and not the impact caused by research carried out in universities resulting in innovations in that region.

Regional innovation policy

This role of geography in creating local networks, for example of skilled labour, has long been recognized, for example with Alfred Marshall's analysis of industrial districts (Marshall, 1890). The 'national innovation systems' literature developed by Chris Freeman and others (see Freeman, 1994, 1995) itself led to discussion of how such systems operated at the regional level (Howells, 1999). And the European Union, among others, has actively promoted the creation of regional innovation systems. These policies have had to battle against the 'regional innovation paradox', that lagging regions with low absorptive capacity may be less well placed to benefit from policy interventions, producing the paradoxical result that even where such policies have the intention of assisting lagging regions, the result may be to leave as large a gap as ever (Oughton et al., 2002).

Government innovation policy has thus covered a range of measures over the years across the globe. How much we include within 'innovation policy' is an open question. Policies to promote research and development, or education and training, are likely to have an impact on innovative capacity and performance. As Driver and Oughton argue (this issue), training and skill development is an important means of building firms' capabilities and their capacity to absorb knowledge. Furthermore, they stress the importance of the macroeconomic environment which is often ignored in the innovation policy discourse. A cyclical downturn can discourage investment in innovation, and volatile financial markets may make it very difficult to raise finance for long-term risky projects.

But within the broader range of measures that will have an impact on innovation but which are at the same time targeting other outcomes, there are a number of policies that governments pursue that seek quite specifically to promote innovation and to try to ensure that such innovations prosper in the marketplace. These include policies to foster the commercialization of university research, encouraging firms to invest in research and development, for example through tax credits, and encouraging the activities of appropriate venture capital funds. A problem with much of the policy discourse is that it focuses on a narrow notion of innovation with particular emphasis on the production and exchange of technology. While the generation of new technologies is an important part of the innovation process, the larger impact on the economy of those firms and sectors that use technology in their business practices, in particular in the service sector, must not be overlooked (Abreu et al., 2008b). Also, much policy focuses on the importance of high-technology small firms often spun out from universities and ignores the potential in established larger firms and in traditional industries. Furthermore, as discussed above, the policymakers' view of the role and impact of universities has been too narrow, tending to ignore the importance of the diversity both of the universities themselves and of the local and regional economic structures within which universities operate.

The innovation exchange

One specific initiative that has sought to promote innovation through networking has been the 'innovation exchange' (known as the InnovationXchange or IXC). This was established in Australia with the support of the employers' federation and public sector backing in the form of membership subscriptions from government bodies. The IXC is a membership organization which provides 'intermediaries' to work under conditions of strict confidentiality across a number of member companies and other organizations, tasked with trying to spot

opportunities for collaboration between the member organizations around innovative proposals. One company may face a challenge to which another has a potential solution, but without the IXC, neither might ever become aware of the other's need or capability. Having a number of intermediaries, who tend to hold PhDs in the sciences, means that the needs and capabilities of each member can be compared with those of all member organizations, not just the ones that a single intermediary is operating in.

In 2006, the UK Government provided funding (under the third round of the Higher Education Innovation Fund) to establish the innovation exchange in the UK (the IXC-UK, on which, see www.ixc-uk.com). This is now operating successfully with a number of paying company clients, based at the University of Birmingham and with a second office in Cambridge and a number of other universities actively involved. The intention is for the IXC-Australia and IXC-UK to launch a global IXC organization, given that many of the client companies are multinationals, and companies from a number of countries have expressed an interest in joining.

'No innovation without representation'?

There is a large literature on the sort of 'progressive' human resource and other management practices that are likely to lead to the degree of employee engagement and commitment that can deliver high productivity, especially in areas of economic activity where monitoring is costly and the productive process relies on high levels of trust. Such practices have been termed 'High Commitment Work Systems'. This research agenda has tended to find the following: first, that such practices need to be introduced and developed in coherent 'bundles' of self-reinforcing policies. Second, introducing such policies by itself is not sufficient; they need to be introduced and implemented in the right way, and this requirement includes engendering a belief across the workforce that the company genuinely believes in and is committed to these policies, and having the policies visibly supported by all levels of management. Third, the policies need to create the necessary skills and capabilities, but these need to be matched by employee commitment and engagement, along with an appropriate work organization to permit the employees to put those skills and that commitment to good effect—in other words, there has to be the opportunity to innovate or raise productivity in some other way. Finally, any such link from practices to performance is contingent on company strategy: an organization would not become more innovative just by adopting these Human Resource Management policies—it also needs to be pursuing a strategy of innovation. Conversely, if the company is pursuing a cost-cutting low-price strategy, investing in such policies may fail to deliver higher productivity or innovative performance.

Thus, for firms to be successful innovators requires the pursuit of innovation to be a part of the company's strategy. These firms also need to adopt and properly develop a range of human resource and other management practices that enable, encourage and facilitate innovative behaviours among the workforce (Michie and Sheehan, 1999).

The globalization of technology

Some networking will often necessarily be local or regional in nature. This allows collaboration between universities and the firms in their vicinity. Such networking allows the personal contact through which tacit knowledge is best spread. And local and regional governmental bodies and trade associations can promote and facilitate such regional activities, whether by promoting and hosting the networking organizations themselves or by providing the productive infrastructure, which may then be available on a shared basis. But none of this cuts across or obviates the need for global collaboration. Indeed, while a university will commonly have links with local companies as employers of graduates, funders of research, and so forth, they—or more particularly their academics—will be part of global academic networks. The two geographical levels are not in conflict. It is precisely because an academic will be tapping into the latest research globally that they are valuable to the local

network or company. Thus, while there has been a 'globalization of technology' on almost any measure one might use, this process hides quite different outcomes across the various processes involved. Thus, while multinational corporations will be involved in research and innovation globally, such activity is often still concentrated in the 'home' base (Archibugi and Michie, 1995).

Conclusion

There is an increasing focus on the role of networks and knowledge exchange in the innovation process. Yet, the policy discourse is often narrowly focussed on areas such as technology transfer and fails to capture the importance of variety, complexity and the role of place and path dependence. The papers that follow in this journal issue help to remedy this deficiency by focusing in various ways on how information and knowledge is diffused within the business community and transferred between universities and firms—with this taken, importantly, to be a two-way iterative and symbiotic process. Where the evidence suggests that innovation and the economic success of regions and nations more generally are enhanced by the operation of such processes, then policies to support such processes are considered. For example, the findings of Warren, Hanke and Trotzer (this issue) would suggest that universities should be more focused and realistic regarding their technology transfer activities. Most of the papers suggest that the role of place and space is important in the operation of networks and innovative outcomes, but that this is not an either/or as between the importance of local networking on the one hand as against the globalization of activities on the other. In most cases, both types of networking have important but different roles to play. The aim should be to enhance the effectiveness of both types of networking—to think local and global and to act likewise.

References

Abreu, M., Grinevich, V., Kitson, M. and Savona, M. (2008a) *Absorptive Capacity and Regional Patterns of Innovation*. London: Department for Innovation, Universities & Skills (DIUS). Available online at: http://www.dius.gov.uk/publications/DIUS-RR-08-11.pdf [Accessed 29 May 2008].

Abreu, M., Grinevich, V., Kitson, M. and Savona, M. (2008b) *Taking Services Seriously: How Policy can Stimulate the 'Hidden Innovation' in the UK's Services Economy*. London: NESTA. Available online at: http://www.nesta.org.uk/taking-services-seriously/

Archibugi, D. and Michie, J. (1995) The globalisation of technology: a new taxonomy. *Cambridge Journal of Economics*, **19**: 121–140.

Asheim, B. T. and Gertler, M. S. (2005) The geography of innovation: regional innovation systems. In: Fagerberg J., Mowery D.C., Nelson R.R. (eds). *The Oxford Handbook of Innovation*. Oxford: Oxford University Press.

Brown, J. S. (2003) *Innovating Innovation, Foreword to Chesbrough*, pp. ix–xii.

Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, MA: Harvard Business School Press.

Cook P, Morgan K. (eds). *The Associational Economy: Firms Regions and Innovation*. Oxford: Oxford University Press.

Cosh, A., Hughes, A. and Lester, R. K. (2006) *U.K. plc: Just How Innovative Are We?* Cambridge, UK: Cambridge-MIT Institute.

Crafts, N. (2004) Steam as a general purpose technology: a growth accounting perspective. *The Economic Journal*, **114**: 338–351.

DIUS. (2008) *Innovation Nation*. Department for Innovation, Universities & Skills. London.

Fearn, H. (2008) A penny for your thoughts. *New Statesman*, 28 February, 31–35.

Freeman, C. (1994) The economics of technical change: a critical survey article. *Cambridge Journal of Economics*, **18**: 463–514.

Freeman, C. (1995) The national system of innovation in historical perspective. *Cambridge Journal of Economics*, **19**: 5–24.

Hague, D. and Holmes, C. (2006) *Oxford Entrepreneurs*. London: The Council for Industry and Higher Education.

Howells, J. (1999) Regional systems of innovation? In: Archibugi D., Howells J., Michie J. (eds). *Innovation Policy in a Global Economy, chap. 5*, pp. 67–93. Cambridge: Cambridge University Press.

Keeble, D., Lawson, C. and Moore, B., et al. (1999) Collective learning processes, networking and 'institutional thickness' in the Cambridge region. *Regional Studies*, **33**: 319–332.

Lambert, R. (2003) *Lambert Review of Business-University Collaboration*. Norwich: HMSO.

Lawton-Smith, H., Glasson, J. and Chardwick, A. (2007) *Enterprising Oxford: The Oxfordshire Model*. Oxford: Oxfordshire Economic Observatory.

Lester, R. K. (2005a) *LIS Project—Phase I Findings: Overview and Discussion*. Cambridge, MA: MIT Industrial Performance Center, Working Paper 05–004. Industrial Performance Center, Massachusetts Institute of Technology.

Lester, R. K. (2005b) *Universities, Innovation, and the Competitiveness of Local Economies*. Cambridge, MA: MIT Industrial Performance Center, Working Paper 05–010. Industrial Performance Center, Massachusetts Institute of Technology.

Lester, R. K. and Piore, M. J. (2004) *Innovation: The Missing Dimension*. Boston, MA: Harvard University Press.

Marshall, A. (1890) *Principles of Economics*. London: Macmillan.

Martin, R. and Sunley, P. (2003) Deconstructing clusters: chaotic concept or policy panacea? *Journal of Economic Geography*, **3**: 5–35.

Michie, J. and Sheehan, M. (1999) No innovation without representation? An analysis of participation, representation, R&D and innovation. *Economic Policy*, **2**: 85–97.

NESTA. (2007) *Hidden Innovation: How Innovation Happens in Six 'Low Innovation' Sectors*. NESTA. London.

Oughton, C., Landabaso, M. and Morgan, K. (2002) Regional innovation systems and regional innovation strategies. *Journal of Technology Transfer*, **27**: 97–110.

Sainsbury, D. (2007) *Race to the Top*. Norwich: HMSO.

Saxenian, A. (1994) *Regional Advantage*. Boston, MA: Harvard University Press.

Schumpeter, J. A. (1942) *Capitalism, Socialism and Democracy*. New York: Harper & Row.

Segal Quince and Partners. (1985) *The Cambridge Phenomenon*. Segal Quince and Partners. Cambridge.

Solow, R. (1987) We'd better watch out. *New York Times Book Review*, 12 July.

Solow, R. (2001) *Information Technology and the Recent Productivity Boom in the US, Cambridge-MIT National Competitiveness Summit, November, Cambridge*. Available online at: http://mit.edu/cmi-videos/solow/text.html [Accessed 29 May 2008].

Tapscott, D. and Williams, A. D. (2007) *Wikinomics: How Mass Collaboration Changes Everything*. Atlantic: London, Portfolio.

von Hippel, E. (1988) *The Sources of Innovation*. New York: Oxford University Press.

von Hippel, E. (2005) *Democratizing Innovation*. Cambridge, MA: MIT Press.