

Devolution and Knowledge Transfer from Universities: Perspectives from Scotland and Wales

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Abstract

This paper constitutes a policy analysis of university knowledge transfer-related initiatives in the devolved regions of Scotland and Wales. Both regions share a number of similar economic development constraints and are seeking to develop science-based innovation strategies in which universities play a central knowledge transfer and commercialization role. Scotland appears fairly well advanced in this regard, whilst in Wales the establishment of regional networks linking actors has been more problematic to establish. It is concluded that access to regional-level resources is an on-going constraining factor limiting the engagement of universities in regional knowledge-based economic development and regional innovation systems.

Key words: devolution; knowledge transfer; knowledge commercialization; universities; Scotland; Wales.

Introduction

Recent political and academic discourse concerning *devolution* has tended to stress the economic advantages of the transfer of power from national to sub-national institutions, characterized as the ‘economic dividend’ of devolution (Rodríguez-Pose and Gill, 2005). In the UK context, devolution in Scotland and Wales since 1997, resulting in the establishment of the Scottish Parliament and the National Assembly of Wales in 1999, has introduced a partially devolved system of higher education, science and research. Although the divergence of higher education policies predates devolution in the UK, this has become more marked over the last decade (see Universities UK, 2008). Nevertheless, it is notable that whilst some powers and responsibilities related to science and innovation policy are devolved to regional governments, national (and transnational) governments still tend to retain significant influence. The power structures in which these institutions interact affects how innovation systems operate regionally and nationally in the globalizing knowledge economy (Kitagawa, 2007). National and regional debates on the regional science and innovation paradigm and the role of universities and higher education institutions (HEIs) are intrinsically linked to these wider issues over governance and devolution, which constitute a multi-level governance (MLG) structure of science and innovation policy (Perry and May, 2007).

In many regions, universities are viewed as the core of the knowledge base and at the heart of the knowledge economy, acting as key elements of innovation systems, supporting science and innovation-based regional growth (Huggins et al., 2008). The processes of globalization and the ‘hollowing out’ of the state (Jessop, 2004) with the

growing significance of city-regions (Scott, 2001; Turok, 2008), and the rise of knowledge-based economy and the (re)emergence of interactions between state, academic and industry through the so-called 'triple helix' model (Etzkowitz and Leydesdorff, 1997; 2000), have been associated with an increasing importance being given to the role of universities in regional economic development (Goddard and Chatterton, 1999; Chatterton and Goddard, 2000). Consequently, university-industry interactions often seem to have been 'subsumed into broader analytical and normative policy debates' concerning innovation and local and regional development (Srinivas and Viljamaa, 2008).

The institutional multi-level dimensions of devolution processes conditioned by different forms of 'economic governance' (Jones et al., 2005; Cooke and Clifton, 2005; Goodwin et al., 2005) and knowledge transfer and exchange between different actors constituting innovation systems warrant further investigation and analysis. Knowledge transfer is seen as one of the priority areas in the UK's research and innovation policies. The effects of devolution on higher education, research funding and the management of knowledge transfer are a growing area of policy concern (Universities UK, 2008). Both Scotland and Wales have developed distinctive institutional mechanisms as part of the political devolution process.

After introducing the two case regions, the focus of the paper is primarily a policy level analysis of knowledge transfer and exchange between academia, governments and industry in Scotland and Wales. Some of these processes have been accelerated by recent devolution, whilst others are constituted through a longer history set apart from the recent devolution process. Scotland and Wales clearly have different histories and different processes of devolution, and it is not the purpose of this paper to compare these. Rather, the aim of this paper is to highlight different structures and institutional mechanisms through which knowledge capabilities are constructed, and identify different patterns of interactions through which triple helix systems are emerging. Furthermore, the paper focuses on a specific actor in the devolution process, namely, universities as dynamic institutions and research actors, and issues concerning the economic governance of knowledge transfer from universities through the devolution process.

The following broad empirical questions are asked throughout this paper: (1) In what ways have processes of devolution impacted on the ‘regional triple helix systems’ of Scotland and Wales respectively? (2) How have policies and strategies for innovation and science, knowledge transfer/exchange from HEIs in Scotland and Wales evolved post-devolution? and (3) What are the main differences in terms of commercialization resources/mechanisms/incentives and performance of HEIs in Scotland and Wales compared with non-devolved English regions of the UK? By reviewing policy discourses and the development of policy initiatives over the last decade, this paper critically examines how processes of devolution *should* and/or *could* facilitate more tightly bounded regional triple helix systems’ and also impact on the developments of the knowledge commercialization performance of higher education institutions (HEIs) in devolved regions. Attention is drawn to the development of regional science and innovation policies, and the strategies implemented by the two case study regions in terms of mobilizing stakeholders to enhance regional innovation and knowledge capabilities, and supporting universities to effectively transfer their knowledge, and for regional businesses to effectively absorb such knowledge.

The paper is structured as follows: the second section provides a review of the literature concerning ‘multi-scalar governance relations’ of science and innovation policy associated devolution. The third section presents quantitative data indicating different types of activities and the impact of the transfer and commercialization of knowledge from HEIs in Scotland and Wales, vis-à-vis English regions. The fourth and fifth sections provide an overview of the evolution of relevant policy in Scotland and Wales respectively. The six and seventh sections focus on the development of university knowledge transfer activities and initiatives. The final section discusses the findings from a theoretical perspective by critically examining the ‘regional triple helix system’ concept. The paper concludes with issues for future research concerning the development of regional triple helix systems and key policy implications.

Regional Science Policy, Higher Education and the Political Economy of Devolution

Science policy has not traditionally been considered a 'legitimate policy target of devolution and regionalization processes' whereas the division of responsibility over innovation and technology policy seems to be more complex (Perry and May, 2007, p1042). Although some powers and responsibilities related to science and innovation policy are devolved to regional governments, national (and transnational) governments still tend to retain significant influence, especially with regard to the social shaping of the 'national science base' (Pavitt, 1998). The processes of globalization and the 'hollowing out' of the state, in parallel with the rise of the knowledge-based economy, and the increasing significance of locality and spatial proximity in economic development and innovation processes, has drawn both policy and academic attention (Huggins and Izushi, 2007). In this respect, several authors have advocated a 'territorially contextualized triple helix model', which arguably can contribute to the formation of regional innovation systems (Coenen and Asheim, 2006; Cooke, 2004).

As Chatterton and Goddard (2000) argue, the issue of territoriality is not so straightforward for universities. To begin with, three spatial levels of activities can be distinguished in the higher education landscapes, namely, international, national and regional/local. These three levels are not exclusive but complement each other. Today universities always hope to be part of 'an international knowledge network', but increasingly even the most traditional and prestigious ones look to their region and locality for support, and also claim credit for adding to the area's economic and social strength (Lawton Smith, 2007; Kitson et al., 2009; Huggins et al., 2008). For example, universities have an important role to play in preserving local jobs, diversifying the local economy and attracting inward investors. Universities as knowledge infrastructures affect the knowledge flows between themselves and other institutions and actors at different geographical scales. The internationalization of university-industry relations has been rapidly developing. Etzkowitz (2002) argues that 'the triple helix' interaction between university-industry-government is a move towards a new global model for the management of knowledge and technology, where an internationalization strategy emerges within domestic policy structures. In this context, one could argue that universities may fulfill a useful role in blurring the line

between these different levels by ‘regionalizing’ world class and small high technology firm relationships, and by making knowledge available to actors whose innovative locus is much more regional in character. Therefore, any ‘regional triple helix systems’ needs to be seen as part of the ‘co-evolution’ process between ‘global and national structures’ and ‘global-national-regional interactions’(Sotarauta and Kautonen, 2007).

In general, although there is recognition that universities are potentially key players in achieving economic transformation, the underlying policy perspective is that they are often under-utilized. In the field of higher education policy, UK policy over the last decade has witnessed a growing alignment between the ‘third stream’ activities of universities and regional economic development (NCIHE, 1997; Charles, 2003; Goddard and Chatterton, 1999). Indeed, recent years have witnessed a plethora of policy interventions highlighting both national and regional government commitment to science and technology, and the importance of the higher education sector in achieving a step change in the UK’s innovation performance by facilitating the growth of the knowledge economy. The last decade has witnessed the transfer and commercialization of university-generated knowledge taking a stronger role within government policies at a number of levels (Lambert, 2003; Sainsbury, 2007; Wellings, 2008; Kitson et al. 2009). However, it has been pointed out that there is still a lack of understanding of how to create effective impacts through knowledge transfer from universities, and the role of regions as part of these processes (Porter and Ketels, 2003). Also, there has been little systematic analysis of differences in the relative contribution of HEIs and their knowledge across UK regions (UNITE Network, 2006; Huggins and Johnston, forthcoming). There are considerable differences in capabilities in the regions and firms to “effectively absorb knowledge” from universities (Huggins et al., 2008). Furthermore, the recent Sainsbury Review identified the complexity and fragmentation of the mechanisms for knowledge transfer and exchange as a barrier to business engagement.

There has been a growing evidence base, both in the academic literature and policy documents, indicating that economic development and the welfare of regions can be enhanced through universities’ various engagement with the local economy, including research, infrastructure development, education, effective industry-university

partnerships, technological innovation and community development (Kelly et al., 2002; Universities UK/HEFCE, 2001; Benneworth and Charles, 2005; Lawton Smith and Bagchi-Sen, 2006; Huggins et al., 2008; SURF et al., 2006; Kitson et al., 2009). An emerging policy concern seems to be ‘the need to align or match regional knowledge producing networks with regional firms’ (Uyarra, 2008). However, recent work has also begun to question the high level of policy expectations, with little understanding of the actual processes of knowledge flows, and the extent to which regional economic development can be actually achieved through the utilization of university knowledge (Power and Malmberg, 2008; Huggins, 2008).

Moreover, there is a lack of clear understanding of the influence of devolution processes on regional knowledge flows from universities. These processes are conditioned by a number of factors including the size of the region; the nature of the regional scientific infrastructure; the types of firms and structure of the industrial base; the scientific/technological fields of importance in regions (Crespy et al., 2007), and the institutional multi-scalar dimensions of governance processes. Devolution, defined as ‘the relative transfer of power and responsibility from the nation state downward to other units of government and governance’ (Jones et al., 2005, p.398), adds further to the dynamics of institutions in the regional science and research landscape, and opens up a number of issues concerning power-relations, different forms of economic governance and forms of public policy. As pointed out by Jones et al (2005) and other contributors in the special issue on devolution and economic governance in *Regional Studies*, the structures and strategies of devolved economic governance are interrelated in a complex way (Jones et al., 2005), shaped by patterns of intergovernmental interaction and existing governance structures between national and sub-national actors. For instance, when comparing economic development financing and devolved state action across the UK, Cooke and Clifton (2005) identify emerging and different ‘institutional structures of economic governance’.

A burgeoning literature has emerged on sub-national government and governance in an attempt to interpret these developments (e.g. Keating, 1997; 2005; Pike and Tomaney, 2004, 2009; Jones et al., 2005; Lobao et al., 2009). One of the central questions for regional policy in the devolved policy context in the UK is ‘whether there is sufficient fiscal decentralisation and capabilities within the regions for

regional governance structures to promote growth and convergence' (Frenz and Oughton, 2005). Devolution in Scotland and Wales has introduced a partially devolved system of higher education, science and research, whilst the situation for the English regions - without an elected regional government structure - remains 'fluid and variable' (Perry, 2007). In England, with the establishment of Regional Development Agencies (RDAs), 'central government-sponsored regionalism' and 'politicization of economic governance' (Jones et al., 2005) co-exist with processes concerning the 'territorialization' of higher education, specifically at the regional level (Warren, et al., forthcoming).

University Knowledge Transfer: Regional and Institutional Landscapes

Higher education policy in Scotland and Northern Ireland is largely developed, while in Wales powers over higher education are devolved to the Welsh executive body, the Welsh Assembly Government, but not until now to the National Assembly for Wales, although this could happen in the future (Universities UK, 2008, p.7). A key concern for the devolved administrations is that despite increased autonomy, the nature of geographic variations across the UK in the demand for higher education mean that English universities are becoming markedly better funded in comparison to institutions in Scotland and Wales (Universities UK, 2008). This especially pronounced in Wales, which still does not have full legislative power for the higher education sector, where the investment gap with England has been estimated to be of the order of £60 million annually (Universities UK, 2008).

At the same time, the UK Government's proposals to shift research funding to a fewer number of departments are likely to lead to a major redistribution of research activities and to bring about highly differential effects, not only on institutional research profiles but also on regional research capacity and diversity (Universities UK, 2003). In England, as a result of its funding mechanisms, there has been a growing concentration of research funding in a few institutions such as Cambridge and Oxford Universities, and Imperial College, further intensifying resources in the so-called "golden triangle". Consequently, there is growing "variability" in the capability of universities to conduct research and to transfer knowledge in their regions and beyond (Huggins, 2008). As a recent report points out, to some extent, the funding bodies in the devolved administrations (e.g. Scottish Funding Council (SFC),

Higher Education Funding Council for Wales (HEFCW)) have recognized the impact of the concentration of research funding in a few institutions in England on their institutions' competitive ability to bid for those research funds available on a UK-wide basis (Universities UK, 2008, p.47).

Table 1 highlights the value added per employee by universities in the UK aggregated at a regional level (see Huggins and Johnston, forthcoming, for a fuller discussion). Significantly, average value added per employee for universities in both Scotland and Wales is less than the overall UK average. The final column of Table 1 indicates the relative contribution of GVA generated by the higher education sector to regional GVA as a whole. Across the UK's regions, Wales is the most dependent on its higher education sector, providing 1.36% of total GVA. The dependency of Scotland is also above the UK average, but it is considerably less than that in Wales. These differences have a clear bearing on policies, both national and regional, promoting the role of universities as catalysts of economic development. In particular, it suggests that while the more competitive regions may be able to benefit from being the home of the majority of the UK's most prestigious and wealthiest universities, more lagging regions - such as Wales and to a lesser extent Scotland - are likely to contain a greater concentration of institutions that are less able to compete in the higher education marketplace with their more prestigious counterparts.

Table 1 About Here

Utilizing data from the annual Higher Education and Business Community Interaction Survey (HEBCIS), which is made freely available by the Higher Education Funding Council for England (although the dataset also covers institutions in Northern Ireland, Scotland, Wales and Northern Ireland), it is possible to calculate the income received by universities in relation to the knowledge transfer and commercialization (KTC) activities. In this case such income includes that received from collaborative research involving both public funding and funding from business, contract research, consultancy contracts, facilities and equipment related services, courses for business and the community, and IP income from patent and licensing activities. Table 2 indicates total KTC income per HEI employee at a regional level across the UK. The list is headed by Wales, with Scotland also having a level of KTC income per employee

above the UK average. Further scrutiny of the data finds that KTC income in Wales has been significantly boosted in recent years due to a rapid rise in collaborative research income received by one institution – Swansea University in connection with the development of the Technium initiative.

Despite this boost, HEIs in Wales have only increased its KTC income between 2001/02 and 2006/07 only slightly more than the UK (120.4% cf. 118.5%). However, this is a higher rate than that achieved in Scotland over the same period. The English regions of the North West, South, West Midlands, Yorkshire and Humber have shown the biggest increases over the period, although there is significant variability across England as a whole. Perhaps the marked feature of the data is that for the UK as a whole recorded, KTC income has more than doubled over a five year period (which may be a result of better accounting on behalf of universities as much as actually increases to income streams). The right-hand column of Table 2 lists the proportion of commercialization income HEIs source from within their region (with the exclusion of collaborative research income for which source data is unavailable). It is highly noticeable that HEIs in Wales source only 8% of their commercialization income from within the region, far lower than HEIs in any other region (with Scotland on a relative par with most English regions). This potentially indicates the existence of a lack of demand from firms within the region for the types of knowledge Welsh universities are capable of supplying. This suggests that regional contexts are an important influencing factor on the economic and innovative performance of universities.

Table 2 About Here

In Scotland, three institutions – the universities of Edinburgh, Glasgow, and Strathclyde - account for more than one half of the KTC income received by the higher education sector (Table 3). A further three institutions – Aberdeen, Heriot-Watt, and Dundee – for a further one third. This indicates a relatively high spread of income and activity across the region's universities, which is stark comparison to that in Wales where two institutions – Cardiff and Swansea – receive more than two thirds of total income (Table 4). However, although this represents a significant concentration of income and activity it is also a shift from the previous situation

whereby activity was largely dominated by Cardiff University alone. The growth in knowledge transfer activity in Swansea, particularly those associated with the Technium initiative, indicates the development of a more balanced picture of higher education involvement in knowledge transfer in Wales, but the gap between the universities of Cardiff and Swansea and other HEIs in the region highlight that more needs to be done if Wales is to achieve the level of distributed activity found in Scotland.

Tables 3 and 4 About Here

Policy Evolution in Scotland

The Scottish Government was established in 1999 as the Scottish Executive, from the extant Scottish Office. Following the 2007 Scottish Parliament election, the Scottish Executive was renamed as the Scottish Government by the new Scottish National Party administration. Scotland has a long-established regional development agency (Scottish Enterprise) established in 1991, combined with a world-class research base (Lyll, 2007). In 2005, Higher Education expenditure on R&D (HERD) was £688 million. Scotland's HERD as a percentage of GDP ranked top out of all the UK regions. However, there has been a significant gap in business R&D expenditure between Scotland and the UK and the OECD averages ((Scottish Government 2008a). However, Scotland is characterized by 'low levels of connectivity between knowledge generating and applying organizations' (Roper et al, 2006).

Scotland was the first region in the UK to seize the opportunity to develop a regional science policy. The recent 'regional science policy model' in Scotland seems to be promoting new *institutionalized* strategies of universities and the funding council, including knowledge exchange activities and strategic approach to research funding and resources in order to compete in a *globalizing* knowledge economy, with an increased emphasis upon their *regional* policy agendas through the *devolution* processes. This has been effective to a point. In *A Smart Successful Scotland* (Scottish Executive, 2001a), three key themes were identified: (1) Growing Businesses; (2) Ensuring Global Connections and (3) Enhancing learning and skills of Scots. A "Global Connections Strategy" (Scottish Executive, 2001b) sets out Scotland's

strategic direction for taking advantage of the opportunities in the knowledge economy and ensuring that Scotland is a globally integrated economy.

It is argued that in the field of science, technology and innovation policy, the Scottish Parliament inherited ‘both a suite of existing UK policies and also a distinctive Scottish trajectory in regional innovation policy and economic development’, characterized as ‘concurrent power’ (Lyll, 2005). In January 2001, the Minister of Science published *A Science Strategy for Scotland* (Scottish Executive, 2001c). The Science Strategy stresses the need to maintain a strong science base and increase the effective exploitation of scientific research. This resulted in increased resources for university science as well as increased funding for knowledge exploitation initiatives such as the Proof of Concept awards and Royal Society of Edinburgh (RSE) Enterprise Fellowships (Lyll, 2005).

Even prior to pre-devolution, there has been a strong policy focus from the Scottish Government, for agencies of Government to “work in partnership with the universities and research institutes to identify and to help take forward promising new commercialization opportunities as they emerge from the research base” (Reeves et al 2009). These agendas were further developed by the new administration in 2007 as part of the Government Economic Growth Strategy (GES), which sets the target to raise Scotland's GDP growth rate to the UK level by 2011 and to match GDP growth rate of the small independent EU countries by 2017. The recent publication by the Scottish Government of ‘Science for Scotland’ (2008b) further endorsed the promotion of commercialization. The Scottish Government sees the contribution of higher education sector in Scotland as ‘a sector in its own right’. In Scotland, there has been a growing commitment to knowledge exchange from academic sector. The Scottish Government has acknowledged that ‘knowledge exchange can and should be used to improve Scotland’s social and economic well-being’.

It should be noted that Scotland has developed an interface organizational model such as the Alba Centre/ The Institute for System Level Integration (which provides postgraduate education, professional training and research in system level integration through four universities – Edinburgh, Glasgow, Heriot-Watt and Strathclyde) and Intermediary Technology Institutes (ITIs). They are successful examples in terms of

organizational structure to integrate knowledge transfer and training into wider research and innovation at the regional level, in order to deal with the exploitation of research and relationships with external organizations. However, Scotland's 'post-devolution' science policy seems to continue to focus on the 'supply side', namely the science base in Scottish universities, disregarding the 'demand side' role that could be played by firms (Lyall, 2007, Roper et al., 2006). How to encourage knowledge exchange activities through embedding 'users' more in the process remains a big issue.

The Scottish Funding Council (SFC) was established in 2005 by combining the roles of the former Scottish Further Education Funding Council (SFEFC) and the Scottish Higher Education Funding Council (SHEFC). Since its inception in 2001/2, Knowledge Transfer Grant (KTG) is the main funding stream for knowledge transfer/exchange in Scottish HEIs. The Knowledge Transfer Grant for 2008-09 is £21.5 million, largely allocated on the basis of relative volume of income from knowledge exchange activity as measured by SFC's metrics (HEFCE, 2008). Cullen (2009) argues that KTG has contributed to "a much greater awareness of KT, a much broader understanding of the range and objectives of KT and, importantly, an embedding of KT within the institutional strategy". Recently, SFC has created a new strategic knowledge exchange grant for 2008-09 - the *Strategic Priority Investment in Research and Innovation Translation* (SPIRIT) will be set at £2 million and will enable strategic knowledge exchange projects to be targeted. SPIRIT meets SFC's corporate plan objectives to 'improve the flow of knowledge, expertise and ideas, to businesses, enterprises and public services' and to 'work with key partners to develop knowledge exchange activities that enhance innovation in public policy and practice in Scotland and strengthen the policy community' (SFC, 2006). SPIRIT will facilitate a range of strategic knowledge exchange investments including projects of national priority as well as those prioritized by SFC.

A key recent policy development in Scotland is that of 'research pooling'. This is a regional response to create 'international research excellence' by 'pooling' specific areas of research excellences that are seen to be of strategic importance to Scotland across universities in the region. The development of 'research pooling' initiatives is interesting against the background of devolution as well as globalization of science,

technology and innovation policy on the one hand, and changing higher education policies and environment in the UK on the other. Research pooling initiatives may be seen as strategic instruments to enhance research capacity and competitiveness of both universities and the region (and sub-regions), attracting students and professors from abroad (Kitagawa, 2009).

Policy Evolution in Wales

As a result of the devolution process in the UK, the National Assembly for Wales was created and became operational in 1999. The National Assembly has responsibility for developing economic policies within the context of central UK policy frameworks giving policy makers in Wales more autonomy than before. Of the twelve regions in the UK, Wales is the least competitive with the exception of only North East England (Huggins and Izushi, 2008). It has the lowest level of Gross Value Added per Capita of all UK regions, coupled with levels of pay, productivity, employment and economic activity that are all significantly below the UK average. A lack of regional innovation is identified as a major barrier restricting the growth of the regional economy, which is manifested by relatively low levels of investment in R&D.

The Welsh Assembly Government's Action Plan for Innovation (WAG, 2002) was one of the first post-devolution policy documents to outline an innovation strategy, with particular emphasis given to the incubator facilities through Technium initiative. Techniums are a key strand of the region's economic development and innovation strategies. This has ensured support from the highest levels of government and academia. The long-term goal for the Techniums is for them to be the foci across Wales for innovation in the knowledge-based industries. Policy intervention has further supported and encouraged commercialization developments through the Wales Spin-Out Programme, which concentrates on the development of arrangements designed to create high quality businesses from the higher education sector. Complementary to the Spin-Out Programme, the 'Know How Wales' initiative, launched in 1999, provides a gateway to university facilities and expertise for existing companies seeking assistance to expand or establish new products and markets. The Lambert Review (Lambert, 2003) identifies the role of Know How Wales as good practice in linking business and academia. In 2001, the Knowledge Exploitation Fund (KEF) was launched to work within the Welsh university community (and further

education institutions) to ‘generate a more entrepreneurial and innovative culture; produce more skilled trainers; increase the training interaction with Welsh industry and accelerate the commercial exploitation of research’. KEF had an annual budget of £16m including European Structural Funds support (WAG, 2004).

In some ways, until 2008/09 government intervention in this area in Wales had not radically altered since devolution. The key knowledge transfer and commercialization activities funded in Wales included: Centres of Excellence for Technology and Industrial Collaboration; the Wales Spinout Programme; a Patent and Proof of Concept Fund; Collaborative Industrial Research Partnerships; Technology Transfer Networks, and Technology Transfer Centres. From the end of 2008 knowledge transfer and commercialization policy has been overhauled with existing funded activities repackaged under two programmes: Knowledge Exploitation Capacity Development; and Knowledge Transfer and Industrial Research. These two programmes are marketed under the ‘Academia for Business’ (A4B) brand, and is supported by a six-year £70 million funding package from the Welsh Assembly Government and European Structural Funds. A4B is advertised as consisting of ‘the best elements’ of previously funded programmes, particularly the Knowledge Exploitation Fund and the Centres of Excellence. A4B aims to support a range of activities in higher and further educational institutions to develop more effective knowledge transfer mechanisms, to commercialize their Intellectual Property, develop new products and processes, increase business investment in R&D and develop and exploit the research base.

At the time of writing it is impossible to say whether or not the new policy approach in Wales will be more successful than its predecessors, but the capturing of significant European finance for these activities does provide a very real opportunity to develop a system of sustained and coherent support, which was a major criticism, recognized by WAG, of previous modes of intervention. Key targets for A4B are: to stimulate new business ideas and help launch as least sixty new products and processes onto the market; act as a catalyst to leverage in an additional £9m of funding into research projects and support more than 120 R&D collaborations; and perhaps most ambitiously to help at least 2,000 businesses to benefit from collaborating and working with universities. It is envisaged A4B will achieve these targets through

activities such as funding audits of intellectual property held by academic institutions to pinpoint projects with the best potential for commercialization; to evaluate potential projects of strategic value to Wales; and to fill the funding gap between basic early research and the start of the market exploitation. The initiative will provide revenue funding for commercial managers and technology specialists and capital funding to invest in new technology and markets.

An important reason underlying the focus on universities as agents of knowledge transfer is that Wales only has two private sector research establishments: the Institute of Grassland and Environmental Research (IGER) at Aberystwyth, and the Centre for Ecology and Hydrology (CEH) at University of Wales, Bangor. The Science Policy for Wales document (WAG, 2006) stated that: ‘no one now builds new government research establishments...It may be a regrettable situation but it is a situation which has to be faced.’ (p. 4). However, the coalition Welsh Assembly Government of Labour and Plaid Cymru established in 2007 resulted in a reversal of this view, with the WAG stating ‘we will work to establish a National Science Academy....we will establish new National Research Centres. (WAG, 2007, p. 25). However, despite the pronouncements apparent development of such an academy and research centres have been too slow to emerge. Indeed, the indications are that rather than new funding being made available, finance will consist of that already allocated by WAG to the funding council. For instance, more than £3 million is due to be provided to a number of Welsh universities to establish a Wales Institute of Visual Computing (WIVC) with the aim of developing an internationally-leading research capacity. Although this is applauded, it would appear that connecting universities strengths is something which should be additional to, rather than instead of, proposed new knowledge and research infrastructure funded through already allocated finance. This has led some to claim that ‘by seeking to develop a Knowledge Economy ‘on the cheap’, the Assembly Government risks losing out to competitor economies across Europe and within the UK’ (HEW, 2008).

University Knowledge Transfer in Scotland

In Scotland, there are 20 universities and higher education institutions, which are funded by SFC. Scottish universities are generating significant income from knowledge exchange activities. In the two year period between 2005 and 2007, the

total reported income from knowledge exchange activities amounted to £583 million, consisting of external research grants, contracts and consultancy (64%), licensing (4%), venturing (8%), enterprise (2%), CPD (18%) and outreach (4%) (Scottish Government, 2008c).

Scottish Enterprise has taken several proactive approaches to strengthening the commercialization of Scottish academic research base through initiatives such as the ITIs, the Enterprise Fellowship Programme and the Proof of Concept awards. These programmes were set up to address the gap between where Scotland has considerable strength in its science base but less success in commercialization (Roper et al., 2006; Lyall, 2007). In 1999, the Proof of Concept Fund was established and funded £33 million in 2004 available over a six year period. When the Proof of Concept Programme was first established there were no comparable initiatives within the UK or mainland Europe. Due to the relatively weak business demand for state of the art research, it was considered to be critical that new companies were created ‘to ensure the most promising ideas emerging from the research base are taken forward’. The Proof of Concept Programme responds to this opportunity by providing funding support for ‘technical activity, protection of IP, market assessment and business model development’ (Reeves et al., 2009). An independent evaluation, announced in October 2006, found that the Programme will generate £125 million gross value added (GVA) for the Scottish economy.¹

Intermediary Technology Institutes (ITIs) were created with the aim of building on the strengths of the Scottish economy by strengthening the commercialization of research. Scottish Enterprise committed £450 million investment to the ITIs. ITIs fulfill a coordinating task that helps to identify, commission, and/or acquire and diffuse pre-competitive research, and a particular emphasis is on Scottish universities, research institutes, as well as existing and nascent SMEs in the fields of communication technology and digital media, life sciences and energy sectors (OECD, 2004). The creation of ITI Scotland in 2003 was a specific intervention by the Scottish Executive to help to address the “Growing Businesses” theme identified in *A Smart Successful Scotland*, focusing on ‘strengthening the link between Scotland’s research base and business innovation and addressing low levels of business R&D’. To date, ITI Scotland has committed over £150 million in research programmes

(Edgar, 2009). There are also several innovation schemes to help Scottish universities work with small to medium sized enterprises (SMEs) in response to the problem of weak links between universities and small industry in Scotland. For instance, the SEEKIT programme is designed to support projects that will promote co-operation in R&D and knowledge transfer between SMEs and the Scottish public sector science base (e.g. universities, Research Institutes, Technology Transfer Organizations, NHS Trusts etc).

Since 2004 SFC funds the Scottish Institute of Enterprise (SIE), which aims to promote an entrepreneurial culture in higher education by providing opportunities for students and researchers to obtain business and management skills and so enhance the contribution of higher education to growth in the economy, employment and productivity. In addition to KTG and SPIRIT, SFC also has a small grant which targets the promotion of knowledge exchange (PKT). The PKT grant (£470k in 2007-08) is used to promote good practice in, raise awareness of, and improve information about, research expertise, commercialization and knowledge exchange more generally. The grant funds initiatives such as Interface, Technology Ventures Scotland and Connect and research and evaluations which provide an evidence base for policy development. Funded projects are often joint activities with other stakeholders recognizing that they sit at the boundary between the supply of, and demand for, knowledge and innovation support. For example, *Interface* – the knowledge connection for business – was set-up in 2005 and is funded by SFC. It is a central point of access for industry to Scotland's research base that provides a unique service designed to address the growing demand from businesses seeking to engage with academia for knowledge and expertise.

University Knowledge Transfer in Wales

The higher education sector in Wales consists of 11 institutions (previously 12, until the merger in 2007 of the Royal Welsh College of Music and Drama). The annual economic contribution that Welsh universities make to the regional economy is estimated to be more £2 billion, when direct and indirect effects are taken into consideration, supporting over 23,000 (HEW, 2009). The university sector is by far the major producer of R&D in Wales, with Cardiff University spending the majority of the total university R&D expenditure in Wales. In general, there has been little

history of interaction between the higher education sector and businesses in the region, universities often targeting large-scale industrial research projects rather than providing services for SMEs in their localities, which is often considered by universities to be non-cost-effective in comparison to working with large firms.

As a response to the existence of a largely laissez-faire triple helix approach, which does not cater for the needs of the region (and has been constrained by an apparent lack of political autonomy), the regional innovation plan explicitly highlights the need for further policy intervention to stimulate university-industry interaction, clearly indicating a political will to evolve to a regime based on overlapping spheres. In Wales, knowledge transfer is supported via the Higher Education Funding Council for Wales (HEFCW)'s Third Mission Fund, with the bulk of the funding allocated on a formula basis. From 2008, a substantial increase in the support available for third mission activities has been available via the Welsh Assembly, which was successful in attracting around £50 million from the European Regional Development Fund (ERDF) for two knowledge exploitation and transfer programmes marketed as Academia for Business (A4B) (HEFCE, 2008).

As highlighted above a key policy development is the Technium programme. These Techniums, of which there are nine throughout Wales, can be classified as either hub or satellite facilities. The management of seven of the Technium involves Swansea University, with the hub Techniums being non-sector specific, with the satellites focusing on particular sectors. Techniums house the full range of incubator support services and the combination of specific and non-sector specific Techniums are designed to allow a balance between networking and clustering: the hub Techniums concern creating sectorally diverse clusters of high-tech and knowledge-based early stage companies; while satellite Techniums focus on networking opportunities for firms within a single sector. Links with academia are regarded by policy-makers as critical to the success of the Techniums. The Techniums also provide space for university spin-outs and house possible graduate employers. As Abbey et al. (2008) note, partnership arrangements with Fudan University in Shanghai has actually resulted in two high-technology Chinese originated firms entering one of the Techniums. Although the early-stage success of the Technium initiative has been disputed (Cooke and Clifton, 2005; Abbey et al., 2008), they at least herald a long-

term investment in the knowledge-based infrastructure that is lacking in Wales. Overall, some estimates suggest that the Technium programme has created more than 550 jobs, worth some £74m, with additional estimated benefits of 760 jobs indirectly supported, worth a further £63m (HEW, 2009).

A leading example of knowledge transfer activity in Wales is Cardiff University's 10-year £25 million agreement with Biofusion, a specialist commercialization company listed on the London Alternative Investment Market (AIM), to provide a ring-fenced fund to invest in companies spun out from the university's research base. The Wales Gene Park initiative also successfully bid to become one of six prestigious gene parks in the UK. Funded by the Welsh Assembly Government, the UK Government and the NHS, the Park aims to exploit the bioscience expertise of five Welsh universities. The first phase of this development, a virtual gene park, is underway but funding issues appear to have somewhat dogged overall development in light of those expected by the initiative's key players. The requirement to internationalize the knowledge networks of Wales' universities has most been prominently recognized by the University of Wales federated institutions through the introduction of The Prince of Wales Innovation Scholarship Programme, which aims to 'attract the world's most talented graduates to work with Welsh businesses'. The programme is seeking to recruit 1,000 of the world's best graduates between 2009 and 2012 to help improve research and development capability and cutting edge thinking in Wales. Also, an independent review of the need to improve of the commercialization of the knowledge residing in Welsh universities recommended the creation of advisory panels comprising experienced and successful entrepreneurs, which are currently being piloted in three institutions (Gibson, 2007).

Discussion and Conclusion

There are a number of policies that governments pursue seeking to promote innovation, including policy initiatives to foster the commercialization of university research, encourage firms to invest in R&D, and encourage the activities of venture capital funds. As Driver and Oughton (2008) argue, the important task for public policy is to characterize accurately the "interplay of causal factors in innovation expenditure", but "identifying the nature of what is required (or how to intervene) is methodologically difficult". The review of policy interventions in the two case study

regions identify several similarities, as well as differences, in terms of regional intervention towards strengthening the role of the university sector in constructing 'regional innovation systems' through triple helix linkages. To be effective, policy initiatives to promote regional innovation require detailed knowledge of the locality and the engagement of a range of regional and non-regional actors. Establishing regional cooperation across universities is considered to be an important element of creating critical mass in less competitive and more peripheral areas (Siegel et al., 2007). There is an underlying assumption that the knowledge generated by universities can be best made use of by networking it regionally (or locally), when increasing evidence suggests that the best use of knowledge is made by linking it globally (or least non-regionally/locally) (Huggins and Johnston, forthcoming).

Since their establishment in 1999, the devolved governments in Scotland and Wales have facilitated partnership development between universities and industry to support more effective collaboration between the knowledge and research base and the business community, particularly within identified key regional growth sectors. In both Scotland and Wales, regional triple helix systems are in the process of creation, shaped by different policy and politics in action. The question is - do they lead to the creation of regional knowledge capabilities? As we have discussed, knowledge transfer is seen as one of the priority policy agendas in the UK research policies. In terms of organizational structure to integrate knowledge transfer into wider research and innovation strategies at the regional level - in order to deal with exploitation of research and relationships with external organizations - an interface organizational model might be more appropriate. Scotland appears fairly well advanced in this regard, and Wales, as well as English regions, can learn from the collaborative environment fostered by their higher education sector. In Wales, a regional wide system of triple helix like linkages, covering government, business and higher education actors, has been problematic to establish given the apparent dominance of one, and more latterly two, institutions in the area of higher education knowledge commercialization.

In order for regions to operate through global network nodes as part of a global-regional innovation system, communities surrounding universities need to have the capability to absorb and exploit the science, innovation, and the technologies

generated by the universities (Florida, 1999). However, there is often considerable differences in the capability of universities to effectively transfer their knowledge, and of regional businesses to effectively absorb such knowledge (Huggins, 2008). In general, firms and regions are better placed to innovate if they have built up “the right resources and capabilities” (Driver and Oughton, 2008). This process is also conditioned by structural, institutional and social factors that interact within regions (Boucher et al 2003), and the articulation of regional policies and the ability of universities to effectively mobilize stakeholders for innovation (Uyarra, 2008). Universities, it is clear, have an important role to play at regional level in the development of the knowledge economy within the devolved policy structures. However, for universities, strategic balance is also important. There is a need to assess the benefits to universities relating the outcomes of knowledge transfer activities to the core mission of teaching and research in their own institutional settings and strategies (Warren et al. forthcoming).

Scotland and Wales share a number of similar industrial structures, constraints in economic development, and the range of challenges both regions are trying to address and have developed similar science-based innovation strategies in which universities play central role in terms of commercialization and knowledge transfer. One of the key differences identified in the approaches adopted in the knowledge transfer strategies in Scotland and Wales seems to be based on the economic and institutional conditions in each region. As Youtie and Shapira (2008) note, leading regions for innovation are often those with multiple nodes of research strength including universities, government laboratories, non-profit research organizations, and private-sector R&D units, while in other regions, there may be only a single dominant university and a lack of other kinds of research and industrial partners with advanced capabilities with whom the university can interact. Local regions in economic ‘catch-up’ positions without multiple nodes of knowledge generation hope that their university will serve as an “anchor tenant” (Agrawal and Cockburn, 2003) to attract other private-sector R&D facilities, such as that promoted in Wales by the Technium initiative. However, despite significant intervention, public and private R&D investment levels in Wales remain below par, and the region has lowest proportion of firms engaged in knowledge-based activities across all UK regions. Although Wales

has had extensive autonomy in recent years to establish policies tailored to creating interventions best suited to catalyzing knowledge-driven regional development, there is as yet little evidence of the accruing of economic returns from these interventions, highlighting the necessity for patience and long-term thinking within this area of policy intervention.

The complexity of the devolution process derives from the interest-conflicts of the various actors involved, and the differences in legitimacy that they share. Most importantly, the interests of sub-national and national governments tend to be at odds across the component factors of devolution. The balance between these two extremes will depend upon the relative strength, or, in political terms, legitimacy, of the two tiers of government. (Rodríguez-Pose and Gill, 2003). For instance, despite the value that devolution and regional autonomy brings to developing these agendas, there is a certain amount of nervousness among some stakeholders in Wales that the strategic coherence of UK innovation policy promoted by the UK Government may result in a focus that is rather England-oriented, and does not take adequate account of the devolved regions. Although the ability to establish regional policies to catalyze the development of innovation systems requires far more than appropriate resource allocation (Koschatzky and Kroll, 2007), a continued lack of funding does appear to be on-going constraining factor limiting the engagement of universities in knowledge-based economic development.

There are a number of remaining issues to be investigated in the future. The analysis in this paper has revealed challenges in terms of evaluating the impact of knowledge transfer and commercialization from research bases in their regions, especially in measuring wider “non-quantifiable impacts” and the benefits of policy intervention. The real impact of initiatives such as the construction of business incubators, the delivery of venture and seed funds and regional innovation support services on regional competitiveness may not be achieved for many years after funding ceases (Warren et al. forthcoming). There is also a need for policy makers at both regional and national levels to recognize the complexity of interactions between the local, national and global levels, and the institutional multi-level dimensions and co-evolution of science and innovation policy, especially through devolution processes. In order to embed ‘regional triple helix system’ in the wider context of economic

governance in the globalizing knowledge economies, science and innovation policy should include wider elements of ‘proximity’ than a geographical one (Boschma, 2005; Wink, 2008). This has to be combined with spatial resource management and institutional strategies on the one hand, and issues concerning joined-up public policies from multi-scalar perspectives on the other.

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Table 1: Regional HEI Value Added 2005/06

Region	HEI Value Added per Full Time Equivalent Employee (£)	Total Higher Education Value Added (£000s)	Contribution to Regional GVA (%)
Eastern England	48,016	913,116	0.83
London	47,371	2,558,439	1.30
Northern Ireland	42,488	269,142	1.02
West Midlands	40,183	899,526	1.01
South East	39,982	1,595,976	0.90
<i>Scotland</i>	<i>39,539</i>	<i>969,618</i>	<i>1.07</i>
North East	38,624	511,966	1.32
<i>Wales</i>	<i>38,577</i>	<i>578,773</i>	<i>1.36</i>
East Midlands	37,409	736,900	0.99
North West	37,181	1,174,995	1.06
South West	37,056	712,005	0.80
Yorkshire and the Humber	36,991	1,004,509	1.22
UK	40,759	11,924,965	1.03

Source: Huggins and Johnston, forthcoming

Table 2: Knowledge Transfer and Commercialisation (KTC) Income Received by HEIs per Employee (FTE)

Region	KTC Income per FTE Employee (£)	% Change in KTC Income 2001/02-2006/07	% of KTC Income Generated from each HEI's Region
<i>Wales</i>	8,751	120.4	8.4
North East	8,417	81.9	21.9
Eastern England	8,175	68.0	23.3
London	7,840	141.6	23.6
<i>Scotland</i>	7,678	107.6	22.6
South East	7,168	116.4	23.0
North West	6,077	179.4	35.1
West Midlands	5,955	162.4	24.4
East Midlands	5,438	63.4	25.5
South West	5,210	170.3	18.2
Yorkshire and the Humber	4,874	144.6	29.8
Northern Ireland	3,692	23.5	59.9
UK	6,717	118.5	

Source: Authors' calculations based on data from the annual Higher Education Business and Community Interaction Survey (<http://www.hefce.ac.uk/econsoc/buscom/hebci/>)

Table 3: Knowledge Transfer and Commercialisation (KTC) Income Received by HEIs in Scotland

	KTC Income (£000s)	% of All Scotland Total	KTC Income per FTE Employee (£)
University of Edinburgh	41,619	17.9	6,543
University of Glasgow	39,326	16.9	8,401
University of Strathclyde	38,729	16.7	12,533
University of Aberdeen	32,308	13.9	11,475
Heriot-Watt University	22,959	9.9	15,232
University of Dundee	19,819	8.5	6,479
University of St Andrews	9,121	3.9	4,878
Glasgow Caledonian University	8,308	3.6	4,863
Robert Gordon University	7,140	3.1	5,468
University of Stirling	5,813	2.5	3,723
University of Paisley	3,117	1.3	2,993
Queen Margaret University College Edinburgh	2,210	1.0	4,520
University of Abertay Dundee	1,130	0.5	1,892
Glasgow School of Art	552	0.2	1,718
Royal Scottish Academy of Music and Drama	70	0.0	349
Scotland	232,221	100.0	

Source: Authors' calculations based on data from the annual Higher Education Business and Community Interaction Survey (<http://www.hefce.ac.uk/econsoc/buscom/hebci/>)

Table 4: Knowledge Transfer and Commercialisation (KTC) Income Received by HEIs in Wales

	KTC Income (£000s)	% of All Wales Total	KTC Income per FTE Employee (£)
Cardiff University	49,271	35.6	10,093
University of Wales Swansea	49,224	35.6	25,203
University of Wales, Bangor	11,545	8.3	7,242
University of Wales, Aberystwyth	7,888	5.7	4,813
North East Wales Institute of Higher Education	6,024	4.4	13,589
University of Wales Institute, Cardiff	4,520	3.3	4,245
University of Glamorgan	3,816	2.8	2,366
Swansea Institute of Higher Education	1,949	1.4	4,119
University of Wales, Newport	1,398	1.0	2,044
Royal Welsh College of Music and Drama	1,170	0.8	7,773
Trinity College Carmarthen	950	0.7	3,620
University of Wales, Lampeter	670	0.5	2,744
Wales	138,425	100.0	

Source: Authors' calculations based on data from the annual Higher Education Business and Community Interaction Survey (<http://www.hefce.ac.uk/econsoc/buscom/hebci/>)

¹ The figure was based on the achievements of the Programme at that date and an initial investment of £28 million . <http://www.academici.com/blog.aspx?bid=3069> accessed 14 July 2009