

# **Intellectual property strategy in publicly funded R&D centres – A comparison of university-based and company-based research centres**

Beth Young\*, Nola Hewitt-Dundas\*\* and Stephen Roper\*,

\* Aston Business School \*\* Queen's University Belfast

Email: gormleyb@aston.ac.uk

August 2007

## **Abstract:**

Recent thinking on open innovation and the knowledge-based economy have stressed the importance of external knowledge sources in stimulating innovation. Policy-makers have recognised this, establishing publicly funded Centres of R&D Excellence with the objective of stimulating industry-science links and localised innovation spillovers. Here, we examine the contrasting IP strategies of a group of eighteen university and company-based R&D centres supported by the same regional programme. Marked contrasts emerge between the IP strategies of the university-based and company-based centres suggesting the potential for very different types of knowledge spillovers from publicly-funded R&D centres in different types of organisations and a range of alternative policy approaches to the future funding of R&D centres.

## **Acknowledgements:**

We are grateful to Invest Northern Ireland for funding the research on which this paper is based. We are grateful too for the time and kindness of staff in the Centres of Excellence during the period of this study. Interpretations and mistakes in the paper are those of the authors alone.

**Key words:** Public R&D, Intellectual Property, Ireland, Spillovers

Copyright of the paper resides with the authors. Submission of a paper grants permission to the EPIP-2007 Conference Scientific and Organizing Committees to include it in the conference material and to place it on relevant websites.

# **Intellectual property strategy in publicly funded R&D centres– A comparison of university-based and company-based research centres**

## **1. Introduction**

Recent thinking on open innovation (Chesbrough, 2003), business eco-systems (Iansiti and Levien, 2004), and the knowledge-based economy (Cooke and Leydesdorff, 2006) stresses the importance of external knowledge sources in stimulating innovation.

Policy-makers have recognised the importance of external knowledge by establishing publicly funded Centres of R&D Excellence with the objective of stimulating industry-science links and localised innovation spillovers (e.g. Feller, 2004; Debackere and Veugelers, 2005; Graversen et al., 2005)<sup>i</sup>. Underpinning the process of technology transfer is the management (i.e. identification, development and exploitation) of IP (Dietz and Bozeman, 2005). For firms, this enables value to be created and sustained. (Coriat and Orsi, 2002; Hanel, 2006). For universities, effective IP management can generate revenue through licenses and spin-out companies (Roper et al., 2004; Siegel et al., 2003; Lee and Win, 2004; and Gloet and Terziovski, 2004).

Our objective here is to explore differences between IP management in publicly funded research centres (PRCs) based in universities and firms and consider how these may influence technology transfer. Our study is based on a real-time monitoring exercise of IP management practices in a group of UK PRCs established since 2002. This localised, and detailed approach, complements the more abstract but broadly based analysis of Guellec and van Pottelsberghe (2004), for example, providing insights into the processes underlying local knowledge transfers. Our paper also helps

to answer the need highlighted by Link and Siegel (2005) for more specific micro-evidence on the operation of technology transfer initiatives in different national and regional contexts.

The remainder of the paper is organised as follows. Section 2 outlines our conceptual approach and empirical propositions. Section 3 reviews the policy context for our empirical study, describes our data sources and profiles the PRCs in this study. Section 4 explores the IP management practices of these PRCs and Section 5 draws out key methodological and policy conclusions.

## **2. Literature and propositions**

Our main interest is the contrasting IP regimes adopted by PRCs in the very different organisational settings represented by universities and firms. Inevitably, these IP regimes will reflect the strategic objectives of the organisations in which they are based (Bozeman, 2000), any ambiguities in these organisational objectives (e.g. Jarzabkowski, 2005), and the situation of the specific business unit or department in which the PRC operates.

In terms of university-based PRCs, for example, the historical norm has been the ‘open science’ model, where new knowledge is viewed as a public good and universities placed little priority on IP ownership. EU (2004) argues that this open science model is most effective in stimulating commercialisation where: *“the technology has far reaching implications and where the risks of mis-appropriation by private interests are detrimental to the public interest”* (p.11). The incentive structure

in the open science model, suggests that PRCs are likely to adopt an essentially passive approach to IP development and exploitation, instead investing any available resources in additional research activity. Commercialisation then depends on the absorptive capacity of firms, i.e. their ability to identify, absorb and appropriate new technologies developed by PRCs (e.g. Zahra and George, 2002)<sup>ii</sup>.

More recently, however, and most notably in US since the Bayh-Dole Act, universities and public research organisations have placed increasing emphasis on their *private* ownership of IP, and consequently adopted a more proactive role in IP development and exploitation. This gives rise to the ‘licensing model’ (EU, 2004). Here, PRCs engage in basic research, but are proactive, and devote resources to, the identification, development and exploitation of IP- generally through patents and licensing (Siegel et al., 2003; Lockett and Wright, 2005). EU (2004) argue that this approach can generate substantial benefits: *“It is estimated that at least half the new products based on university patents would not have been developed if the results had been put in the public domain without patent protection,”* (p.11)<sup>iii</sup>.

Mowery et al. (2004) argue that the increased focus on commercialisation has, however: *“changed the research culture of US universities, leading to increased secrecy, less sharing of research results, and a shift in the focus of academic research away from fundamental towards more applied topics”* (p.1). In this ‘innovation model’, PRCs both adopt a proactive approach to IP development and exploitation *and* re-orient the type of R&D they are undertaking to bridge the gap between fundamental university research and its commercialisation. EU (2004) argue that the

social benefits resulting from the adoption of the innovation model may be larger, and more regionally focused, than those from the licensing model: “*certain PROs have pioneered the implementation of the Innovation Model with conclusive evidence of success in terms of increased new company generation, enhanced relations with industry and licensing activity*” (p.11).

In addition to these three models of university-based PRCs we are also interested in company-based PRCs<sup>iv</sup>. Here, a potentially important distinction exists between PRCs located in locally-owned firms and those located in the local plants of MNEs.

Research conducted by indigenous firms, for example, will tend to focus on building internal technological capabilities with results evident in terms of improvements in “*locally anchored technological capability and internationalization,*” (Kumar and Aggarwal, 2005, p.456). By contrast, the increasing globalisation of R&D is likely to mean that PRCs located in MNEs are part of an international R&D endeavour, and therefore the spatial distribution of the commercial benefits of R&D activity may be very different to that of the R&D activity itself (e.g. Reddy, 1997). One implication is that PRCs in locally-owned firms are more likely to need to devote internal resources to the development and exploitation of IP than MNE-based PRCs.

The organisational differences and contrasts between the types of R&D being conducted in these five types of PRC suggest our first proposition:

*P1: IP strategy will differ between university and company-based PRCs.*

We also anticipate:

*P1a: IP strategy will differ between PRCs hosted in locally-owned and MNE firms; and,*

*P1b: IP strategy will differ between university-based PRCs depending on which IP model they adopt.*

Implementing these strategies, however, focuses attention on the process of IP management (Hanel, 2006). Graversen et al. (2005), for example, suggest that the organisation and management of research centres is as vital to their success as the political and economic climate in which they operate. This suggests our second proposition:

*P2: PRCs will implement incentives for the creation and protection of IP which reflect the nature of the host organisation and the IP model being adopted.*

As suggested earlier, however, different types of PRCs in different settings are likely to devote differing levels of resources to IP protection and development. PRCs in smaller firms, for example, may find it difficult to invest the level of resources necessary to protect their IP effectively and may adopt alternative commercial strategies to maintain their technological leadership. This suggests:

*P3: Use of formal IP protection methods will depend on the organisational background of the PRC and is:*

*P3a: less likely among PRCs in locally-owned firms than those in MNEs; and,*

*P3b: more likely among PRCs adopting the innovation and licensing models than those adopting the open science model.*

*P4: PRCs will use specialist services to support their IP protection and exploitation strategies. Use of these services will reflect the nature of the host organisation and the IP model being adopted.*

### **3. Data and methods**

The research centres considered here were established in 2002 as part of the Centres of Excellence programme with support from Northern Ireland (NI) government, with the explicit objective of contributing to regional competitiveness<sup>v</sup>. Eight university and ten company-based centres were established as a result of a six month open call for proposals during 2001. Table 1 gives a brief overview of each centre. Managed by Invest NI- the regional development agency for NI- the programme received public funding of £34m (29.3 percent) matched by additional private sector funding of £82m over three years. As a result of the competitive nature of this programme, the centres' sectoral focus is diverse, with an under-representation of private services which accounted for 10.3 percent of total grant-aid to the company-based centres but 24.3 percent of BERD in NI in 2002 (DETI, 2003, p.10). In terms of manufacturing, pharmaceuticals was over-represented, accounting for around 12.3 percent of manufacturing BERD in the region in 2002 but around a third of the programme

expenditure and grant-aid. Programme expenditure is also notably more capital intensive than R&D spending in general in NI, 29.6 percent compared to 7.6 percent, (DETI, 2003). This is not surprising given the infrastructural nature of the programme.

Data used in this paper comprises three main elements. First, each PRC completed a detailed email or postal questionnaire every four months between February 2004 and September 2006. This provided regular quantitative data on the level and type of R&D activity conducted by each PRC, its links to external partners and its commercialisation activities. An overall response rate of 75 percent was achieved. Second, in-depth face-to-face interviews were conducted with each PRC on an irregular basis to validate data being returned in their questionnaires and follow-up issues of particular interest. Finally, in mid-2006 we carried out a series of semi-structured interviews which focussed specifically on IP development and management. Sixteen of the eighteen PRCs in the programme (88 percent) participated in this round of interviews.

Drawing on these interviews, the broader organisational profile, the types of R&D undertaken and their patterns of dissemination we were able to classify the PRCs in terms of the models identified in Section 2. Classification of the company-based PRCs was relatively straight forward as the main differentiation was in terms of company ownership, i.e. whether the PRC was based in a locally-owned firm or the local plant of a MNE. Five company-based PRCs (CoE.9, 10, 15, 17 and 18) were based in locally-owned firms, while five (CoE.11, 12, 13, 14 and 16) were part of larger MNE operations (Table 1).

Classification of the university-based PRCs was more complex. The key distinctions between the models of university-based PRC were the types of R&D they were conducting and their approach to dissemination. As Table 1 shows, all of the university-based PRCs were conducting applied R&D as either a major or minor focus; similarly each PRC (with the exception of CoE.6) was carrying out some developmental research. Only four of the eight university-based PRCs were involved in basic R&D. Therefore the type of R&D undertaken on its own was a relatively poor predictor of the IP model being adopted. Considering the dissemination profile of the PRCs provided more discriminatory power, however. Specifically, we classified the average number of publications and presentations made per employee for each PRC between February 2004 and September 2006 (Table 2). A cluster analysis of the university-based PRCs' dissemination activity together with the extent to which they focussed on basic R&D generated three clusters. This identified four Open Source PRCs (CoE.3, 4, 7 and 8), which were involved in some basic R&D and had fairly low levels of publications and presentations. Two PRCs followed the Licensing Model (CoE.1 and 6), focusing on applied R&D and actively publishing and presenting their work. The two PRCs following the Innovation Model (CoE.2 and 5) focused on developmental R&D and had fairly low levels of publication and presentation activity.

## 4. Empirical results

### 4.1 IP strategy

Our discussions with the PRCs highlighted considerable differences in IP strategy between the company-based PRCs and those in universities but less clear differentiation within the group of university-based PRCs. Within the group of company-based PRCs, however, IP strategy did seem to reflect the characteristics of the host organisation with evident differences between locally-owned and MNE-based PRCs.

CoE.15 was relatively typical among locally-owned PRCs, in that the IP strategy was based largely on achieving speed to market. Patents were not seen as providing a huge commercial advantage, but were seen as a potential asset from an investor's point of view (Coriat and Orsi, 2002; Arai, 1999). The company's IP strategy was described as:

*“partly being driven by our investors who would like more of an IP portfolio... Most of it is; we have a route to exploitation, if we have something, use it as quickly as possible.”*

For the MNE-based PRCs, however, IP strategy was more strongly related to longer-term concerns and IP codification and protection. CoE.12, for example, was concerned with ensuring the company was well placed to utilise future technologies (Roper et al., 2004), and claimed:

*“We would be more interested in what we call our technology pipeline... If it does have patentability or some form of IP that is a bonus”.*

Other MNE-based PRCs emphasised the importance of IP protection, although this also reflected the industry within which PRCs were operating:

*“It’s very critical that everything we develop has IP protection around it. That may be a new product, process, compound or just something new, but we always try to get patent protection on this, especially in our industry.”*

As anticipated in P1a we therefore see a clear distinction between the IP strategies of PRCs based in locally-owned and MNE companies, with the latter more likely to engage in formal IP protection (e.g. Blackburn, 2003).

For the university PRCs, IP strategies emphasised knowledge creation and dissemination rather than achieving competitive advantage, reflecting the public good nature of much of their research. As CoE.7 put it:

*“our main interest is being able to actually publish the work. If we can’t publish the work then really we get absolutely no benefit from it.”*

Some university PRCs were clearly more engaged in a commercialisation agenda, as CoE.3 explains:

*“A key focus of the new vision within [the university] is a greater emphasis on knowledge exploitation, technology transfer and commercialisation. [CoE.3] is at the forefront of that.”*

However, in the majority of cases where PRCs were engaging in IP exploitation, it was seen as secondary to winning new research grants. According to CoE.4:

*“there would be a more determined effort to get research council type projects, but there is also a technology transfer type role.”*

Other PRCs were seen as an intermediary step towards commercial activities. CoE.6 explained:

*“The idea behind the Centre was not to do projects which would be immediately commercially viable, but to do projects which, if they work, would give you the basis of a project which would be commercially viable.”*

Moreover, industrial links formed by the university-based PRCs through licensing agreements or consultancy work are often viewed as a means of gaining access to a company in order to pursue a particular research agenda. CoE.1 commented:

*“Our strategy is really to use that model and the qualifications that we have been building up through the funding for the Centres of Excellence programme*

*in order to get a foot in the door with some local companies and then to start pursuing some research agendas with those companies.”*

PRCs following the innovation model, on the other hand were much more focused on the practical application of their research. As the original project proposal explains, the purpose of CoE.5 was to develop:

*“environmental tools capable of being used to solve a wide range of environmental issues for industry.”*

However, in an interview it was pointed out that the PRC’s IP is not always commercialised, but often used within ‘members companies’ who help fund the Centre’s research:

*“our member companies are entitled to royalty-free access... if they are using the technology within their own companies. If they want to use a technology commercially then they have to negotiate a separate licensing agreement with us.”*

As P1 suggests therefore we identify profound differences between the IP strategies of the company and university-based PRCs. For company-based PRCs codified IP is a primary source of competitive advantage; whilst for university-based PRCs commercialisation remains secondary to knowledge creation and dissemination.

We also find the anticipated differences (P1a) between the IP strategies of locally-owned and multinational PRCs. While there was some evidence that PRCs following the innovation model were more focused on the practical application of their research, we could identify no clear differentiation in IP strategies of the university PRCs, i.e. no clear support for P1b. This may reflect the limited extent to which the PRCs considered here have adopted the licensing model.

#### **4.2 IP incentives**

These contrasts in IP strategy are reflected in the practical steps taken by the different PRCs to develop and protect their IP. Both university and company-based PRCs provided incentives, encouraging staff to engage in IP identification and protection. In the university-based PRCs considered here any revenue from IP (e.g. royalties from licensing agreements) was split between the university, the researcher and the researcher's school or department. No such revenue sharing agreement was evident in the company-based PRCs although some companies, notably the MNEs (i.e. CoE.12, 13, 14 and 16), gave the inventor a bonus or patent award for any invention which the company went on to patent. These awards ranged from a token gesture of \$1 in CoE.16 to sizable sums of \$1,500 in CoE.13. CoE.12 also had a 'Hall of Fame' for employees with 10 patents; this included a \$10,000 bonus.

As well as monetary incentives the PRCs were actively training staff on IP issues. According to CoE.14 this meant that the IP management process had become ingrained in company culture:

*“I suppose you would say that’s the culture within the company. In the engineering departments there would have been training on the process. Therefore team managers would be aware of it and should be encouraging the staff and reminding them of the process. There is also a policy document which is available on the intranet.”*

Training on IP issues was not limited to the company-based PRCs. As CoE.3 explains:

*“[We] have seminars were people come and talk about IP and about patents and the patent process... The opportunity is there, but if I am being honest they are not terribly well attended. We run them and there might only be a dozen or so people would come along.”*

In this sense we therefore find some support for P2 with both university and company-based PRCs having implemented HR practices which actively promote the development and identification of IP. The approaches to incentivising staff clearly differ, however, between company and university-based PRCs. Within the MNE-based PRCs especially- which employed more aggressive IP strategies than PRCs in locally-owned firms- there was a clear financial incentive structure, encouraging the identification and protection of IP. This was less evident in the locally-owned PRCs, which presumably have fewer resources to dedicate to such a scheme. In the university-based PRCs on the other hand incentives were contradictory to promotion criteria, reflecting a conflict in organisational objectives.

### 4.3 IP protection

In general, the company-based PRCs commercialised their IP internally. The level of protection sought by company PRCs and the formality of that protection depended on organisational objectives, available resources and the type of technology being developed, however. For the MNE-based PRCs IP protection was seen as a competitive strategy used to block imitation. Therefore more formal/ legal methods of protection were used. CoE.16, for example, commented:

*“The IP really is to protect the product. Although it is an asset and it has commercial viability as a patent in itself. The reason we get it is to stop people coming in and copying our idea. So the patenting is really as a protective measure to ensure the idea cannot be genericised.”*

In contrast the locally-owned firms appear to have fewer resources to devote to formal IP protection. As CoE.15 explained:

*“You can spend an awful lot of time and waste a lot of talented people’s time, chasing after something that is not there in the end... You really have to have something pretty good and then you have to defend it... and usually that involves a lot of technical people.”*

Formal IP protection was not always appropriate for the type of technology being developed in the PRCs. According to CoE.12:

*“The technologies that we develop from this site are impossible to reverse engineer from the finished product. Hence they wouldn’t be patented. They [patents] actually put that know-how into the field and once it’s out there it’s at risk from either being reverse engineered or misused.”*

Other organisational mechanisms were used by company-based PRCs to protect their IP. Few staff in the company-based PRCs, for example, gave papers at workshops or conferences. CoE.10 commented:

*“We don’t actively go out to give papers these days. We would have given papers and we would have written papers in the journals of... technology in the past, but we don’t do that anymore. We are too close to the market in these things. The whole industry has become more commercial and secretive.”*

More specifically among the company-based PRCs, only CoE.15 published any working papers<sup>vi</sup>, while all of the university-based PRCs submitted papers for publication.

The majority of university-based PRCs sought to patent their IP where possible and then either license out that IP to a third party or create a spin-out company. The choice of exploitation route was dependent on the route most appropriate for the technology developed and did not appear to be influenced by the model adopted by the PRC. CoE.6 and 8 engaged in both licensing and spin-out activity. CoE.6 explained the choice of exploitation route depends on the project:

*“There are six major projects running in the Centre: one of them has got sufficiently far enough for us to say that this is definitely going to be a spin-out company; another one of them is in negotiations with relevant food companies, that one would probably go by way of either us providing a service for them or us just selling them the total rights. The other four: one of them seems to be working and will probably go through a patent and then try licensing the patent... One of them is just too early to say and the other two: one of them is almost certainly going to go down the patent route... and the other has taken up a lot of time and hasn't produced anything that we can definitely patent yet.”*

However, some university-based PRCs voiced concerns about the cost of patenting, identifying this as a barrier to more rigorous IP protection strategies. One PRC claimed:

*“It's such an expensive thing to do... You have to be restrictive and try to cherry pick which things to patent... For example, we may not be able to afford to take out a worldwide patent which leaves our IP vulnerable to being exploited.”*

CoE.1 and 7 however did not commercially exploit their IP. In these PRCs the main output, in terms of IP, was the publication of papers. Both PRCs undertook

commercial consultancy with the primary purpose of engaging companies in research activity which could lead to academic papers.

We therefore find considerable support for Proposition 3, with the majority of PRCs engaged to a greater or lesser extent with IP protection. Clear differences exist between the IP protection strategies of PRCs in multinational and locally-owned firms. The distinction between the university-based PRCs was less clear. This provides partial support for P3a.

#### **4.4 Specialist services**

IP protection in the university-based PRCs was carried out in conjunction with the university technology transfer office (TTO) which played a largely reactive role-responding when notified of discoveries with a potential commercial application. The extent to which the university-based PRCs involved the university's TTO in IP management, however, depended on the prior experience of the academic staff involved. Where academic staff were familiar with the patent process then the TTO was simply used to fulfil legal and administrative obligations. Less experienced academic staff tended to contact the TTO at a much earlier stage to seek advice regarding patentability and support throughout the patent process. Similarly if the academic involved had strong links to industry, or if there was an existing relationship with a particular company, then the TTO was only involved at a basic level, i.e. in the signing of contracts or non-disclosure agreements. If, on the other hand, the academic was not well connected they also used the TTO to identify potential licensing partners.

This difference in experience levels was reflected in the use of the TTO by the different types of university-based PRC. Staff working in open science PRCs tended to be less experienced in the patenting process and therefore tended to rely more heavily on the TTO from the initial identification of patentable IP right through to exploitation. CoE.4 detailed their involvement with the university TTOs:

*“We identified that we had IP that was patentable and through the university we are getting that patent. That was actually done through [the TTO]. Then the ongoing exploitation of that IP is being done in consultation with [the TTO].”*

Where academics have technology transfer experience, they tended to be more involved in the transfer process, using the university TTO to a more limited extent, i.e. to fulfil administrative and legal requirements. This is highlighted by CoE.1 (a licensing PRC) who described their approach to IP management:

*“What IP management we have, I have taken care of... I negotiated the licenses with an organisation in America... and then took the legal documents along to [the TTO].”*

In terms of IP management in the company-based PRCs, a clear difference emerges between PRCs in locally-owned firms and those which were part of MNEs. In the locally-owned PRCs, IP issues were internally driven, with staff within the PRC

taking responsibility for IP identification and codification. CoE.15 explained their process:

*“This isn’t a large group of people so that kind of regular communication is daily. We don’t formally sit down and do that, it kind of happens by osmosis.”*

IP development and protection in the MNE PRCs involved a wider group of staff either internal to the firm (CoE.11, 12, 13 and 14) or involving external patent lawyers (CoE.16). In CoE.14, for example:

*“[the Project Engineer for Design and Patents] would know all of the inventors... [and] would know if they have any new ideas. Then we have invention disclosure forms, which they would briefly fill in. It is just a rough description. We would time and date stamp that to give us proof of the creation date. We would get in touch with the company’s patent lawyers at that stage...*

*There would be some forum were those ideas are discussed and categorised... The way it works means that there is a central or focal point. The engineers know where to go if they have any intellectual property questions or technology questions. It is structured.”*

We therefore find considerable support for P4 with all PRCs having access to specialist support services. Again the use of these services depended on the IP model

adopted in the university-based PRCs and organisational context of the company-based PRCs.

## **5. Conclusion**

Our data, drawn from a set of eighteen UK R&D centres funded through a single government programme, suggest some contrasts in IP strategy and management between university-based and company-based R&D centres despite their common funding source. To a lesser extent, however, we also observe differences within each group depending on the nature of the firm in which each R&D centre is located and the IP model adopted in university centres.

In terms of IP strategy, we find continuing differences between the IP strategies of company and university-based PRCs. For the company-based PRCs codified IP is a primary source of competitive advantage, which despite their public funding, restricts external dissemination and therefore any positive ‘pure knowledge’ externalities arising from knowledge transfer (e.g. Beugelsdijck and Cornet, 2001). Of course, IP gains to the firms involved in the programme may still generate private benefits to the organisation and rent-based spillovers as the firm with the PRC interacts with its customers and suppliers<sup>vii</sup>. For the university-based PRCs in our sample on the other hand, IP commercialisation remains secondary to knowledge creation and dissemination, with little clear difference between centres adopting different IP models. For the university-based PRCs therefore the public good aspect of their activities remains predominant, epitomised by extensive dissemination activities.

Therefore we found no evidence of the increasingly secretive culture which Mowery et al. (2004) identified in the US universities. This clearly creates the potential for pure knowledge spillovers. Although the potential for rent based spillovers, evident for the company-based PRCs, is less evident here. This contrast suggests the alternative patterns of regional spillovers which might stem from public funding of university and company-based PRCs: i.e. rent-based spillovers from company-based centres and knowledge spillovers from university-based centres.

What's more within the group of company-based PRCs organisational characteristics, such as size and ownership, did appear to influence their use of formal IP protection. With centres based in MNE's more likely to engage in formal IP protection than those in smaller locally-owned firms. This reflects the availability of resources.

Given the increasing importance of IPR (Hanel, 2006; Coriat and Orsi, 2002; Arai, 1999 and Allen, 2003) it was encouraging to find that all PRCs had clear and well defined IP ownership policies where IP created by the PRC was owned by the sponsoring organisation, thus protecting the organisations' investment in R&D and avoiding unnecessary legal disputes. In addition, many centres, including all of those based in universities, actively encouraged the creation and protection of IP by providing incentives or patent awards and staff training on IP issues. In all university-based PRCs the researcher was awarded a share of the royalties from licensing agreements. Most of the MNE-based PRCs gave inventors financial rewards for patent applications. There was, however, clear evidence that the cost of obtaining and defending patents was prohibitive for some locally-owned and university-based PRCs.

In each case these difficulties are likely to have a negative effect on the longer-term regional benefits of any public investment in R&D either by encouraging secrecy on the part of the company-based PRCs or by creating unprotected intellectual assets in the university-based PRCs.

What was encouraging was that every PRC had access to expert advice on IP management, either from within their sponsoring organisation or through external patent lawyers. This means not only are the PRCs seeking to create advantage by protecting their IP from misuse by other companies, but they are also actively trying to exploit it for their own financial gain. This should have a positive influence on the innovative capacity of the PRCs and therefore on their ability to generate positive regional spillovers (Graversen et al., 2005; Link and Siegel, 2005).

**Table 1: Profile of PRCs**

PRC	Budget £m	FTE in 2005	Subject Focus	Host Organisation	Types of R&D Undertaken		
					● Major Focus	○ Minor Element	
					Basic R&D	Applied R&D	Experimental Development
<b>University-Based PRCs</b>							
CoE.1	1.51	2	Software Process Improvement	University		●	●
CoE.2	0.95	5.5	Technology Start-up & Incubation	University		○	●
CoE.3	37.76	110	Electronic Communication Technologies	University	●	●	○
CoE.4	4.20	4	Medical Polymers	University	○	●	○
CoE.5	3.95	22	Environmental Monitoring Technologies	University		●	●
CoE.6	4.00	7	Functional Genomics	University		●	
CoE.7	3.65	10	Aeronautical Technologies	University	○	●	○
CoE.8	11.65	17	Nanotechnology	University	○	●	○
<b>Company-Based PRCs</b>							
CoE.9	2.71	30	Automotive Engineering	Locally-owned SME			●
CoE.10	4.71	22.5	Food Research and Development	Locally-owned firm			●
CoE.11	6.52	23	Electric Power Engineering	MNE operation		○	●
CoE.12	7.97	27.5	Recording Media Substrate	MNE operation		●	
CoE.13	4.99	41	Mobile Software Systems	MNE operation			●
CoE.14	4.50	221 <sup>viii</sup>	Electrical Engineering Test Centre	MNE operation		○	●
CoE.15	3.14	15	Scientific Cameras	Locally-owned SME		○	●
CoE.16	7.03	23	Controlled Drug Delivery	MNE operation		○	●
CoE.17	2.89	35 <sup>ix</sup>	Proteomics	Locally-owned firm		○	●
CoE.18	4.15	20	Speciality Pharmaceuticals	Locally-owned SME			●

**Table 2: Models of technology transfer in PRCs**

PRC	Basic R&D Focus	Publication Activity	Presentation Activity	Model
<b>University-Based PRCs</b>				
1	None	High	High	Licensing
2	None	Medium	Low	Innovation
3	Major	Low	Low	Open Source
4	Minor	Medium	Medium	Open Source
5	None	Low	Low	Innovation
6	None	High	Medium	Licensing
7	Minor	Low	Low	Open Source
8	Minor	Low	Low	Open Source
<b>Company-Based PRCs</b>				
9	None	Low	Low	Local Firm
10	None	Low	Low	Local Firm
11	None	Low	Low	MNE
12	None	Low	Low	MNE
13	None	Low	Low	MNE
14	None	Low	Low	MNE
15	None	Low	Low	Local Firm
16	None	Low	Low	MNE
18	None	Low	Low	Local Firm



<sup>i</sup> The effects which publicly funded research centres can have on innovation and economic growth is the subject of a wealth of studies (Link and Scott, 2005; Debackere and Veugelers, 2005; Roper, 2000; Siegel et al., 2003; and Chen et al., 2004).

<sup>ii</sup> This may be a particularly pressing issue in less developed regions where the absorptive capacity of local firms is less well developed (e.g. Rodriguez-Pose, 1999; Fernandez et al., 1996).

<sup>iii</sup> The same report, however, questions whether the adoption of the licensing model has been as successful in Europe as in the US, viz. *“mere application of the licensing model has not been able to generate the same level of financial or economic results [in Europe] as in the US”* (EU, 2004, p. 11).

<sup>iv</sup> Arguments for this type of public investment are often made in terms of market failure which suggests that firms are generally unable to capture all of the benefits of their R&D investments and therefore tend to under-invest in R&D relative to the social optimum (Nelson, 1959; Arrow, 1962; Dasgupta and David, 1994). Empirical support for the value of public investment in private sector R&D comes from a number of studies which suggest a degree of additionality from public support (e.g. Griliches, 1995; Mamuneas and Nadiri, 1996; Luukkonen, 2000).

<sup>v</sup> Specifically: *“The RTD Centres of Excellence programme supports the establishment of R&D centres to stimulate leading edge, industrially exploitable and commercially focused research which will demonstrably improve the competitiveness of Northern Ireland industry,”* (Invest Northern Ireland, 2003).

<sup>vi</sup> The motivation for this was described as follows:

*“Our publishing is mainly driven by being seen to be active. Remember our customers are researchers. That is where our income comes from. Being associated with that community and seen as part of that community is important. As far as possible we don’t publish papers on things that would be useful to our competitors. We come at it from a slightly different angle because researchers are our customers.”*

<sup>vii</sup> *“Rent spillovers arise when quality improvements by a supplier are not fully translated into higher prices for the buyer(s). Productivity gains are then recorded in a different firm or industry than the one that generated the productivity gains in the first place. Rent spillovers occur in input-output relations. Pure knowledge spillovers refer to the impact of the discovered ideas or compounds on the productivity of the research endeavours of others. Pure knowledge spillovers are benefits of innovative activities of one firm that accrue to another without following market transactions”* (Beugelsdijk and Cornet, 2001, p.3).

<sup>viii</sup> Centres of Excellence funding did not directly support the salaries of these staff.

<sup>ix</sup> This Centre was not available for interview; therefore the FTE suggested in the original proposal has been used.

## References

Allen, K. R. (2003). *Bringing New Technology to Market*. New Jersey : Prentice Hall.

Arai, H. (1999). *Intellectual Property Policies for the Twenty-First Century: The Japanese Experience in Wealth Creation*. Policy Advisory Commission of the World Intellectual Property Organization.

Arrow, K. (1962). *Economic Welfare and the Allocation of Resources for Invention*. In *The Rate and Direction of Inventive Activity* (pp. 609-625). Princeton: Princeton University Press.

Beugelsdijk, S. & Cornet, M. (2001). *How Far do they Reach? The Localisation of Industrial and Academic Spillovers in the Netherlands*. Centre Discussion Paper, No.47.

Blackburn, R. A. (2003). *Intellectual Property and Innovation Management in Small Firms*. London and New York : Routledge.

Bozeman, B. (2000). *Technology Transfer and Public Policy: A Review of Research and Theory*. *Research Policy*, 29, 627-655. Amsterdam : Elsevier.

Chen, J., Zhu, Z. & Xie, H. Y. (2004). *Measuring Intellectual Capital: A New Model and Empirical Study*. *Journal of Intellectual Capital*, 5(1), 195-212. Emerald Group Publishing Limited.

Chesbrough, H. (2003). *Open Innovation*. Harvard : Harvard Business School Press.

Cooke, P. & Leydesdorff, L. (2006). *Regional Development in the Knowledge-Based Economy: The Construction of Advantages*. *Journal of Technology Transfer*, 31(1), 5-15.

Coriat, B. & Orsi, F. (2002). *Establishing a New Intellectual Property Rights Regime in the United States Origins, Content and Problems*. *Research Policy*, 31, 1491-1507. Amsterdam : Elsevier.

Dasgupta, P. & David, P. (1994). Towards a New Economics of Science. *Research Policy*, 23(5), 487-521. Amsterdam : Elsevier.

Debackere, K. & Veugelers, R. (2005). The Role of Academic Technology Transfer Organizations in Improving Industry Science Links. *Research Policy*, 34(3), 321-342. Amsterdam : Elsevier.

Department of Enterprise, Trade and Investment (2003). Northern Ireland Research and Development Statistics, 2002. 28 November, 1-30. National Statistics Publication, Northern Ireland Statistics & Research Agency.

Dietz, J. S. & Bozeman, B. (2005). Academic Careers, Patents, and Productivity: Industry Experience as Scientific and Technical Human Capital. *Research Policy*, 34(3), 349-367. Amsterdam : Elsevier.

European Commission, Expert Group (2004). Management of Intellectual Property in Publicly-Funded Research Organisations: Towards European Guidelines. 1-72. Luxembourg : European Commission.

Feller, I. (2004). S&T-Based Economic Development and the University. *Economic Development Quarterly*, 18(2), 138-150. Sage.

Fernandez, E., Junquera, B. & Vazquez, C. (1996) Government Support for R&D: The Spanish Case. *Technovation*, 16, 59-66. Amsterdam : Elsevier.

Gloet, M. & Terziovski, M. (2004). Exploring the Relationship between Knowledge Management Practices and Innovation Performance. *Journal of Manufacturing Technology Management*, 15(5), 402-409. Emerald Group Publishing Limited.

Graversen, E. K., Schmidt, E. K. & Langberg, K. (2005). Dynamic Research Environments: A Development Model. *The International Journal of Human Resource Management*, 16(8), 1498-1511. London.

Griliches, Z. (1995). R&D and Productivity: Economic Results and Measurement Issues. 52-89. Oxford.

Guellec, D. & Van Pottelsberghe De La Potterie, B. (2004). From R&D to Productivity Growth: Do the Institutional Settings and the Source of Funds of R&D Matter? *Oxford Bulletin of Economics and Statistics*, 66(3), 353-378.

Hanel, P. (2006) Intellectual Property Rights Business Management Practices: A Survey of the Literature. *Technovation*, 26(8), 895-931. Amsterdam : Elsevier.

Iansiti, M. & Levien, R. (2004). *The Keystone Advantage*. Harvard : Harvard Business Press.

Invest Northern Ireland (2003) RTD Centres of Excellence. Retrieved February 2, 2006, from Invest Northern Ireland website:

[http://www.investni.com/index/develop/dv-invest-in-rdt/research\\_and\\_development/rtdcentresofexcellence.html](http://www.investni.com/index/develop/dv-invest-in-rdt/research_and_development/rtdcentresofexcellence.html)

Jarzabkowski, P. (2005). *Strategy as Practice: An Activity-Based Approach*. London : Sage.

Kumar, N. & Aggarwal, A. (2005). Liberalization, Outward Orientation and in-House R&D Activity of Multinational and Local Firms: A Quantitative Exploration for Indian Manufacturing. *Research Policy*, 34, 441-460. Amsterdam : Elsevier.

Lee, J. & Win, H. N. (2004). Technology Transfer between University Research Centers and Industry in Singapore. *Technovation*, 24(5), 433-442. Amsterdam : Elsevier.

Link, A. N. & Scott, J. T. (2005). Universities as Partners in U.S. Research Joint Ventures. *Research Policy*, 34, 385-393. Amsterdam : Elsevier.

Link, A. N. & Siegel, D. S. (2005). Generating Science-Based Growth: An Econometric Analysis of the Impact of Organizational Incentives on University-Industry Technology Transfer. *The European Journal of Finance*, 11(3), 169-181. London.

Lockett, A. & Wright, M. (2005). Resources, Capabilities, Risk Capital and the Creation of University Spin-Out Companies. *Research Policy*, 34(7), 1043-1057.

Amsterdam : Elsevier.

Luukkonen, T. (2000). Additionality of EU Framework Programmes. *Research Policy*, 29, 711-724. Amsterdam : Elsevier.

Mowery, D., Nelson, R., Sampat, B. & Ziedonis, A. (2004). *Ivory Tower and Industrial Innovation: University-Industry Technology Transfer before and After the Bayh-Dole Act*. Stanford : Stanford Business Books.

Nelson, R. (1959). The Simple Economics of Basic Scientific Research. *Journal of Political Economy*, 67

Reddy, P. (1997). New Trends in Globalization of Corporate R&D and Implications for Innovation Capability in Host Countries: A Survey from India. *World Development*, 25(11), 1821-1837. Oxford : Elsevier Science Ltd.

Rodriguez-Pose, A. (1999). Innovation Prone and Innovation Averse Societies: Economic Performance in Europe. *Growth and Change*, 30(1), 75-105.

Roper, S. (2000). *Benchmarking Regional Innovation: A Comparison of Baden-Württemberg, Bavaria, Northern Ireland and the Republic of Ireland*. Working Paper No. 56. Belfast : NIERC.

Roper, S., Hewitt-Dundas, N. & Love, J. H. (2004). An Ex Ante Evaluation Framework for the Regional Benefits of Publicly Supported R&D Projects. *Research Policy*, 33(3), 487-509. Belfast

Siegel, D. S., Waldman, D. A., Atwater, L. E. & Link, A. N. (2003). Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. *Journal of High Technology Management Research*, 14, 111-133. Pergamon.

Zahra, S. & George, G. (2002). Absorptive Capacity: A Review, Re-Conceptualization, and Extension. *Academy of Management Review*, 27, 185-203.