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David Charles

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UNIVERSITIES AS KEY KNOWLEDGE INFRASTRUCTURES IN REGIONAL INNOVATION SYSTEMS

David Charles

There are different dimensions to the role played by universities in regional innovation. One perspective is to examine the different forms of knowledge and knowledge transfer in the form of commodified knowledge, human capital and social capital. A second perspective is to look at different governance and policy contexts and consider national systems of higher education, national programmes for regional innovation as well as regionally specific interactions. Examples of university engagement in Europe across these different scales are presented. Overall, there is a need for integration and joining up of policies at the regional scale.

Universities are increasingly recognized as having a key role to play in the regional development process (Goddard *et al.*, 1994; Keane & Allison, 1999; Chatterton & Goddard, 2000). The role of universities in this respect is likely to further increase given the development of a 'knowledge-intensive' economy and society—both in terms of the expansion of the knowledge sector itself and in terms of the growing focus on information and knowledge in all sectors and activities. Subsequently, universities across Europe have been seeking an intensification of their engagement with regional development issues and the regional development community.

This engagement is taking place in the context of a wider set of changes with which universities must contend. These include changes in the educational role ascribed to universities with the move from elite to mass higher education (Delanty, 2002); changing funding regimes as states seek to control the education budget and increase the 'efficiency' of universities (Shattock, 2003); changes in the uses of technologies in education and research (the 'virtual' university) (Robins & Webster, 2002); a growing crisis of legitimation around the academic role and identity of the university and its claims to a monopoly of certain types of knowledge and learning (Readings, 1995; Barnett & Griffin, 1997); changes in the regime of 'knowledge production' (Gibbons *et al.*, 1994); and an increasing awareness of universities as having a major economic role: as an employer, as a source of technological know-how and as a source of human capital development in promoting a flexible and adaptable workforce (Goddard & Chatterton, 1999).

Much of recent thinking on processes of regional development stresses the role of knowledge as a development factor, often raising it to an overwhelming importance relative to more traditional factors such as labour and capital (Morgan, 2004). In the

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framework of this discourse, universities and other knowledge infrastructures occupy a key role as resource endowments within the region but also, more interestingly, as active participants in the construction of regional competitive advantage (Goddard & Chatterton, 1999). It is necessary, however, to develop a conceptual framework for understanding the customary or routine role that universities may play in processes of regional economic development and not just as an account of exemplary regions. Indeed, the question is whether there are institutional variations in university roles that contribute in some way to differential regional outcomes.

Universities are one element of regional institutional systems that are struggling to adapt to the needs of a global process of competition for investment and jobs. The importance of the universities derives from their role in the knowledge generation and transfer process that underpins the success of regions in attracting and retaining high value-added activities in the form of mobile capital and talent (Florida, 2005) or through processes of endogenous development. Cultures of learning, association and institutional adaptation shape the extent to which universities can be beneficial to regions but are themselves supported by the work of universities.

This article examines some of the ways in which universities engage with processes of regional development with a particular focus on innovation. First, we examine different forms of knowledge and its application through university regional engagement, thereby providing a rationale for a broader model of the university role. This is then followed by a discussion of the scales of regulation and policy which govern the engagement of universities in their regional innovation systems.

Universities and Different Forms of Knowledge

Knowledge as a Commodity

Models of endogenous development from the 1980s identified universities as sources of knowledge which could be commodified for use within the local economy either through licensing or the formation of new firms. As a result, much of the contemporary debate about the role of universities in regional economic development has focused on technology transfer and spin-off firms (see, for example, Charles & Howells, 1992; Etzkowitz, 2003). The positive experiences of a few exemplary regions during the 1970s and early 1980s led to a flurry of initiatives centred on science parks and technology transfer offices. These have, however, been variably successful (cf. Luger & Goldstein, 1991; Charles *et al.*, 1995; Bruhat *et al.*, 1995).

Central to models of endogenous development, which are based on the concept of the appropriation of knowledge, is the assumption that the university is able to exert control over intellectual property (IP): the commercialization or commodification of knowledge is dependent on the exertion of ownership rights over the knowledge developed within university research (Webster & Rappert, 1997). In some countries, this led to the devolution of IP rights to individual universities, not least in order to motivate university management and staff to actively engage in this process (Etzkowitz, 2003). In parallel, a number of mechanisms and policies were developed for enhancing the commercialization process, such as the support for spin-off firms (Charles & Conway, 2001). As an aside, it is important to recognize that the commercialization of university knowledge is not constrained to conventional areas of science and technology but can

also apply to the humanities, cultural science and management. The IP issues may be less clear, but the principles of exploitation are similar.

However, the question of who pays and who benefits remains central in a system of publicly funded science, where a presumption of open science as a public good may be regarded as in conflict with the desire for the commodification of knowledge produced and ultimate private benefit. There is a conflict inherent in the contract between society and the individual in certain forms of formal intellectual property rights (IPRs), such as patents, where the individual inventor is expected to make public the knowledge of the invention in return for monopoly rights to exploit that knowledge for a period of time. In more traditional academic discourse, knowledge is made available without such restrictions, through open publication, but other scenarios may be presented whereby knowledge is appropriated without any form of open communication. Given such a variety of forms of appropriation/communication, governments responsible for funding universities as well as university management have been much concerned over the effect of policy on the site of appropriation and the allocation of benefits.

Knowledge can be appropriated on three different spatial scales: international, national and local. A common concern of policy makers, and the prime reason for the introduction of a regime of appropriation within the university system is the desire to prevent free appropriation on an international level. Different regimes of governance over the process of appropriation can be used to attempt to control the location of the benefits. If IPRs are managed by the university and traded in return for revenue, then the university can control the location of exploitation to some extent, but the interests of the institution may be best served by international exchange through higher licence fees. For national government or regional interests this may be undesirable, and local appropriation either through an existing local company or a new spin-off may be preferred. The location of benefits, and the ability of the ultimate funder of the research to control that location depends on the negotiation of the interests between the various parties: firms, individual inventors, universities, national government and regional interests. The use of commodified university knowledge in a region will therefore depend on national policy contexts and relations between national and regional policy tools.

Knowledge as Human Capital

An even more important element of the role of universities in economic development is in the formation of human capital through the education of students as well as training activities for people already in work. Yet recent frameworks for understanding the formation of human capital, such as the learning economy perspective, look beyond formal education and training in defining the kinds of learning needed in an economy (Lundvall & Johnson, 1994). Lundvall and Johnson stress the importance of interactive learning as the basis for innovation and change in modern developed economies. They define the learning economy as an economy where the success of individuals, firms and regions reflects the capability to learn but also to forget old practices; where old skills rapidly become obsolete and new skills are equally rapidly in demand; where learning is not just about increased access to information but also, more importantly, about skills and the building of competencies; where learning is all-encompassing across societal sectors and does not merely take place in high-tech sectors; and where net job creation is in knowledge-intensive sectors.

Within the learning economy different kinds of knowledge can be identified. First, *know what*, that is facts and information. Second, *know why*, that is principles and laws necessary to reduce trial and error; third, *know how*, that is the skills and capability to do something; and finally *know who*, that is information about who knows how to do what and the social capability to establish relationships to special groups in order to draw on their expertise. Each of these different forms of learning uses different channels for knowledge exchange. In the case of know what and why, formal learning in school and universities is the normal channel. Know how depends on practical experience through tacit learning (e.g. through apprenticeships) but also increasingly through network relationships with industrial and commercial partners. Finally, know who is learned from social interaction via professional associations, day-to-day dealings with customers, sub-contractors and a wide range of other actors and agencies.

Universities are therefore likely to address only a part of the learning needs of a region, although particular policies may seek to extend their involvement beyond 'know what' and 'know why' to 'know how' and 'know who'. However, universities in many countries have traditionally focused on the 'know what' and 'know why' and produced raw graduates for a national labour market dominated by large public- and private-sector employers, with little concern for SMEs, the non-profit sector or graduate retention in local labour markets. This model has begun to break down in response to changing patterns of employer demands such as the decentralization of large corporations into clusters of smaller business units and the greater role of smaller businesses as sub-contractors, suppliers, franchisees, etc. with consequent implications for the skills required of graduates and the location of the recruitment decision. At the same time, regional agencies are promoting graduate retention initiatives as a way of upgrading the stock of higher level local skills. In parallel with these demand-side changes the expansion of higher education provision together with rising numbers experiencing the need to change career later on in life is leading to a growing supply of mature local students for undergraduate and postgraduate programmes. Such developments place new requirements on universities to engage in a wider perspective on learning and encompassing what we might term network knowledge which enables graduates and other people undertaking training to better integrate in their regional economy.

This is problematic for a university as such network knowledge is a hybrid form of knowledge that is neither completely public nor completely private. It depends on trust rather than the market and is characterized by such considerations as reliability, honesty, cooperation and a sense of duty to others. Network knowledge refers not only to the skills of individuals but the transfer of knowledge from one group to another to form learning. Because network knowledge is highly dependent on interpersonal relations, it can most readily be developed within a particular region, thus Florida (1995, p. 532) argues that to be effective in this increasingly borderless economy, regions must be:

defined by the same criteria and elements which comprise a knowledge-intensive firm: continuous improvement, new ideas, knowledge creation and organisational learning. Regions must adopt the principles of knowledge creation and continuous learning; they must in effect become *learning regions*.

Other writers have emphasized more institutional questions in understanding the role of learning in regional development (Morgan, 1995). Key to such an idea of the learning region, however, is the human infrastructure and the institutional mechanisms that foster

interactive learning, and a central part of this infrastructure, in terms of the reproduction and adaptation of human resources, should be universities.

Notwithstanding these developments, comparatively little is known about the flow of students through higher education into local labour markets in many EU countries and how this relates to the overall economic performance of regions. Yet a key characteristic of the learning region is the way in which knowledge is transferred from one group to another to create learning systems. In terms of universities this includes knowledge of the appropriate skills and competencies required of the workforce.

What constitutes 'appropriate skills' will depend on the overall regional development strategy, be it indigenous development based on local enterprise, exogenous development based on attracting inward investment, or a combination of the two, for example by upgrading local suppliers to support and 'embed' inward investment. In this context, the analogy between regions and organizations is one in which personnel management based around handling individual employment contracts and personal development shifts to human resource development which harnesses people development to the strategic objective of the organization. So the key question becomes: does the region include human resource development as part of its overall strategy? This question raises a number of specific challenges concerning the *type* of training programmes, *what* institutions are best placed to provide the programme, and *where* within the region, or for that matter outside, this provision should occur.

Knowledge as Social Capital

Although most research has focused on the direct contribution of universities to the economic success of their localities, a further question concerns the indirect contribution of universities to the social and cultural basis of effective democratic governance and, ultimately, economic success. For example, Putnam *et al.* (1992) have shown the strong relationship between a civic culture and institutions (understood as 'norms of reciprocity and networks of civic engagement') and wider socio-economic performance. Regions or localities that are rich in such networks 'encourage social trust and co-operation because they reduce incentives to defect, reduce uncertainty, and provide models for future co-operation'. In so far as universities are by tradition classically 'civic' institutions, they can play a key role in the development of the cultural and political determinants of socio-economic success. A key challenge is to enhance the role which universities, and their staff and students, play in the development of such networks of civic engagement, and hence in the wider political and cultural leadership of their localities (e.g. through the formal and informal engagement of universities in the local political process, through university staff serving as elected politicians or providing a source of talent for local administrations, contributions to the media, etc.).

Connecting together these ideas of knowledge as a commodity, human capital and social capital, we can see the potential for universities to occupy a key and integrating role in regional innovation systems (Braczyk *et al.*, 1998). Innovation systems require all of these forms of knowledge in combinations that are both coherent and mutually reinforcing; yet there is another challenge facing universities in their regional engagement, and this is the way in which they integrate across different levels of governance between the region and its actors and the national and even international levels.

Universities and Regional Innovation Systems

The contribution of universities to innovation activities in their regions is well researched at the level of case studies, but the emphasis tends to be placed more on individual mechanisms than on the roles of the university in the regional innovation system as whole.

Support for innovation in business is perhaps the least controversial area of university regional engagement from a policy perspective and has been subject to considerable international transfer of policy lessons. However, there are three key questions to be addressed here:

- Do different *national systems of HE* encourage and adequately resource these activities, and provide appropriate institutional governance systems?
- Do the *national systems support interaction with regional innovation systems* as distinct from national orientation, and are there dedicated incentives and funding for such initiatives?
- How do universities negotiate with *regional governance systems* to deliver mutually desirable policy outcomes?

The following three sub-sections examine each of these forms of national–regional policy development with selected examples drawn from the European UNIREG study of university engagement in regions.¹

National HE Frameworks and Regional Innovation Systems

National higher education regulatory systems act on many aspects of the innovative potential of universities, not least through their effect on patterns of recruitment and training of students. Innovation systems must encompass the nature of human capital development, but our focus here is on more direct support for industry through research and technology transfer. National frameworks have a number of specific points of relevance here:

1. The regulation of the appropriation of knowledge—how do universities or their staff appropriate and thereby control the ways in which their knowledge and discoveries can be valorized economically?
2. The role of universities in national research and innovation policies—are universities seen as economic development motors nationally or regionally, and therefore are they encouraged through public investment and regulation to collaborate with industry?
3. The distribution of research resources across universities—are there differences in the level of research intensity between universities, and how do these differences map out across the regions?
4. How is research in the universities funded?—is it primarily nationally funded or is there a significant regional element, and what are the implications for the scale and orientation of research in the universities in different regions?

The question of appropriation is the most fundamental as it lies at the heart of institutional autonomy and freedom, and the public-good nature of university research. At one extreme, the Anglo-American or liberal model of universities sees the state as a part-funder and regulator of universities, which are independent non-profit bodies. Thus UK

universities, though established by Act of Parliament, are autonomous charitable bodies receiving in many cases less than 40% of total income in government block grant. Regulatory control varies in nature, between say the UK and Australia, but typically permits universities control over their own activities, including intellectual property and freedom to engage in a range of income-generation activities. Thus universities in the UK may benefit financially from the stimulation of spin-off companies, contracts with industry, commercial property development, etc., subject only to the limitations implied by non-profit status where applicable. In this model governments may seek to encourage greater participation in innovation through various grants and incentives, rather than through direct managerial control.

At the opposite extreme, the state-controlled model sees universities as publicly controlled bodies subject to direct state control, delivering state objectives in teaching and research, but restricted as to commercial activities and in some cases even restricted as to ability to exert ownership over intellectual property. In this model the universities are unable to enter into economic development activities for income generation as their budgets are state managed. If there is any direct contracting with industry or IP exploitation it tends to be done by individual professors through consultancy operations. So Finnish universities do not own land or property but lease buildings from a state-controlled company, and in many EU countries academics as public servants are prohibited from taking management positions in spin-off companies.

In reality, the state-controlled system has been modified in most countries to enable some interaction with industry, whilst the Anglo-American model moves further into a set of market relationships, including those relating to core government funding. Thus although rights over IP are now well established in Anglo-American systems such as the UK, Ireland and Australia, there have been developments elsewhere to encourage university IP ownership. In Germany the universities are just beginning to take ownership of IP, as it was formerly left to individual professors to patent and license their inventions.

This question of institutional autonomy links also with the role of universities in national economic development. The role of the universities can be seen in two dimensions—the role of state-funded institutions in innovation and economic development, and the balance between universities and other organizations in the state-funded sector. All of the countries within the study recognized to some degree the responsibility of the state in innovation, although with varying levels of investment. The primary difference, however, was in the importance placed on non-university organizations. In Germany the universities are but one of many state-funded research institutions, and economic development is more centrally seen as a role for the Fraunhofer centres and Fachhochschulen. So the role of universities is seen more in terms of teaching and basic research (Kunzmann & Tata, 1999). In contrast, in Ireland the universities are the primary research and innovation institutions owing to a relative absence of other state-funded bodies (Boucher & Wickham, 1999). In Spain and Greece the universities are important in quantitative financial terms, but a historically low level of involvement with industry as a result, at least in part, of strong state control means that a new emphasis on innovation is resulting in a parallel process of university reform and the creation of new intermediaries (Garcia, 1999).

Questions relating to the distribution of research resources have a fundamental effect on regional development at several levels: through the direct economic impact, through the spill-over arising from spin-offs and labour market interactions, and through

wider effects on indigenous and exogenous development strategies. Typically, countries with a primate city and structure and centralist government have seen highly concentrated R&D within the university as well as government and private sectors. This has certainly been true of Ireland, Greece, Finland and to an extent Spain and the UK too. Only Germany, the Netherlands and Australia have had a more balanced distribution of research resources due to a mixture of federalist policies (in Germany and Australia) and a concept of equality among universities (in Germany and the Netherlands). Changes in the university system in recent years have in some cases ameliorated these imbalances with the development of new provincial universities, although often with relatively low research budgets, although there may be some new universities established specifically with a research and economic development mission.

The UK and Spain are more complex though. For many years in the UK there has been a widely dispersed system of universities, reinforced by 1960s expansion and the unification of the university and polytechnic systems in 1992. However, despite all regions containing some research excellence, the quasi-market funding of research, based on research assessment, has the effect of concentrating research resources, with 33% going to just five institutions in London, Oxford and Cambridge. In Spain there is likewise a wide distribution of universities with new institutions established in the 1980s and 1990s. The move to regional funding has increased regional R&D capacity, but the historic dominance of Madrid continues alongside Barcelona. Thus regional variations in the ability of universities to meet the aspirations of their regions in terms of research infrastructure and orientation towards regional innovation systems remain subject to national university policy.

National Programmes for Regional Innovation

Given the national funding of most university systems, engagement in regional innovation systems is invariably underpinned by national funds, whether general university funds or more specific regional programmes. The latter has been a growing element of the university policy framework in recent years as governments have sought to encourage universities to support SMEs, usually within the local region, and to address regional economic disparities through innovation programmes.

National funding for regional innovation has tended to fall into three categories:

- national programmes to encourage innovation involving collaborative activities and implementation in each region;
- national strategic developments in selected regions only, to foster centres of excellence, often in disadvantaged areas;
- national funding for regionally initiated schemes.

The latter of these will be discussed in the next section in the context of regionally initiated developments as the national role tends to be reactive, but the first two are our present focus.

National programmes for regional innovation have taken on a wide variety of forms. One dimension is the nature of the support—research infrastructure, technology transfer, graduate placements, consultancy, demonstration sites—the variety is extensive. Another dimension is the institutional orientation—whether project based (often departmental), university level, or based through independent intermediaries or university consortia. A

third dimension is whether there is a competitive process in the allocation of resources between regions or a fixed allocation to each university or region. Through the interaction between these a highly differentiated set of initiatives can emerge in different countries. So one option might be support for regional technology transfer through graduate placements delivered through specific projects allocated to university departments on a competitive basis, such as the UK Knowledge Transfer Partnerships. Elsewhere, investment might focus on building capacity for the management of links with business through a network of technology transfer offices located in every university such as the Spanish OTRI centres, where the general emphasis is perhaps more on changing the nature of the university than on providing a focus for regional innovation system development.

The UK shows this diversity of approaches most clearly with a number of nationally funded programmes for encouraging greater interaction between universities and business. Although funding is not earmarked specifically for interaction with regional rather than national business, in practice most universities see such national funding as involving primarily regional interaction. This funding is available to all regions (although devolution in certain regions gives them a different policy environment) although often allocated on a competitive basis according to the proposals made by universities and regional partners. The schemes concerned include the 'Science Enterprise Challenge' promoting science-based spin-offs and entrepreneurship and largely implemented through regional consortia. More significantly the Higher Education Reach Out to Business and the Community programme (HEROBC), subsequently renamed the Higher Education Innovation Fund (HEIF), which is focused largely on individual universities, seeks to build core capacities for promoting university–business interactions. These schemes complement more focused locally and nationally funded collaborative research and business support programmes by encouraging a more strategic focus for university–business interaction with new outreach offices, incubators, venture funds and programmes for cultural change within universities. Finland also provides a good example of national programmes to support regional interaction through the Centres of Expertise programme (Sotarauta, 2001).

Contrasting this with a more focused national policy, Ireland provides an alternative approach where national funding has been focused on a specific development pole in Limerick. The National Technological Park (NTP) was founded in 1984 as 'the country's first science/technology park' through a joint partnership between Shannon Development—a government agency, other regionally based agencies and the University of Limerick (UL). Specifically, 'a central activity of the Park's management is to ensure optimum usage of University facilities and services by client companies, for example, use of University library facilities, participation in Co-Operative Education Programmes and links to university research activity'.

The NTP's 'balanced blend' of overseas and indigenous science and technology companies suggests that the park provides more than simply a regional dimension to UL's research and technology transfer strategy. This balance reflects the university's overall research policy (as well as institutional ethos) which incorporates local, regional, national, European and global dimensions ideally for the benefit of the region. Thus, the NTP is the home to 'overseas companies that use the National Technology Park as their European base' as well as a 'vibrant [indigenous] sub-supply sector and a concentration of new, Irish high-technology companies' (ibid.). While linking these overseas and indigenous companies together, 'the whole thrust of the Park's development has been to harness

the technology resources on the site, and particularly those at the University of Limerick campus, towards the needs of enterprise and economic development' (Boucher & Wickham, 2000).

Localized Innovation Initiatives

The third dimension examined here is that of primarily regional interactions. I consider this with reference to the case of the North East of England where interactions were initially focused around the regional Structural Funds partnership, but have subsequently developed in collaboration with a new regional development agency.

The North East was the first UK region to form a university association in 1983 in the form of Higher Education Support for Industry in the North (HESIN) (Potts, 1999). One of the specific projects to emerge from HESIN, and indeed carried through into a successor organization, Universities for the North East, was Knowledge House (KH). The idea behind KH was that SMEs faced a range of barriers in accessing the knowledge resources of the universities. In turn, this created barriers within the regional innovation system, and discouraged regional university/SME collaboration.

KH was created in 1995 specifically to overcome these barriers, and to increase the amount of technology transfer taking place between local firms and universities. The purpose of the scheme was to create a structure which suited SMEs looking for some particular technical service. The main barrier that an SME faces in contacting a university in search of such a service is not knowing who to contact. Therefore, KH offered the benefits of a single point of contact for all five universities. KH can be accessed via a central node, based at the Regional Technology Centre in Sunderland, or any of the five university nodes. The initial enquiry would then be sent out to the relevant people at all of the five regional universities, inviting them to suggest academics who could address the identified need. Each university has a coordinator responsible for ensuring that the leads are disseminated to the correct contacts. Ideally, KH will be able to offer the SME a choice of academic consultants and will facilitate a meeting for the firm's managers to meet with and select the most appropriate person for their needs.

The Structural Funds provided part-funding for the running of the KH network, including the costs of coordinating staff and some time input from academics. Without such investment the project would not have been able to be established. A key element was the subsidy of the first five days of academic consultancy, and although the level of support provided was small, it was sufficient to overcome the inertia that academics are faced with when asked to divert effort away from their core research activities. Subsequently, with the launch of the Higher Education Innovation Fund as core third-strand funding for universities in England, as noted above, the KH activity has been funded by that source rather than Structural Funds.

The creation of a regional development agency in 1999 led to a new set of opportunities for the universities in North East England to engage within their region. The new agency was required to develop a regional economic strategy as one of its first tasks and placed the role of the universities as central to that initial strategy—indeed, as one of only six key themes the agency identified 'Placing universities and colleges at the centre of the region's economy' (see Charles *et al.*, 2001). A concordat was signed between the vice-chancellors of the universities and the agency identifying a set of common interests and concerns, although in subsequent policy developments the main emphasis has been

placed on the commercialization of university technologies associated with a set of centres of excellence established by the agency to collaborate with the universities.

Integration and Innovation

The examples above show that the patterns of interaction between universities and their regions depend on a mix of three different scales of policy and governance. In each region the nature of the specific role of universities in regional innovation systems depends on how they have combined with the strength of regional governance and local institutional thickness. Universities have also displayed different levels of capability and opportunity to make use of national frameworks and funding as part of negotiated regional strategies. At the same time, national governments have sought to create a system in which incentives are in place for universities to support regional-level innovation. The forms of multi-level governance within which universities negotiate their roles might be expected to continue to evolve, with governments at all levels increasingly benchmarking their policies against other countries and trying to further encourage universities in their interaction with business and with regional innovation strategies. Typical of this is the general trend in favour of more active management of university IP and the need to reform national regulation of this aspect of a university's activities. At the same time, governments are introducing support programmes for technology transfer and encouraging new entrepreneurship programmes.

From the perspective of the universities, they have sought to combine resources and programmes at the different scales to construct integrated innovation support infrastructures. Often this creativity is left to the individual staff of university departments, but increasingly universities are building specialized units to manage the configuration of these external relations. This provides a framework within which integration can take place between different forms of knowledge transfer—commodified knowledge, human capital and social capital. A good example of this is a focus on cluster-type initiatives at the regional scale where a range of mechanisms and funding streams is brought together by universities in partnership with regionally based cluster partners (see Charles, 2006 forthcoming, for examples of this). There are clear synergies here between the needs of a region and the needs of a university in building critical mass in terms of research as well as targeting that at economic sectors that are priorities for policy makers. Thus universities that wish to enhance their own competitiveness in international research rankings are forming alliances with regional actors to obtain additional resources through cluster-type strategies. In some cases these alliances are resulting in quite significant levels of investment: new research centres, funds to attract global star academics, or even major infrastructure. In the Australian state of Victoria the state government has paid for a synchrotron, the first in Australasia, to be constructed on the campus of Monash University. Such alliances between regions/states and universities may disrupt national university hierarchies and existing patterns of expenditure by national governments, with the competitiveness of the university being tied to the future aspirations of the region.

There is therefore no standard recipe or package that can be recommended for an appropriate role or mechanism for universities in their specific and individual regional innovation systems. Different universities in different national and regional contexts with different governances and different innovation contexts will need to adopt different combinations. The central message is that the university role needs to evolve out of these

contexts and co-evolve with the regional innovation system itself. Indeed, the governance contexts at national and regional levels are part of the innovation system as well as key influences on the responses of the universities.

It is expected that with the evolution of the European dimension to research and technology policy, and the interplay between the EU programmes and regional actors, the system will become more complex. Regions are already looking to international collaborations and the position of universities within regions will be increasingly as the key nodes between regions, connecting regional systems through networks of excellence. Again, the support from the region for international excellence and networking is a key element in building unique competences in the region, and access to European networks, and alliances even beyond this, will be one of the drivers of regional support.

Returning to the debate, in the introduction, about the nature of universities as knowledge institutions, it is clear that there are important roles for universities to play, especially the role of integrators of forms of knowledge, and this raises questions for the types of university that are needed by regions. Universities are only one among many knowledge-based institutions in regions, but their special contribution is their breadth and potential in joined-up governance, and for that some of the traditional characteristics of universities must be reinforced and defended, notably the combination of teaching and research (or scholarship) and multidisciplinary and autonomy. Successful innovation systems require the integration of research with labour markets, a connection between the research priorities and governance and public debate, and a focus on knowledge that goes beyond narrow technological priorities to include culture and creative activities, management knowledge and support for the public policies and infrastructures that underpin economic development. Universities are increasingly engaged in all of these things and not just in technology development (Charles *et al.*, 2001). Without these characteristics what is lost is not just the university as we know it but a central element in regional innovation systems.

NOTE

1. The UNIREG project was a two-year EU Fourth Framework Programme Targeted Socio-economic Research project, coordinated by the author with partners from the universities of Amsterdam, Dortmund, Joensuu, Athens, Trinity College Dublin, and the Institute for Regional Development in Seville, with an additional collaborator from the University of Southern Cross, Australia.

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