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**Universities, Technology and Innovation Centres and Regional Development:
The Case of the North East of England**

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Abstract

The paper examines the role of Technology and Innovation Centres (TICs) in bridging the gap between the university research base and industry in order to foster economic development in a lagging industrial region. The context is provided by an academic literature on the role of universities in regional innovation systems, some of which casts doubt on the capacity of universities to operate in this domain, particularly within a lagging region. The empirical case reports on a bold experiment initiated by the Regional Development Agency in the older industrial region of the North East of England to create and support new TICs in the fields of process innovation in high value manufacturing and new and renewable energy, and on the engagement of a regionally committed university with these centres. The evidence presented suggests that while there are links between the university and the centres both are principally operating in a national science and technology system in which contributing to addressing uneven regional economic development is a secondary concern.

Introduction

This paper focuses on the role of intermediate organisations in the form of technology and innovation centres (TICs) in bridging the gap between the local university research base and industry within a region. It is set within the context of the higher education and regional policy drivers that are encouraging universities to become more engaged with regional business innovation (Lambert, 2003; OECD, 2007, 2011). As OECD has demonstrated the nature of these drivers and associated barriers to engagement are highly contingent on regional and national circumstances and the differences between industrial sectors. So the paper asks the question: to what extent can TICs overcome barriers between a university and specific industries within a particular regional and national context?

Following a discussion of the literature on the role of universities in regional innovation systems, the paper focuses on one of the UK's lagging regions, the North East of England, its largest research intensive university, Newcastle University with part of its mission being '*to contribute to the economic, social and cultural development of North East England*'. The paper examines the links between the University and two sector-based and regionally funded TICs, the Centre for Process Innovation (CPI) and the New and Renewable Energy Centre (Narec), both of which were established by the Regional Development Agency (RDA), One North East. These relate to sectors undergoing major technological change where the region has significant historically shaped industrial assets and a university with academic areas mirroring the older industrial base of the region, but research strengths in new and emerging technologies relevant to the sectors. By focussing on areas of engineering where the exploitation of the research base is not characteristically via spin-outs but by the scale

up of laboratory processes, the paper highlights the role of *external* agencies providing this capacity rather than *internal* intermediaries like university technology transfer offices (see Wright *et al.*, 2008).

Following a review of *The Current and Future Role of Technology and Innovation Centres in the UK*, TICs are here defined as ‘organisations focused on the exploitation of new technologies, through an infrastructure that bridges the spectrum of activities between research and technology commercialisation. ... TICs are mission-driven organisations that develop their in-house knowledge and capability by working closely with leading Universities ... through publicly funded R&D and innovation programmes. ... Typical activities and outputs of TICs therefore include the development and scaling up of manufacturing processes, and the production of technology and application demonstrators’ (Hauser, 2009, pp.5). This definition fits the activities of the North East centres and the paper considers how and in what ways such activities are beyond the scope of academic units within the University and its technology transfer function, even within an institution strongly committed to working with the world outside of academia.

The paper draws on unpublished papers, presentations, consultant’s reports and contractual documents from the RDA, Newcastle University and the centres. These have been supplemented by in-depth interviews with key decision makers in each of these organisations and other universities in the region and with individual academics, with the object of triangulating collaboration from within and without the University. We concentrate on one university because of its explicit regional mission, the significant funds it received from the RDA to support that mission, and the access we had to key officers,

academics and documentary evidence. The analysis covers a ten year period of 'active' regional policy from 1998 to 2008 and the stages whereby a 'bottom up' approach by the RDA to building a bridge between industry and the research base within a region becomes incorporated into a national system of Technology and Innovation Centres and the associated multi-level governance issues. It concludes by assessing the sustainability of the regional role of these particular TICs and the regional engagement of Newcastle University in the light of this incorporation and the withdrawal of long term regional sources of funding that underpinned the public good dimension of the links between the University and the region. From this specific UK experience some lessons concerning the mobilisation of universities in support of European regional and innovation policy are drawn.

Universities, regional innovation systems, and intermediaries

Research on national systems of innovation helped broaden understanding of innovation from a process that takes place linearly within firm boundaries to an outcome of network interactions, technology transfer, and other knowledge spillovers between a range of institutional actors (Lundvall, 1992; Freeman, 1995; Metcalfe, 1995). In economic geography, a regional innovation systems (RIS) framework was developed (Cooke *et al.*, 1997; Braczyk *et al.*, 1998; Iammarino, 2005) by combining this systemic perspective on innovation with existing institutional and evolutionary based theoretical understandings of regional economies (e.g. see Storper, 1997; Cooke and Morgan, 1998; Gertler, 2004). The RIS concept shows that the various institutional resources that collectively influence innovative capabilities in a territory (including productive culture, learning, and financial

system components) are unevenly distributed at the (sub-national) regional as well as national scale (Cooke *et al.*, 1997). The evolutionary strand of economic geography has focused on how 'path dependent' technological change is shaped by existing regional institutional environments, which are themselves products of their area's industrial history (Boschma and Lambooy, 1999; Martin and Sunley, 2006; MacKinnon *et al.*, 2009). This has been used to explain the decline of regions that had specialised in traditional heavy industries in terms of institutional rigidity leading to technology path 'lock-in' and failure to develop competences in newer innovation-dependent sectors (Grabher, 1993). Hence, the more successful regions in a knowledge-based economy have come to be seen as those with sufficient economic variety and institutional adaptability to support ongoing innovation and adjustment to changing market conditions (Boschma and Lambooy, 1999). These developments in theoretical understanding have been broadly reflected in regional policy thinking, where focus has shifted from a previous orthodoxy of attempting to transfer resources or attract investment to lagging regions, to measures aimed at developing their institutional base so as to encourage endogenous and more sustainable growth (Amin, 1999).

Universities have been a key part of these policy efforts to support bottom-up knowledge-based economic development, particularly in less successful regions where they are often amongst the most important indigenous research and innovation assets (Boucher *et al.*, 2003; Huggins and Johnston, 2009). More specifically, the emphasis placed on universities in regional policy is often as active drivers of growth in the local economy, and not merely as institutions providing indirect support by, for instance, supplying graduates to specialist labour markets (Lawton Smith, 2007). This position assumes that universities produce

knowledge that can be a valuable input to innovation in the economy, and that they are able to transfer this knowledge to industry, either by establishing collaborative relationships with firms or by seeking to set-up enterprises to commercialise the knowledge themselves (Mueller, 2006). The second of these avenues, academic-led entrepreneurship, has featured prominently in the regional innovation policy discourse around the growth of clusters in newer knowledge-based industries. This belief is founded in-part on the reported importance of mechanisms such as university spin-off firms to the genesis and growth of technology districts in locations such as Silicon Valley or Cambridge in the UK that had little previous industrial history (see Castells and Hall, 1994; Saxenian, 1994; Keeble *et al.*, 1999). University spin-off firms are seen to have a significance for regional economies that goes beyond their normally small size, because of the cumulative effects they have in upgrading the local knowledge base and stimulating the development of clusters by building links with other firms (Benneworth and Charles, 2005; Garnsey and Heffernan, 2005).

Academic-led entrepreneurship has also entailed institutional change on the part of universities. Etzkowitz (2003; 2006) refers to this approach to science and innovation policy as an '*assisted* linear model' to highlight the importance of intermediaries like technology transfer offices (TTOs) and science parks in providing an interface between academia and industry to facilitate the commercialisation of scientific research. He traces the advent of these hybrid organisational forms as a modification of the post-war American linear science-push model, which consisted primarily of the federal government directing support for research and development 'upstream' to universities instead of intervening more directly in the economy (Etzkowitz, 2006). These institutional innovations have been widely replicated so it is now a conventional feature of research universities throughout North America and

Europe to host or be affiliated with a science park and to have units like TTOs or business incubators as part of their core structures. This is reflected in a considerable literature that has grown around the relationship between technology transfer support by universities and successful academic spin-off or commercialisation (see Wright *et al.*, 2004; Markman *et al.*, 2005; Rothaermel *et al.*, 2007). The adoption of a business support function is linked to the emergence of 'entrepreneurial universities', driven by the need for institutions to develop new revenue streams (including but not restricted to the commercialisation of research) in response to falling relative levels of state expenditure on higher education (Slaughter and Leslie, 1997; Clark, 1998). In terms of their internal organisation, as well as restructuring to accommodate new central administrative units like TTOs, entrepreneurial universities have been characterised by a shifting of resources from traditional academic departments to outward-facing research centres in interdisciplinary fields such as life sciences (Slaughter and Leslie, 1997). These income-generating research groups represent another important interface between academia and industry (Etzkowitz, 2003).

Despite the evidence for academic entrepreneurship having underpinned regional growth being limited to a relatively small number of international cases, encouraging university spin-offs and other forms of university commercialisation have become a standard part of innovation policies even in less successful regions (Benneworth and Charles, 2005; Tödtling and Trippl, 2005; Harrison and Leitch, 2010). More recently, however, the notion that universities can be transformative agents within all local economies has been increasingly questioned in the regional development literature (see Lawton Smith, 2007; Huggins *et al.*, 2008; Power and Malmberg, 2008; Huggins and Johnston, 2009; Christopherson and Clark, 2010; Harrison and Leitch, 2010). Much of this critique is based on variants of what Oughton

et al. (2002, pp.97) have called the regional innovation paradox: ‘the apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities compared to more advanced regions’. Less successful regions will often not have the existing industrial capacity required to assimilate and capitalise on new knowledge or applications stemming from research in proximate universities (Christopherson and Clark, 2010). Furthermore, the innovation system in these regions is frequently partnered by a relatively weak local entrepreneurial environment (Malecki, 2009) that supports the growth of academic spin-off firms (Harrison and Leitch, 2010). These factors mean that in such regions, those universities that do generate research with industrial applications are more likely to seek commercialisation opportunities further afield, often with suitable national or international firms (Huggins and Johnston, 2009; Christopherson and Clark, 2010).

In this context, we would also question the ability of university-based ‘intermediaries’ to have an impact in supporting local business development that significantly transcends the constraints of their regional industrial environments. The ‘translational’ role of TTOs in the wider economy is likely to be restricted by their relatively limited resources and function which is mainly focused on spin outs and the management and marketing of intellectual property and serving (and protecting the interests of) the whole university (Wright *et al.*, 2008). University technology transfer offices are also usually embedded within the function that supports the winning of research funding from public research bodies and the associated ‘assisted linear model’ of innovation, whereas TICs are characteristically plugged into not only business but national innovation policies with their different logic. As primarily

educational and research institutions, the prevailing academic drivers and culture within universities are not aligned with them taking on a leading or strategic role in the development of regional economies (Huggins *et al.*, 2008; Power and Malmberg, 2008). David and Metcalfe (2007) argue that a successful 'ecology' of innovation is characterised by a division of labour between scientific and technological knowledge and all of the other factor inputs into the innovation required by firms. Because firms are very different kinds of or organisation and fulfil very different economic purpose and societal functions, this inevitably creates challenges of connection and co-ordination. For this reason they suggest that 'bridging organisations, technology brokers or boundary organisations ... not only serve to connect different components of innovation systems in responsive mode, but also perform pro-actively, by animating new connections that might not arise spontaneously' (David and Metcalfe, 2007, p.12). Nowhere is this lack of spontaneity likely to more true than in a lagging region.

It is against this backdrop that we will explore the role of Technology and Innovation Centres (TICs) as 'external intermediaries' between universities and industry (Wright *et al.*, 2008). Similarly to university-based intermediaries like TTOs, these centres can be conceptualised as organisational interfaces between the different institutional spheres of the 'triple helix' (Etzkowitz *et al.*, 2000), with the crucial difference that they typically develop from the government domain through public funding subsidy. There is an established literature on these applied research and sector support centres in national innovation systems (e.g. Crow and Bozeman, 1998; Mason and Wagner, 1999; Larédo and Mustar, 2004), and a growing interest in geography on their role in regional development (see Van Helleputte and Reid, 2004; Benneworth and Hospers, 2007; Clark, 2010). Mina *et*

al. (2009) compare TIC models in Germany, Belgium, the Netherlands, Taiwan, and South Korea. Their analysis that the funding, governance, and strategic characteristics of these centres are strongly shaped by their specific national context points to the need for further research of TIC models in different territorial settings. Studies have discussed the varying division of labour between these centres and universities in different national innovation systems (e.g. Larédo and Mustar, 2004; Edquist, 2005; David and Metcalfe, 2007), but the links between these two forms of public research organisation has less often been a focus of previous empirical research (for exceptions Fritsch and Schwirten, 1999; Mason and Wagner, 1999), despite the various types of formal and informal interactions that occur between these sometimes complementary and sometimes competing institutions. Here we will consider these interactions with TICs as a potentially important supplement or alternative to universities' contributing to economic development through academic entrepreneurship or direct collaborations with individual firms. A key advantage of such centres is that they are 'capable of identifying and 'federating' local business demand for innovation ... and channelling it towards regional/national/international sources of innovation ... which may give response to these demands' (Landabaso, 1997, pp.11). This suggests that, compared to universities, they will be strategically and functionally better positioned in RISs to address the 'regional innovation paradox' (Oughton *et al.*, 2002). These centres may also act as a policy response to 'systemic failure' in an institutionally fragmented or underdeveloped innovation system (Laranja *et al.*, 2008), but only if they develop strong links with other regional actors including universities.

Our case study in this paper covers two examples of a particular TIC model that is notable for originating at a sub-national level, having been established in the early 2000s by the

North East of England's Regional Development Agency (One North East). These centres (dedicated to supporting technological development in the field of new and renewable energy and process innovation in high value manufacturing) were part of a programme that, for the UK, has been an unusual instance of concentrated *regional* public expenditure being used to build a new innovation capability in an old industrial region in sectors of national importance and where the mode of knowledge exchange with the academic research base is characteristically not by the spin-out of new enterprises. While built off-campus because of the scale of facilities required, links to regional universities were seen as integral to the activities of the centres from the outset, as they were chosen in-part on the basis of university research strengths. The rest of this paper will discuss the ways in which these relationships have evolved as these centres have matured towards a status of more-independent national-leading centres in a dramatically changed public funding landscape. This ongoing tension between the centres' and the University's position within the national (UK) and regional (North East) innovation systems raises salient policy issues about the relationship between the scales of governance for science and technology policy (see Perry, 2007). The case studies therefore explore the vertical multi-level governance issues raised by the establishment of TICs that are funded both regionally and nationally, and the horizontal boundary issues raised by their establishment functionally and physically *outwith* a regionally ambitious university with its own embedded technology transfer organisation. These challenges lead in turn to questions around the steering, goal setting and organisational identity of the TICs, particularly in relation to their role in animating a regional innovation system embracing universities.

The North East of England, Newcastle University and national/regional innovation policy

The story of Newcastle University and the recent economic development of North East England can be characterised by a re-appraisal by key regional agencies of the potential latent assets left behind from earlier institutional formations and industrial innovations, linked to a period of devolution of some responsibility for regional development, including support for innovation, from central government (OECD 2008; 2011). Thus it is well known that the Tyneside city region was a centre of innovation and shipbuilding and electrical engineering in the 19th century. Armstrong College, precursor of the present University of Newcastle, created departments in mechanical and electrical engineering to provide a scientific and educational underpinning to local firms. Notwithstanding this support, industrial decline occurred in the 20th century but left a legacy of skills, sites and academic and training expertise (e.g. several local colleges with a focus on aspects of the maritime industries). Likewise the prosperity of another North East city region, Teeside, in the mid 20th century was linked to chemical and process industries, especially ICI which developed a strong R&D base at Wilton and links to a new chemical engineering department at Newcastle University. The collapse of ICI in the 1980s also left a legacy of skills, sites and university expertise. A new Regional Development Agency, One North East, established in 1998 recognised the failure of traditional regional policy based on attracting mobile investment on the basis of cost factors and replaced it with a new Regional Economic Strategy which focussed on building a knowledge based economy (One NorthEast, 2002; Hudson 2011). This placed universities 'at the heart of the regional economy'.

In parallel to these developments in regional policy universities were being encouraged by central government to work more closely with business and given some *non-regionally specific* funding for this purpose (Lambert 2003). Under a new Vice Chancellor appointed in 2000, Newcastle University introduced a new mission: *'To be a world class research intensive university, delivering teaching of the highest quality and playing a leading role in economic, social and cultural development of the region'*. The university very clearly signalled its intention to re-discover its roots in 'excellence with a purpose' having largely ignored the region over the previous decade (Goddard and Vallance 2009). This new mission was linked to a profound re-structuring of the university to create larger multi-disciplinary schools, research institutes, and services units (including a strengthened business development directorate) overseen by a powerful Executive Board. The restructuring took account of the 'pathways to transformation' suggested by Clark (1998) required to create an 'entrepreneurial university'; namely a strengthened steering core, an expanded development periphery, a diversified funding base and a stimulated academic heartland leading to an integrated entrepreneurial culture.

Notwithstanding such changes in Newcastle, the challenge of re-integrating the region's universities into the regional economy was highlighted by consultants appointed in 2001 by the RDA. In a report 'Realising the Potential of the North East's Research Base' the consultants noted that:

[T]he strengths of the universities and the regional firms are not particularly well matched, limiting the scope for intra-regional cooperation. ... The absence of large, research-intensive firms headquartered in the North East is a further disadvantage.

... Intermediary and technology transfer organisations are numerous, but few are effective. There are too many initiatives, most of which are too small to make much impact. There is a lack of clarity as to 'who does what' ... insufficient emphasis on industry needs, cultural and competency barriers in universities and intermediary bodies, weak communication and technology transfer mechanisms, and inadequate incentives for people from the research side to become heavily involved in business links and commercialisation.

(Arthur D. Little, 2001, pp.7-8).

According to this analysis the North East exhibited many of the characteristics of the regional 'innovation paradox' defined above (Oughton *et al.*, 2002) – a strong academic research base (the 'supply side') poorly matched to regional industrial needs, limited absorptive capacity within that industry (the 'demand side') and weak mechanisms connecting supply and demand. To overcome these weaknesses the RDA decided to create five 'centres of excellence' in areas where there was proven research strength in universities and industrial opportunities which had been identified by the consultants, alongside investment funds to assist in catalysing new ventures and growth of existing small to medium sized businesses. These included a New and Renewable Energy Centre (Narec) based at the Port of Blyth where there had already been some public investment in testing facilities for on-shore and off-shore wind, a Centre for Process Innovation (CPI) based on the former ICI research site at Wilton on Teesside, and a Centre for Emerging Nanotechnology Micro and Photonics Systems which was subsequently incorporated into CPI. While there were some research strengths in Newcastle University, these were spread across several schools; in contrast its strongest and most focussed areas in terms of established research

institutes were in the medical sciences where the region lacked an indigenous industrial base. However the RDA did decide to invest in this area in and close to the University and teaching hospital within the City of Newcastle itself, with a view to establishing a new industrial base through spin-outs and the attraction of inward investment. So the decision to establish intermediate organisations with their own facilities outside of the University and the city was: sector specific; related to the degree of research focus within the University relevant to these areas, and last but not least the opportunity to redevelop run down areas using physical regeneration funding streams as well as innovation funding.

In order to meet Treasury rules for accountability, both Narec and CPI were established by the RDA as private not for profit companies with regional innovation objectives written into their memorandum and articles of association. Company boards including university members in their individual capacity were established and CEOs recruited with a track record of research leadership in the private sector. Over the period 2002-2007 the RDA invested £35m in CPI and £24m in Narec. This was made up of core running costs and project funding, chiefly for the installation of specialist equipment (Simmonds and Stroyan, 2008). This subsequently was used to lever in central government funding emanating from its Technology Strategy Board (TSB) established in 2007, leading to the centres fulfilling a national as well as regional role. With this scale of budget, the centres were able to employ specialists who could not be afforded or rewarded appropriately by the University's technology transfer office which, by definition, had responsibility for the commercialisation of the whole spectrum of university research. The Centres were also able to acquire equipment that could neither be afforded nor accommodated on campus. But as we show below this has inevitably created boundary spanning issues with the University.

The centres were designated as key components in two of what were subsequently named as the ‘three pillars’ in the regional ‘Strategy for Success’ (subsequently renamed Innovation, Industry and Science Programme) with the other pillar being health care. The key *outcomes* were ‘to change the industrial structure of the region, through support for strategic sectors with high value added and potential for significant future growth [and] to achieve regional economic growth, through technology-led innovation’ (Simmonds and Stroyan, 2008, p.11). Increased university-industry links were expected to be one intermediate *output* to be underpinned by the activity of funding the research pipeline. But as we show below from both the perspective of the centres and the University this has not been a direct process from *regional* industry via the centres to the University and *vice versa*; rather a more nuanced multi-level ecology of innovation support has emerged, not least to overcome the challenges of working between separate organisations.

The Centre for Process Innovation (CPI)

CPI defines itself as a ‘World class innovation centre supporting the process industry’. It seeks to do this by:

- 1) Providing assets to prove concepts, develop a technology and demonstrate it to reduce scale up risks [for investors].
- 2) Creating collaborative partnerships between industry, academia, public and private sectors to leverage resource and reduce development risks.

3) Building multi-disciplinary teams that cross the boundaries between invention and delivery by combining engineering, process development and systems skills.

4) Creating new businesses and joint ventures where appropriate.

(Perry, 2010).

The Centre has some understanding across the full spectrum of technology readiness (1-9), but actual facilities and operational expertise are mainly at levels 4-7 and therefore focussed on bridging the gap between university research at levels 1-3 and firms which typically operate at levels 8-9. It currently has 170 staff including 46 holding doctoral qualifications, of which two thirds were recruited from industry (Perry, 2010). In addition there is an external Technical Advisory Committee, which includes four academics from Newcastle University. The CEO holds a visiting professorship in Newcastle University, but in terms of management and governance there are no joint appointments or overarching contractual arrangements. So the Centre is connected to the University in a formal but not legal sense.

Its business model is predicated on an equal three way split between private income derived from contracted collaborations with a small number of leading companies who use its facilities, public/private projects funded by the TSB and European Framework programmes, and purely public funds to develop the asset base and operating revenue to support economic development [Interview with CEO of CPI].

The initial remit for CPI was as a translational vehicle, basically *'taking university research and moving it into the market'* [CEO: CPI]. The objective was to create technology platforms so that the sector skills, knowledge and expertise of industry and academia could come

together in collaborative projects. As far as the regional universities are concerned, it was recognised that Newcastle was exceptionally strong in chemical engineering but not in chemistry, where the main academic excellence in the region was in Durham University. To enhance Newcastle's strengths in chemistry, CPI used funds from the RDA to enable the University to appoint a senior academic into its School of Chemical Engineering and Advanced Materials to develop the skill set around industrial bio-technology and catalysis, areas highly relevant to the technical changes underway in industry on Teesside. Likewise RDA investment in facilities in the School of Electrical, Electronic and Computer Engineering enabled it underpin CPI work in plastic electronics. So there was upstream investment in the science base.

However when it came to later stages of technical development with business involvement CPI made use of its own facilities, not least because the Universities lacked the technician support and to avoid the problems of intellectual property rights enforced by University. To enhance these facilities it successfully bid for the *National* Innovation Centre for Industrial Biotechnology. CPI's academic partners now include a wide range of universities in the UK such as Cambridge, Imperial College London, Liverpool, Manchester and York as well as Newcastle and Durham in the North East of England, and international companies collaborating in projects funded through EU framework programmes and the TSB. Its large specialist team is able to tap into the most appropriate academic expertise wherever it is located. This has enabled CPI to become one of the sites within the first national Technology and Innovation Centre consortium recognised by the TSB and operating in the field of High Value Manufacturing. Significantly, several university-based members of the consortium are

highly autonomous and physically detached research units within their institutions, of a type which cannot be found in Newcastle outside of Medical Sciences.

So if CPI has evolved as a national centre, what of its links with the regional industrial base and where have universities fitted into this? In terms of locally owned businesses it operates an incubator for start ups in the process industry sector in the Tees Valley and has spun out a number of companies who will all use CPI's core process technology skills. Audited outputs show that it has supported 2,900 companies contributing to leveraging £520m of private sector investment into the UK, created 2,400 jobs and set up 125 high value manufacturing businesses since 2004. The CEO of the Centre argues that, by comparison, universities: *spin out too early and they don't have the access to the management that's required. But that said we coach, and are on the board of directors of, [a number of regional university spin-outs]*. Its networking with established local business has been highly focussed linking firms to its own or appropriate academic expertise globally as well as locally. Given the dominance of the sector by branch and subsidiary operations of global companies, the emphasis has been on the technological upgrading of local companies in the supply chain as one means of tying down the global in the local. And for these global companies the outputs of doctoral students from Newcastle Universities Bio-processing and Bio-technology centre (BBTC) referred to below is another possible anchor.

How has Newcastle University responded to the evolution of a highly autonomous technology and innovation centre given its regional as well as global mission? According to the CEO of CPI it has informal relationships at the VC, PVC and with small groups of academics with specific interests in the exploitation of some of the areas of science and

technology covered by the Centre. The most notable group is within the School of Chemical Engineering and Advanced Materials who have established a national transdisciplinary Bio-Processing and Biopharmaceutical Centre (BBTC). This was in response to a recommendation in the report of the Government's Bioscience Innovation Growth Team to establish capabilities within leading university centres to:

- 1) Deliver graduate training designed to create interest, interdisciplinary awareness, and expertise in bioprocessing;
 - 2) Develop leading edge research resulting in a strong IP position in emerging areas of bioprocessing [and]
 - 3) Build collaboration with leading UK-based companies to ensure real-life experience.
- (Bioscience Innovation Growth Team, 2003, pp.26).

Although this was a national initiative which a group of academics in the University plugged into, it had obvious regional implications given the concentration of firms in this sector in the North East. The Newcastle University centre seeks to bring together the biosciences and engineering sciences in the translation of laboratory and bench scale research to pilot and production scale operations. It therefore makes connections within the University between engineering and the life sciences and between two of the pillars in the RDA's Innovation, Industry and Science programme. Its core activities in addition to research are regional industrial support and teaching at the undergraduate, postgraduate and professional development levels. The RDA has contributed to setting up the Centre as part of its upstream support for the process industry pillar with a particular emphasis on the higher-level skills agenda which CPI was not in a position to address. Its masters and doctoral

training programme involve collaboration with CPI and continuing professional development programmes delivered to regional firms working with CPI. Indeed the academics leading this Centre suggest that relationships developed through these programmes have generated new research challenges and business links [Interview with academics, Newcastle University], thereby emphasising the role of teaching and learning in the knowledge exchange process highlighted by David and Metcalfe (2007). The University is therefore contributing to human as well as intellectual capital development in the sector, but in the case of masters and doctoral programmes not necessarily benefitting the region given high levels of graduate mobility (Faggian and McCann, 2009). So as a national centre its research and teaching links are not exclusively with CPI or regional firms, in the same way as CPI's links are not wholly focussed on regional universities.

In summary, it would appear that CPI has concentrated on developing a role as a national centre working with universities and companies wherever business opportunities have arisen. With the support of the RDA it has undertaken regional networking and spun out its own businesses, but this activity has only sporadically involved Newcastle University. For their part, academics have worked with the Centre in some areas, but there has been limited long-term strategic collaboration through planned co-investment in people and facilities. To a large degree this can be attributable to a governance model set down by the RDA and its sponsoring central Government Department that established CPI as an independent company and required it to become self sustaining. Significantly, the sponsors required no formal links to regional universities and metrics relating to such interactions.

New and Renewable Energy Centre (Narec)

While CPI can be seen as a defensive investment designed to secure the future of the established chemical and process industry in the region, Narec can be viewed as an proactive investment seeking to build a new industrial sector. Narec now brands itself as ‘the national centre for the UK dedicated to advancing the development, demonstration, deployment and grid integration of renewable energy and low carbon generation technologies’. It covers offshore and onshore wind, wave and tidal distributed energy sources and connecting electrical networks. While it lists ‘economic regeneration’ in its portfolio, the New and Renewable Energy Centre has recently renamed itself as the *National Renewable Energy Centre* thereby signalling its role beyond the region. Building on the initial regional investment, it has won £25m from the Energy Technologies Institute (which falls under the Technology Strategy Board) to establish in conjunction with a Midlands based private company a ‘state-of-the art, open access, wind turbine drive train test rig [which is] seen as crucial to the continued success and further expansion of the UK’s offshore wind industry’ (ETI, 2011). This success puts it in a strong position to become part of a future national Renewable Energy Technology and Innovation Centre which will focus on technologies for offshore wind, wave and tidal power (TSB, 2011).

According to the CEO, it has evolved from its original focus on linking the region’s universities and industry:

When the original concept of Narec was put together it was always recognised that it would be a very strong link into Newcastle University, and the University has played a very big part in trying to develop what Narec should be and what facilities it should

have, and I guess an awful lot of where we started off was almost looking at the expectation that universities would be a major user of its facilities. As it developed, the RDA wanted us to follow a commercial path and that led to us more having to stand on our own two feet, where the relationship with the universities both regionally and beyond was to be where we could see some commercial activity.

In the initial phase of its development, large scale wave energy testing facilities to complement small scale facilities embedded within the school of Marine Sciences and Technology within Newcastle University were established. Initially collaboration with the University was by way of what the Centre subsequently came to see as essentially technology push projects. It then moved on to using its '*market knowledge to identify where there are gaps in technology*' [CEO: Narec]. So it is now, for example, beginning to act as an agent for large overseas companies to manage UK university research links. This is because '*[the companies] don't have the knowledge or structural understanding that's here, they don't have that knowledge of getting right down into the universities, ... for example the right man in gear teeth*' [CEO: Narec]. So in addition to its links with a wide range of academics in Newcastle, Narec now links to Durham, Edinburgh, Herriot Watt, Strathclyde, Loughborough, Northumbria, Warwick, Sunderland, Bath and other universities. Narec therefore sees its future more in the commercial area of selling services around its facilities base and doing funded R&D, for example, as part of the EU Framework programmes where collaborative R&D is funded from the public purse on a competitive basis.

Narec's business model therefore involves identifying individual academics, finding out what they are doing that is of interest to the centre and its customers, and what capacity it has to offer them. In the case of Newcastle University, while there is a strategic relationship at the

VC/PVC level and some strong links with individual groups, there is a perception within Narec of a missing middle layer at the level of the School, which if it were there might result in co-investment by the Centre and the University. An academic advisory panel for Narec has been wound up and there are no significant links with the University's TTO. While a member of the University is a non-executive member of the Narec board he is there in his individual capacity and has a fiduciary duty to look after the interests of the company and not the University. Part of that responsibility is to ensure that Narec has academic credibility with industry and this is achieved by publications based on the participation of its staff in EC Framework projects, including joint publications with researchers from across the EU, not exclusively with regional universities.

How does this business driven profile link to Narec's responsibility in terms of regional economic development? It receives funding from the RDA to run seminars, workshops and conferences and supply chain events to make companies aware of the opportunities in the sector. Academics from the region's universities contribute to these events, which are often highly focussed on particular areas. So an event on tidal device blades might bring in experts on materials, the water column and water flow. Narec then brings business development expertise to the events.

Narec has played a limited role in developing human capital relevant to its area. However in the sub sea sector (pipelines, platforms etc.) which is a major contributor to the offshore wind area that is at the heart of Narec's future development, an industry association, Sub Sea North East, has mobilised significant contributions to skills enhancement from the higher and further education sector on Tyneside. New initiatives led by Newcastle University

and pump primed by the RDA include an MSc in Sub Sea Engineering and Management; a new Sub Sea stream in the BEng in Marine Technology and Offshore Engineering; an academic-industry steering group reviewing other engineering and management provision; student projects with firms; a graduate sub-sea placement scheme; market testing new provision with executive employees; a foundation degree programme with Newcastle College; identification of progression routes and improved visibility of career opportunities. This example demonstrates the contribution of higher education sector as whole to enhancing human capital across a broad spectrum of skills. Whether the partners would have taken these initiatives without pump priming from the RDA is an open question.

To what extent could Narec's interface with Newcastle University be strengthened by the University bringing together *all* of its expertise relevant to new and renewable energies in a single institute? The University has endeavoured to pool *some* of its expertise by the establishment of the Sir Joseph Swan Centre for Energy Research with a mission to provide an intellectual lead in the pursuit of the low-carbon economy of the future, by developing new technologies that reconcile human needs for energy conversion and use with social and ecological needs. It has recruited an academic with a background in both the private and public sector to head it. The CEO of Narec sits on the research strategy board for the Centre. It has established two flexible renewable energy MSc programmes and Narec suggests projects for the students. The Director and the CEO both sit on the Energy Leadership Council for the North East, a body created by the RDA to bring together public and private interests in this area. In terms of research collaboration, the Sir Joseph Swan Centre has worked closely with Narec on one of its largest projects, for the Crown Estate, which is exploring the issues surrounding the utilisation of sectors of the North Sea for new and

renewable energy production. This has included work on the possible natural environmental challenges to large scale wind farms in deep water with the aim of identifying risks to investors. Other areas of opportunities for the Crown Estate relate to underground coal gasification beneath the sea bed. In both of these areas Narec has not had the necessary expertise in fields such as animal behaviour and geotechnical engineering, and the Centre has been able to identify this from within the University. Nevertheless, most of the challenging new and renewable energy projects coming forward to Narec from private investors require such a broad range of expertise such that no single university could meet the requirements. For its part the University has decided to establish a Newcastle Institute for Research on Sustainability, which will incorporate the Sir Joseph Swan Centre. According to its website the institute 'will provide coordination and support for the wide range of research on sustainability undertaken by the University and our collaborating partners, including global organisations, national government, local government, a diverse range of companies and non-governmental organisations'. The focus is on solution-led responses to major challenges in areas such as urban living, low carbon energy and transport, food security, water management and clean manufacturing by bringing together broad interdisciplinary teams. The University therefore places the challenge faced by Narec in a much broader context.

Discussion

The establishment of CPI and Narec has been a bold experiment in science based regional economic development. The RDA, not the University, was the initial funder and played the

key role in steering and setting the key goals for the centres. It has clearly sought to establish them as institutions in their own right, having an economic impact as a consequence of their autonomy and national standing, and as a result becoming anchor institutions in their own localities. While building links between business and regional universities was part of the original rationale for the centres, they have not been systematically evaluated against this criterion. No metrics were devised by the RDA to measure the extent and significance of university links. Rather the centres had to fit into a nationally determined model of regional outputs such as new jobs created, which were laid upon all RDAs by one part of central government not least to meet state aid rules. They were also expected to win funding from national technology and innovation programmes emanating from a different part of central government where regional development objectives were not the main priority. In response the centres have acquired many features of a university themselves, but with a focus on later technology readiness levels as opposed to a university's focus on earlier levels.

There have been point to point interactions between individuals in the centres and individual academics, not exclusively in the region. Notwithstanding the intervention of the RDA, this is not dissimilar to the general pattern of interaction between university researchers and business. For example a group working from the School of Electronic and Electrical Engineering in the micro-electronics area and which fell within the domain of CPI has also received substantial support from the RDA, particularly to enable it to work with SMEs to assist them to embed microelectronics into their products. The group had historically worked solely with global companies with the support of grants from the UK's Engineering and Physical Sciences Research Council but technological advance has created

opportunities for small firms including those based in the region and known to CPI. In addition the group's own direct marketing did yield links with regional companies but in the sub-sea sector linked to the new and renewable energy pillar and in the supply chain of Rolls Royce where the group had a longstanding relationship. In short the academic-business links spread across the University had their own logic independent of CPI.

So while this diversity may add resilience to the national innovation system, the relationships between one university and business regionally have not been marshalled into a set of structured links that embrace the full spectrum of technology readiness levels, and the teaching, that is needed to underpin that research with the development of the necessary skills. In the area of postgraduate education, some close relationships are emerging with Newcastle University in certain areas, not least because there has been significant RDA investment in the education as well as research capacity of the University. For its part, the University has independently created new research centres and institutes in cognate areas. The RDA aspiration was based on the idea that:

really successful places have world class universities working with world class translation companies in one geographical locality ... [We've] been trying to develop parallel paths in the hope that one day they will converge... [and] build research capacity in universities ... not that there would be a clear linear relationship. So it's about making investment ... [to support] a broad trajectory of technology ... plugging into an eco-system at different stages of time. [Head of Strategic Economic Change: RDA]

But because there has been no formal structure linking the centres to the University it has been a disjointed process – a regional 'triple helix' without the bridges between the strands,

or with the bridges left to emerge serendipitously through time. While the Centres and parts of the University can fairly claim to be *independently* embedded in an emerging national structure for the exploitation of *science and technology* overseen by the TSB, doubts must remain as to whether the bottom up regional links are there in a form that would suggest that the University is a key agent in a regional *innovation system* as discussed in the literature we have reviewed. In terms of that literature, the RDA investment has clearly identified some latent assets in the industrial legacy of the region, and within the University enabled a declining sector in the process industries to *begin* to re-invent itself through technological innovation and a new sector in renewable energy to *begin* to emerge (for more on 'phoenix industries' see Tödtling and Trippl, 2004; Christopherson, 2009). In this regard the region may be on the road to breaking 'path dependency' and 'lock in' (Grabher, 1993; Martin and Sunley, 2006). But this is an early stage on an inevitably long journey.

The fact that the University has been a relatively minor player on this journey may be attributable to two key factors. The first of these is widely acknowledged in the literature, namely that the focus of university collaborative research with industry tends to be with leading companies with research capacity and these are largely to be found outside lagging regions like the North East of England. This is in turn related to the limited absorptive capacity and low research and development intensity of regional businesses. So in this case it is doubtful that the 'innovation paradox' (Oughton *et al.*, 2002) over the ten years reviewed here has so far been resolved. This also supports the argument that technological innovation should not be treated as a regionally-bounded process, but seen to occur through larger spatial complexes of overlapping territorial innovation systems and relational linkages between firms and research bodies (see Oinas and Malecki, 1999; 2002). The

second factor, which is not so widely acknowledged in a literature that tends to focus on the commercialisation of university research via spin-outs, is the fact that most universities do not have the organisational capacity and especially space to provide facilities to scale-up or make ready market technologies emerging from engineering laboratories; nor can they provide the specialist market knowledge and advice through internal technology transfer to engage with potential investors. As one of the University's Pro-Vice Chancellors has observed in relation to CPI and Narec:

I don't think they are really research centres of excellence but they are definitely centres for industrial innovation and have their finger on the pulse of what's happening in the industry sector and a good feeling of the art of the possible. Their strength is that they are full of people with genuine experience and some standing in industry. I don't think the University could have done this in house. We did not have enough genuine expertise except in a few areas, and the establishment of the Centres forced us to pull together these pockets of expertise.

If the University were in the future to decide to invest further downstream in terms of technology readiness and enhance the scale and scope of its technology transfer function it would then face the problem of competition with TICs that now have to operate in the marketplace.

Looking to the future, the successes that have been achieved may largely be attributable to the availability of significant regional public funds and the activities of a few key individuals in the RDA, the Universities and the Centres: so much so that it is doubtful whether a sustainable system is in place when these individuals move on or the funding dries up.

According to the Head of Strategic Economic Change at the RDA:

there is not the structure in the UK which allows this to happen as there is in Germany or France, so it is much more ad-hoc and about personal relationships. Those personal relationships stop for a whole lot of different reasons and the whole activity stops.

As the 2009 review of the current and future role of technology and innovation centres has noted, ‘the UK approach is by comparison [to other countries] sub-critical; follows no national strategy; and pays insufficient attention to business requirements and the location of relevant [scientific] expertise’ (Hauser, 2009, pp.3). The review is particularly critical of regional initiatives: ‘The sub-national approach to investment also appears to have resulted in highly dispersed activity with potential duplication’ (pp.18). However, it does acknowledge the national significance of CPI and Narec, and this would appear to have helped in CPI’s bid to become part of the national TIC in High Value Added Manufacturing.

While the Centres are now well established, the long-term sustainability of their regional role remains an issue. Central government is committed to closing down the RDAs and centralising innovation and inward investment policy. However it also committed to rebalancing the economy sectorally and geographically and, through its Research Evaluation Framework, encouraging university research that has an impact beyond the academy (HEFCE, 2011). To this end a strong linkage between a regionally committed university and the two centres reviewed in this paper would be a way forward that contributes to both objectives. Both Centres have built up expertise and assets, which could significantly extend the reach of the research base in the University in terms of its contribution to economic development through a clear understanding of the place of the University and the centres across the full spectrum of technology readiness. Conjoint investment by the centres and

the university in the development of human capital could also anticipate the high-level skills shortages that are likely to confront companies working in the process industries and the new and renewable energy sector. The security provided by a long established institution could provide assurance to global investors seeking to realise the opportunities in the North Sea. And last but not least, viewing these technological developments as part of the wider contribution of research and innovation to tackling global challenges of sustainable development could be seen as a justifiable investment on the part of the state.

Policy Conclusions

What lessons can be learned from this relatively short lived UK experiment in terms of the incorporation of a university into a regional innovation system? This is a key question given the emphasis being placed within OECD and European Union policy circles on the regional dimension to innovation policy and the expectation that universities should play a key role. Thus the European Commission states that: 'Regions have a key role to play as they are the primary institutional partner for universities, other research and education institutions and SME's which are key to the process of innovation making them an indispensable part of the Europe 2020 strategy' (EU, 2010). Our analysis suggests that in practise regions are not, nor should they be, a *primary* focus for universities. While universities can be incorporated into a regional innovation system this needs to be carefully planned (EU, 2011).

First and foremost, this must be part of a long term strategy which may in certain instances need public support for the establishment of a professionally staffed intermediate

organisation or organisations with specialist facilities like the TICs described here. Whether these are located physically and functionally within a university or not, appropriate governance and management structures will need to be put in place to ensure a clear division of labour upstream to the research base and downstream to business. Second these arrangements will need to be underpinned by resources to assist with the articulation of business needs through industry associations/networks, the provision of translation research facilities where firms and academics can work together on joint development projects, and the development of targeted teaching programmes where skill gaps are identified. Last but not least, the TIC and its university partners need to be able to demonstrate their credibility by participation in national and international development programmes to ensure that local industry has access to leading edge technology and expertise.

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