

ERSA 2003 CONGRESS

University of Jyväskylä, Jyväskylä, Finland, 27-30 August 2003

Paper number 398

THE ROLE OF UNIVERSITIES IN LEARNING REGIONS

David Newlands

Department of Economics

University of Aberdeen

Aberdeen AB24 3QY

United Kingdom

Email: d.newlands@abdn.ac.uk

Abstract

Universities' economic relationships with their regions can be divided into spending impacts and knowledge effects. Spending impacts refer to the effects of consumption and capital spending by universities and their staff and students on income and employment. Knowledge effects refer to the benefits of university activities, notably the production of highly educated graduates and the production and dissemination of knowledge. Until comparatively recently, most studies of the role of universities in regional development were confined to spending impacts. Now, there has been an explosion of research on knowledge effects and the ways in which universities contribute to learning regions, and thus to employment creation and the enhancement of regional competitiveness. Universities add to the human capital of the region and assist the innovative processes of firms but in turn their teaching and research activities are informed by businesses in the region. This paper reviews a number of studies of the roles of European and American universities in enhancing regional competitiveness in the contemporary learning economy. It discusses the different economic processes involved and includes several case studies of individual universities. In so doing, the paper argues that the role of universities in learning regions has often been overstated.

1. Introduction

Information resources have come to be seen as a key input into all economic activities. A reduction in the length of product life cycles has placed greater emphasis upon research and development, both its volume and the integration of research activity into the organisation of firms. Innovation or the importance of “knowledge” or “learning” have come to be viewed as features which should be ubiquitous throughout the firm. In all firms, but particularly high tech manufacturing and service sector activities, developed cognitive skills are becoming seen as an increasingly important source of competitive ability. The claim, or assumption, that knowledge has become crucial in the organisation of production, indeed in the operation of the economy more widely, has led to an explosion of interest in the “information economy”, the “knowledge economy”, the “learning firm”, the “learning region”, and so on (Hudson, 1999). In turn, the discussion of the production and exchange of knowledge has led to a growing recognition of the potential role of universities as a driver of national and regional economic development, as vital contributors to the research and development efforts of the economy and to the cognitive skills of the workforce

The literature on “learning regions” has a strong underlying theme of the expanded opportunities for autonomous regional development. The forging of regional innovation systems improves the supply side, creates bottom-up strategies, builds indigenous development, improves regional competitiveness. However, there have to be losers. In terms of relative growth rates, regional development strategies are, always have been, and always will be, zero sum games.

Some of the arguments about the potential contribution of universities to learning processes are grossly overstated. At one level, it is self evident that universities are the source of much new knowledge but they are not the only producers of knowledge let alone distributors of knowledge. Nor is it the case that universities are inevitably a key contributor to the success or otherwise of regional development strategies.

This paper seeks to advance the debate about the role of universities in learning regions. It considers a number of the mechanisms by which knowledge effects are transmitted

between universities and business, illustrating these with a number of European and American examples. It should be stressed at the outset that these illustrations are necessarily selective. It would be a near impossible task to identify and summarise all the existing studies of university-business relationships.

The paper advances three interlinked arguments. Firstly, that while traditional multiplier studies have become almost passé we should not forget that such studies have long demonstrated that universities have distinct, significant, regional impacts. Secondly, universities do not have such clearly identifiable effects upon the knowledge base of their regions. Thirdly, developed university-business relationships are not a sufficient condition for dynamic regional economic performance and probably not a necessary condition either.

The structure of the paper is as follows. The next section sets out a theoretical framework within which to understand the contributions of universities to regional economic development. Sections 3 and 4 discuss traditional spending impact studies and newer analyses of knowledge effects respectively, drawing upon European and American experiences. Section 5 seeks to identify some of the lessons of these experiences. Finally, there is a brief statement of the key conclusions.

2. A theoretical framework

Felsenstein (1996), in a study of the impact of Chicago's universities on that metropolitan area's economy, divided universities' impacts on their local areas into backward and forward linkages. Backward linkages refer to the effects of spending by university staff and students, and of universities themselves, on income and employment in the local area. Forward linkages refer to the outputs of university activities, notably the production and dissemination of knowledge within the local economy, through graduates and the conduct of research with links in the local economy.

There are three different types of backward linkage, to local households, local government, and local business. Universities' impacts on local households are generally

positive through direct and induced effects on income and employment. Effects on local government may be mixed. The presence of a university may widen the tax base and thus increase the revenues of the relevant local authority. On the other hand, a university might make considerable demands upon the provision of services by local government. Effects on local business may also be mixed. Local firms may benefit from the supply of goods and services to a university. However, universities may operate on such a scale as to compete with local firms in labour and property markets, leading to some displacement effects.

Felsenstein (1996) also identifies three types of forward linkage, in the form of changes to the local level of human capital, to the pool of knowledge, and to the attractiveness of the local area to households and firms. Universities raise the level of human capital in their local economy but only to the extent that graduates stay in the local area after completing their studies. Universities add to the knowledge base of the area through a whole series of university-business links, including consultancy and contract research. Universities may also add to the attractiveness of an area through the creation of positive “quality of life” externalities.

Beck et al (1995) suggest how expenditure effects and knowledge effects can be incorporated in a single measure. Overall economic impact can be defined as the difference between the existing level of economic activity in a region and the level of activity if the university concerned did not exist. Allowing for the university’s impact on the region’s stock of human capital and technological base, and other dynamic effects, this single measure would be the discounted value of differences in flows of future economic activity. This procedure would be next to impossible to pursue in practice. Apart from anything else, the data requirements are formidable, as is demonstrated below in section 4. However, there is a potentially greater problem in attempting to marry expenditure effects and knowledge effects in the way that Beck et al (1995) suggest. While their method may at first glance appear theoretically sound, because expenditure effects and knowledge effects are very different in nature, the appropriate means of analysing them are also very different. Expenditure effects are largely static in nature whereas the importance of knowledge effects – but also the difficulty in analysing them – stems from the fact that they are dynamic in nature.

3. Spending impact studies

There is a well established procedure for the estimation of the spending impact of universities. The initial injection of income into the local economy – consisting of expenditure by staff, students and the institutions themselves, and off campus expenditure by students and visitors – constitutes the direct effect. In addition, however, there are indirect effects (arising from investment spending) and induced effects (arising from consumption spending). The ratio of the sum of direct, indirect and induced effects to the direct effect is a measure of the multiplier value of a university's spending impact on income and employment in the local area.

Most studies worldwide, and in some countries almost all studies of the impact of universities on their regions, concentrate on spending impacts. This is true for example of the majority of British studies, even the most technically detailed studies. The majority of studies employ a Keynesian multiplier analysis but some use input-output analysis. There are even some examples of the special construction of an input-output table. This was true of one of the earliest studies, of St Andrews University, by Blake and McDowall (1967). More recently, Harris (1997) used data from a special survey to construct an 87 x 87 sector input-output table as part of his study of the impact of Portsmouth University on its local economy.

There will inevitably be many more university spending impact studies. Good practice in the conduct of such studies would include, in addition to the standard estimates of local income and employment multipliers, such features as the calculation of separate income multipliers for different categories of spending, attempts to fill data gaps – for example, for off campus visitors expenditure – through special surveys, analysis of the linkages with local government, and the identification and quantification of any displacement effects (Armstrong, 1993; Harris et al, 1997).

Spending impact studies do have their uses. Universities are large employers, not least because they are very labour intensive organisations. In a number of towns and cities,

higher education is among the largest of local employers. Combining the spending of university staff and students with that of universities themselves as institutions, the importance of university spending on the local and regional economies is self evident. There will long be value in identifying the extent and magnitude of these links with the regional economy.

4. Analyses of knowledge effects

As just noted, most studies of the economic impact of British universities on their local areas concentrate almost exclusively on spending impacts. This perhaps reflects the ill developed nature of university-business links in the UK in comparison with other countries. In contrast to the studies of British universities, studies of the economic impact of various European and American universities on their local areas have at least sought to identify the nature of knowledge effects. However, much remains to be done to better understand the role of universities in regional development.

There are various indirect relationships by which universities contribute to dynamic changes in the regional economy. These include technology development and transfer to local companies, the spinoff of new firms from university activities, vocationally oriented training, and support for economic development agencies, for example in the attraction of inward investment (Stone, 2000). It has been argued that a new breed of “entrepreneurial universities” has emerged (Smilor et al, 1993; Slaughter and Leslie, 1997; Clark, 1998). Such universities are “characterised by a more direct involvement in the commercialisation of research activities, and a more proactive approach to regional economic development. Universities are paying increasing attention to the value of more applied research, innovative and relevant teaching and service to the local and national public and private sectors” (Oatley, 1998, p.255).

The nature of knowledge effects and of university-business relationships themselves vary according to the type of university involved. The terms “university” or even “higher education institution” cover a wide spectrum of organisations. Technical universities, polytechnics, and regional or local universities are very different from

prestigious, research led universities of international repute. The latter may be involved in more innovative activity but they tend to operate at a national or international scale. The closer relationships with local business have generally been forged by the new universities. Several illustrations of this conflict between the local and the global are given below.

The role of universities in technology transfer has received increased attention in recent years (OECD, 1992; Goddard et al, 1994; Braczyk et al, 1998). This has been the result of various developments. Increased technological complexity has led firms to resort more to external sources of technology. As a result of the contraction of employment in large branch plant firms, the concern of policy makers has shifted towards the support of small and medium sized businesses, especially in high technology industries. Universities have themselves been under increased pressure to increase revenue from the sale of technology.

The term “technology transfer”, although very widely used, is potentially misleading since implicit in the expression is the simple, unidirectional model employed in the early stages of the study of processes of industrial innovation. In this model, knowledge progressed from pure research involving university research motivated by a thirst for knowledge through to company involvement once ideas’ commercial opportunities became clearer. This model has since been discredited and it is now recognised that there are continuous exchanges of ideas between business organisations and university researchers and such exchanges are important in the eventual success of the commercialisation and application of research. Thus, companies are involved in sponsoring long term research projects as well as consultancy and shorter term research funding. Universities and businesses are involved in complex and mutually dependent relationships with both sides contributing to ongoing processes of knowledge acquisition and transfer.

Various processes by which knowledge in universities is exchanged with knowledge from industry can be identified. Research links and collaboration involve universities in generating new forms of information or carrying out specific research tasks. However, universities often face a conflict between aspiring to levels of international excellence in

their scientific research and aiming to help local firms. The research expertise of university staff may be very technologically advanced and highly specific. Such staff may collaborate with firms but these are likely to be businesses which are equally technologically advanced. Few of these firms are likely to be local. The majority of local businesses, especially if small, will not be engaged in activities which can make use of the expertise of university researchers. Thus, somewhat paradoxically, “universities can contribute more to local firms in terms of knowledge by concentrating on the global, as they are then able to introduce new ideas and concepts” (Goddard et al, 1994, p.22).

Research grants and contracts are the main form of direct technology transfer. However, in general, support by industry accounts for a small proportion of universities’ research grant income while research contracts with local industry account for a much smaller proportion still. Thus, “contracts are placed by the larger firms, usually on a national basis, and previous research has shown that such relations are developed with universities with a particular specialism, regardless of region” (Goddard et al, 1994, p.24).

In contrast, consultancy involves universities in a mode which is more responsive to the needs of the regional economy. Since consultancy does not generally require new information gathering, but rather consists of advising firms on the basis of existing information, it is generally more appropriate and more affordable for small firms.

Further mechanisms by which knowledge in universities is exchanged with knowledge from industry include the movement of personnel (staff or students) carrying with them both formal and tacit knowledge, and spinoffs by which a body of knowledge in a university is transferred to the private sector by the wholesale transfer of an organisation and its staff.

There have been various European and American studies of university-business links although most are quite crude. The Valenzuela and Moreno (1995) study primarily involves an analysis of the 1448 “collaboration agreements” signed between 1978 and 1991 between the five public universities and businesses in the Madrid region. O’Neill

at al (1996) discuss the commercialisation of Columbia University's research, particularly licensing revenues, but note that virtually none of this activity takes place in New York City. Analysis of research links in the study of Rutgers University's impact on New Jersey is largely confined to description of sources of research funding and some examples of sponsored research. A more interesting study is that by Feldman (1994) who constructs a simple model of the innovation process which is then applied to the impact of Johns Hopkins University on innovation in Baltimore. This study, which concludes that Johns Hopkins University has not fostered high technology industry in its local area due to the absence of an effective innovation infrastructure in Baltimore, is considered further in the next section.

The conflict between meeting local needs and operation on a global scale is particularly acute for older, research oriented universities. However, in many countries, there are polytechnics and newer universities, often themselves ex-polytechnics, which have closer relationships with local business. These universities are often highly vocational in terms of both their teaching and their research (Stone, 2000). However, the European and American literature provides far fewer detailed case studies of newer universities than of older ones.

In addition to links with local business, a further example of knowledge effects in which universities make an important contribution to the local economy is the provision of graduates with subject specific knowledge and a range of transferable skills. There are a number of ways in which an improvement in university induced local human capital can manifest itself in the local economy. First, at the individual level, a university increases the skills of local workers thereby raising their earnings and employment opportunities. Second, a university by raising the average level of human capital may raise local productivity growth, a theme that crops up frequently in the endogenous growth theory literature. One mechanism suggested by Lucas (1988) is that higher levels of human capital in the economy facilitate the development and implementation of new technologies. Rauch (1993) argues that if groups of highly educated and skilled workers are concentrated in an area this facilitates the swapping of ideas through random meetings and this sharing of knowledge generates technological improvements in a local economy.

The effects on local productivity and thereby competitiveness depends on whether graduates produced by a university remain within the local economy. A migration of graduates may simply add to and improve the human capital base of other regions or localities, though there may be compensating movements of graduates from other universities entering the local economy concerned.

Despite the fact that human capital accumulation, reflected in gains in knowledge and skills, plays a crucial role in determining local competitiveness, delineating its precise impact upon the local economy can be problematic. The main constraint is lack of data allowing researchers to evaluate the earnings of graduates of individual universities and the effects of local human capital accumulation on the growth of the local economy.

The conventional way to evaluate the effects of graduates is to determine the effects on earnings. This is usually done by calculating the rates of return on investment in a university education (Johnes, 1993). These aggregate studies consistently show high rates of return to the individual from a university education. A number of studies have found rates of return of 20 per cent or more. The finding of high rates of return to graduates has to be qualified in various ways. Obviously, not all graduates will enjoy high rates of return. The rates of return on higher education vary with the state of the economy. The economic evidence also suggests that the social rate of return to society as a whole – of higher education is less than the private rate of return – to individual graduates since students do not bear the full cost of their university education. Against this, however, the university system delivers certain benefits which cannot be measured in monetary terms (and are not therefore picked up in calculations of social rates of return). In particular, universities may play an important role in the propagation of social and cultural values. Though difficult to quantify, these effects are nevertheless important.

A further qualification is that, while high rates of return are associated with a university education, they may not be determined by that education. It may be that to some extent higher education is less about an individual or social investment in specific or general skills and more about identifying or screening out those people in society who have a

relatively high productive potential to employers. There is no strong evidence for this “screening hypothesis” but it remains a possibility that some of the apparent economic benefits of the university system in raising skill levels and productivity, as reflected in rates of return on higher education study, are exaggerated. Higher education would thus seem to have both a productivity and an informational augmenting role (Psacharopoulos, 1979).

The rates of return studies are based on aggregate data on graduates from different institutions. The same is true of most information about the earnings of graduates. Though the effects of human capital on national economic growth are well documented (Romer, 1990), much less is known about the effects of an individual university on local growth and productivity.

The consequence of these methodological difficulties is that most studies are reduced to the use of such indirect indicators as the retention of graduates in the region. Thus, O’Neill et al (1996) in their study of Columbia University assemble figures on the proportions of alumni remaining in and around New York City after graduation. The study of Rutgers University similarly proxies its contribution to local human capital by the number of alumni remaining in New Jersey.

Some case studies are more sophisticated, covering the higher education system as a whole and analysing the nature of courses provided. Baden-Württemberg is a frequently cited example. It has the largest network of universities, colleges and training centres in Germany. Moreover, many higher education institutions are technical colleges rather than elite universities, providing very specific, trade based courses and promoting the movement of individuals between higher education and industry. The Baden-Württemberg case is also interesting for another reason. It illustrates that university-business networking can not only facilitate effective collective learning but may also impede it. Especially where familiar conventions become established, “sclerosis” can set in. Areas become locked into outdated and inferior technologies and institutions. It has been argued that in Baden-Württemberg institutional inertia and resistance to change have begun to undermine the advantages the region once enjoyed. Specifically, the vocational training system “acts as a barrier to labour and skills-based flexibility.

Traditional vocational boundaries impeded collaboration, innovation and co-operation” (Raco, 1999, p.962).

Finally, it is worth noting that the same potential conflict between the global and the local which was identified with regard to university-business links surfaces again with regard to human capital accumulation. The best graduates of any university are likely to gain jobs with business firms and other organisations of international renown, few of which may be located locally.

5. Lessons of European and American experiences

European and American experiences highlight the importance for the effective transfer of knowledge within the regional economy of an innovation infrastructure. This is of two types: a physical infrastructure such as transport and telecommunications networks and a knowledge infrastructure consisting of universities and research centres. The physical infrastructure is very important but readily visible. The nature and functioning of the knowledge infrastructure is less well understood. However, while aspects of the relationship between the knowledge economy and regional development are still under researched, there is an emerging consensus about certain key factors. These include agglomeration economies and economies of scope, the importance of trust, and the existence of dense networks of small firms and supportive institutions. A culture of institutional learning which emphasises the importance of tacit knowledge and face to face learning is important. Effective regional development depends on “institutional thickness” within the region.

Wider global and structural forces frame the knowledge economy in any region but factor conditions and economic culture in the region are also important. Indeed, “it is the interrelationship of knowledge and the knowledge infrastructure with local factor conditions and regional contexts, which shape the ‘look’ and quality of a learning region” (Keane and Allison, 1999, p.897). Innovation should thus be viewed as an interactive process which is framed by the institutional context in which it takes place (Morgan, 1997; Cooke and Morgan, 1998).

Following such arguments, it has become the conventional wisdom that the presence of a research university is one of the necessary conditions for the creation and maintenance of a learning region and a high technology industrial base. Research universities provide the scientific knowledge, technical information and skilled personnel upon which high technology industries are founded. Oft-cited examples of successful regional development along such lines include Silicon Valley in California and Route 128 in Massachusetts (Saxenian, 1994), the Research Triangle in North Carolina (Feldman, 1994), Grenoble in France (De Bernardy, 1999), and the Cambridge phenomenon in England (Keeble et al, 1999).

However, it may be that proximity to a major research university is not a necessary condition of successful regional economic development. Relevant to this question are a number of econometric studies of university research transfers (Jaffe, 1989; Audretsch and Stephan, 1996; Anselin et al, 1997; Varga, 1998; Anselin et al, 2000; MacPherson, 2002). Jaffe (1989), in the earliest and still best known such study, notes that the “transport” mechanisms by which research findings are transferred from universities to firms are inadequately understood. “If the mechanism is primarily journal publications, then geographic location is probably unimportant in capturing the benefits of spillovers. If, however, the mechanism is informal conversations, then geographic proximity to the spillover source may be helpful or even necessary in capturing the spillover benefits” (Jaffe, 1989, p.957). For another “transport” mechanisms, formal research contracts between universities and companies, spatial proximity may facilitate interaction but is unlikely to be necessary.

Jaffe (1989) models research transfers within a “knowledge production function” framework which is then applied to the states of the US. He proxies industrial innovative activity by the number of patents and industrial R&D expenditure. Academic research is proxied by university research expenditures. University research and industrial R&D are modelled as a simultaneous system to allow for university research depending on industrial R&D and the reverse. The principal conclusion is that “there is only weak evidence that spillovers are facilitated by geographic coincidence of universities and research labs within the state” (Jaffe, 1989, p.968). Broadly, this

finding has been confirmed by subsequent studies. For example, of the four high technology sectors in the analysis by Anselin et al (2000), there was a positive and significant effect of both industry and university research on industrial innovation only in the case of one sector, electronics. There may be size effects at work, however. For example, MacPherson (2002), in a survey of manufacturers of medical devices in New York State, found that smaller firms appear to interact more strongly with the academic sector than larger firms do.

Perhaps very significantly, almost all the studies that find any evidence of research spillovers being facilitated by physical proximity are American. The study of Dutch universities by Florax and Folmer (1992), which is one of the few non American econometric studies, provides an interesting contrast. They define knowledge effects as “changes in the quality of production factors induced by the knowledge produced at universities” (Florax and Folmer, 1992, p.439). In an attempt to identify such effects, they construct a regional investment model with total university expenditures as their knowledge variable. They distinguish between contagious and hierarchical diffusion of knowledge generated by universities. Contagious diffusion occurs where knowledge is concentrated close to the originating source and decays rapidly with distance. In the hierarchical case, knowledge diffuses from core regions and cities, regardless of where it originated, and only later trickles down to peripheral areas. Florax and Folmer (1992) apply this model to a time series of cross section observations for 40 areas in the Netherlands for the period 1977-1984. Their results suggest that Dutch universities enhance investment through hierarchical rather than contagious diffusion. As a relatively small, homogeneous and densely populated country, the Netherlands may be something of an extreme case but it is probably reasonably typical of other European countries in the lack of strong regional partnerships between firms and universities.

While there remains some debate as to whether proximity to a research university is a necessary condition of dynamic regional development, it most certainly is not a sufficient condition. This is well illustrated by the experience of Johns Hopkins University and the Baltimore region. Johns Hopkins University has an international reputation in medical, scientific and engineering research and is the single largest recipient of US federal government research funds. However, despite the presence of

Johns Hopkins University, Baltimore has a lagging regional economy. There has been a very limited spinoff and development of technology intensive industry. Feldman (1994) attributes the failure of the Baltimore region to capture the benefits of proximity to a major research university to the absence of an effective knowledge infrastructure. There has been limited clustering of related firms and industries in the Baltimore area and an under representation of appropriate sources of venture capital. For its part, Johns Hopkins University has not shown the same success in training students that it has in attracting research funding and has failed to encourage the entrepreneurial activities of its staff.

Evidence from case studies of successful regional development – and unsuccessful development such as in the Baltimore region – thus points to the importance of a knowledge infrastructure. It is the quality of this infrastructure which determines the extent to which the outputs of universities, the production of knowledge and of graduates, are absorbed by the regional economy. Further case studies will help in the identification of the very varied foundations of a knowledge infrastructure, including industrial liaison agencies, research and innovation centres, and bodies to facilitate networking between firms, and between the firms and universities concerned.

6. Conclusions

Universities have the potential to make an enormous contribution to regional development. This potential is increasing all the time as the importance of knowledge and information within the global economy increases. However, the involvement of universities in regional development is neither unidirectional nor unidimensional. Universities are not the sole originators of knowledge. Economic relationships which feed back from local business to universities may be equally important. Regional economic development policy and practice are multilayered with universities involved at different levels and in different roles. Perhaps the key characteristic of the learning region is the way in which knowledge is transferred between different actors in the regional economy to create learning systems.

While some aspects of the relationship between universities and effective regional development are not well understood, progress is being made. Analysis of the relationship between universities and regional development has moved well beyond the familiar university spending impact studies. There is more appreciation and understanding of the importance of knowledge effects. Quantification of these effects is still in its infancy but the number of case studies is increasing rapidly.

Finally, it is worth restating the principal arguments of this paper. Universities have distinct, significant impacts upon their regions but through their spending and that of their staff and students. They have far fewer clearly identifiable knowledge effects upon their regions. Moreover, it appears that developed university-business relationships are not a necessary condition for dynamic regional performance and certainly not a sufficient condition.

References

Anselin, L., Varga, A. and Acs, Z. (1997) "Local geographic spillovers between university research and high technology innovations", *Journal of Urban Economics*, 42(3), pp.422-428.

Anselin, L., Varga, A. and Acs, Z. (2000) "Geographical and sectoral characteristics of academic knowledge externalities", *Papers in Regional Science*, 79(4), pp.435-443.

Armstrong, H. (1993) "The local income and employment impact of Lancaster University", *Urban Studies*, 30(10), pp.1653-1668.

Audretsch, D. and Stephan, P. (1996) "Company-scientist locational links: the case of biotechnology", *American Economic Review*, 86, pp.641-652.

Beck, R., Elliott, D., Meisel, J. and Wagner M (1995) "Economic impact studies of regional public colleges and universities", *Growth and Change*, 26, pp.245-260.

Blake, C. and McDowall, S. (1967) "A local input-output table", *Scottish Journal of Political Economy*, 14, pp.227-242.

Braczyk, H-J., Cooke, P. and Heidenreich, M. (eds) *Regional Innovation Systems: The Role of Governance in a Globalised World*, UCL Press, London.

Clark, B. (1998) *Creating Entrepreneurial Universities: Organisational Pathways of Transformation*, Pergamon Press, Oxford.

Cooke, P. and Morgan, K. (1998) *The Associational Economy*, Oxford University Press, Oxford.

De Bernardy, M. (1999) "Reactive and proactive local territory: cooperation and community in Grenoble", *Regional Studies*, 33(4), pp.343-352.

Feldman, M. (1994) "The university and economic development: the case of Johns Hopkins University and Baltimore", *Economic Development Quarterly*, 8, pp.67-76.

Felsenstein, D. (1996) "The university in the metropolitan arena: impacts and public policy implications", *Urban Studies*, 33, pp. 1 565-1580.

Florax, R. and Folmer, H. (1992) "Knowledge impacts of universities on industry: an aggregate simultaneous investment model", *Journal of Regional Science*, 32(4), pp.437-466.

Hudson, R. (1999) "'The learning economy, the learning firm and the learning region': a sympathetic critique of the limits to learning", *European Urban and Regional Studies*, 6(1), pp.59-72.

Goddard, J., Charles, D., Pike, A., Potts, G. and Bradley, D. (1994) *Universities and Communities: A Report for the Committee of Vice-Chancellors and Principals*, Centre for Urban and Regional Development Studies, Newcastle University.

Harris, A., Lloyd, M.G., McGuire, A. and Newlands D (1987) "Incoming industry and structural change: oil and the Aberdeen economy", *Scottish Journal of Political Economy*, 34(1), pp.69-90.

Harris, R. (1997) "The impact of the University of the Portsmouth on the local economy", *Urban Studies*, 34(4), pp.605-626.

Jaffe, A. (1989) "Real effects of academic research", *American Economic Review*, 79, pp.957-970.

Johnes, G. (1993) *The Economics of Education*, MacMillan, London.

Keane, J. and Allison, J. (1999) "The intersection of the learning region and local and regional economic development: analysing the role of higher education", *Regional Studies*, 33(9), pp.896-902.

Keeble, D., Lawson, C., Moore, B. and Wilkinson, F. (1999) "Collective learning processes, networking, and 'institutional thickness' in the Cambridge region", *Regional Studies*, 33(4), pp.319-332.

Lucas, R. (1988) "On the mechanics of economic development", *Journal of Monetary Theory*, 22, pp.3-39.

MacPherson, A. (2002) "The contribution of academic-industry interaction to product innovation: the case of New York State's medical devices sector", *Papers in Regional Science*, 81, pp.121-129.

Morgan, K. (1997) "The learning region: institutions, innovation and regional renewal", *Regional Studies*, 31(5), pp.479-490.

Oatley, N. (1998) "The role of further and higher education in local economic development", *Local Economy*, 13(3), pp.255-257.

- OECD (1992) *Technology and the Economy: The Key Relationships*, OECD, Paris.
- O'Neill, H., Bane, D. and Fefer, A. (1996) *Columbia University's Contribution to the New York City Economy*, Appleseed, New York.
- Psacharopoulos, G. (1979) "On the weak versus the strong version of the screening hypothesis", *Economics Letters*, 4, pp.181-185.
- Rauch, J. (1993) "Productivity gains from geographic concentration of human capital: evidence from cities", *Journal of Urban Economics*, 34, pp.380-400.
- Romer, P.M. (1990) "Human capital and growth: theory and evidence", *Carnegie-Rochester Conference Series on Public Policy*, 32, pp.251-286.
- Rutgers University (no date, 1994?) *Return on the Investment: The Economic Benefits of Rutgers University to the Citizens of New Jersey*, Rutgers University, New Jersey.
- Slaughter, S. and Leslie, L. (1997) *Academic Capitalism: Politics, Policies and the Entrepreneurial University*, Johns Hopkins University Press, Baltimore.
- Smilor, R, Dietrich, G. and Gibson, D. (1993) "The entrepreneurial university: the role of higher education in the US in technology commercialisation and economic development", *International Social Science Journal*, 45(1), pp.1-11.
- Stone, I. (2000) "Universities – at the heart of regional economic development?", *Northern Economic Review*, Spring/Summer, pp.69-93.
- Raco, M. (1999) "Competition, collaboration and the new industrial districts: examining the institutional turn in local economic development", *Urban Studies*, 36(5/6), pp.951-968.
- Saxenian, A. (1994) *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Harvard University Press, Cambridge, MA.

Valenzuela, M. and Moreno, J. (1995) "Universities and economic restructuring in postindustrial metropolitan society: the case of Madrid", *European Urban and Regional Studies*, 2(1), pp.81-84.

Varga, A. (1998) *University Research and Regional Innovation: A Spatial Econometric Analysis of Academic Knowledge Transfers*, Kluwer Academic Press, Boston.