Paradigm shift in Local Economic Development: Serving Knowledge-based business

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Abstract

Creating the right environment in which to establish a partnership between universities and businesses requires a detailed understanding of the needs, culture and practices of the organisations involved and of the process itself.

At one time the view of this relationship was that universities would develop technology that would pass to the private sector for exploitation. This view has changed substantially over the last 20 years and what has emerged is that there are two sides to the process which reflects a supply of technology and skills from universities and a demand side which comes from business which have to be integrated to create an effective environment for innovation. The environment at this interface is critical because of number of factors that include: a change of culture between the university environment and business; a change of funding from grant supported to either loan or equity finance, the transfer of risk from a university to a company and the exposure to the market of technology that has to prove that there is a demand for it rather than being something that just works.

In 2002 the Lambert Review looked at the relationship between universities and industry and concluded that the supply side of the equation was successful; however, the demand side for technology from business needed to be strengthened.

Despite the clear message to industry for the need to invest more in R&D and operate in a more innovative way the issue still remains to be resolved in the European context. However, it is also clear from some pan European work that there has to be an appropriate environment if this process of innovation is going to be encouraged and the relationship between industry and universities alone is in itself insufficient to create an innovative environment that has the potential to create a strong and vibrant economy that is able to compete.

It is suggested that to create a more innovative society in Europe there needs to be a strategy to create a market for innovative goods and services, focussed resources, new financial structures and mobility of people, money and organisations. Together these constitute a paradigm shift going well beyond the narrow domain of R&D and innovation policy. This degree of change requires a pact for research and innovation to drive the agenda to create and environment that will support innovation and this requires a huge act of will and commitment from political, business and social leaders.

This paper highlights some of these issues and looks at how the UK university sector is responding to this and what kinds of encouragement there is at a national level to improve the performance of universities – industry links.

Introduction

"Cities and regions are being profoundly modified in their structure and conditioned in their growth dynamics by the interplay of three major historical processes: technological revolution, the formation of a global economy and the emergence of an informational form of economic production"[1].

There is no doubt about this change and however hard some may try to ignore this it is clear that this process is unavoidable and if ignored those that do, will be left behind.

Where these changes have been embraced many of the processes and components that make up the complex web of interplay that is described as an economy have had to change.

[1] Castells M, and Hall P., Technopoles of the world. Routledge.

These changes are taking place on a global scale, however, the delivery of responses to these do not occur on a global scale but rather at a national, regional and local scale through policies and investment by government, their agents, education and those in business.

Together these elements combine to influence the technology, business and social environment which in turn has a significant impact on the processes that underpin economic development. At a sustainable level this encourages economic activity that has traditionally involved either increasing the number of companies that operate in an area or the size of companies that operate in an area. However, with the paradigm shift known as the knowledge economy, what has also emerged is the value of increasing productivity of the individual companies that operate in regions.

At a national scale policies that influence the fiscal environment in which business operates have some influence. It is clear where effective partnerships between business and government exist fiscal environments that encourage investment can be created. Government policy and investment in science and technology are also critical.

The global market has introduced powerful competition. The ability of information to be moved quickly compresses differences between regions and this means that to maintain an economic status they have to create a set of conditions that make their region attractive and unique.

In contrast to this negative side to competition there is a positive aspect in that the globalisation has increased the opportunity for many more organisations to enter the competition. In essence the technological revolution has created a market place for goods and services that allow many more people if they have the right skills to contribute to economic development.

This leads to the issue of informational production. An information society is one in which the creation, distribution and manipulation of information is becoming a significant economic and cultural activity. The knowledge economy is its economic counterpart whereby wealth is created through the economic exploitation of understanding.

Specific to this kind of society is the central position information technology has for production and economy. Examples of this central position include: the information industries which together are a rapidly growing part of economy. The demand for information goods and services from consumers is increasing. In the case of consumers, media including music and motion picture, personal computers, video game-related industries, are among the information industries. In case of businesses, information industries include computer programming, system design, so-called FIRE (finance, insurance, and real estate) industries, telecommunications, and others and the demand for these industries is growing nationally and internationally, and this has created an opportunity for an urban, regional, and in some cases national economies to grow rapidly by specializing on these sectors.

It is also clear that the information industries are considered to boost innovation and productivity of other industries. An economy with a strong information industry might be a more competitive one than others, other factors being equal.

Finally some believe that the effect of the changing economic structure (or composition of industries within an economy) is related to a broader social change where, as information becomes the central part of our economic activities, the society as well is becoming an “informational society”. For example, some observers have noted the increased role of mass media, digital technologies, and other mediated information in our daily life, leisure activities, social life, work, politics, education, art, and many other aspects of society; all of which are a significant influence.

These changes are clearly profound and have begun to alter society at a number of levels.

It is clear that the extreme competition and the need rapid and high levels of innovation necessary to compete in this new profoundly modified set of circumstances requires new relationships, infrastructure and skills to be developed.

The importance of innovation as a process has prompted many people to both research the process as well as try to understand the conditions most likely to be conducive to supporting the process. Despite this interest looking across Europe there is a consensus that the countries on this continent must break out of structures and expectations established in the post 1945 era which leave it today living a moderately comfortable life on slowly declining capital[1] because it is failing to innovate at a sufficient rate.

This concern about the economic health of Europe prompted the European Commission to set up an expert panel chaired by Esko Aho to study this issue.
The main conclusion of the panel that followed this wide ranging study was that to create a strategy for innovation in Europe there needs to be a combination of a number of factors at the heart of which is the creation of a market for innovative goods and services, more focussed resources, new financial structures and mobility of people, money and organisations.
To encourage this, the view of Aho's panel was that simultaneous and synchronous efforts would be needed in three areas.
The first being to provide an innovation-friendly market for business. To achieve this the panel suggested that there was a need for actions on regulation, standards, public procurement, intellectual property and fostering a culture which celebrates innovation and that a combination of supply and these measures to create demand should be focused in large scale strategic actions and they identified several examples: in e-health, pharmaceuticals, energy, environment, transport and logistics, security, and digital content.
This view is consistent with the recognition that small and medium sized enterprises (SMEs) have the best chance of survival if they work in the slipstream of large trans-national companies that would be the kinds of organisations that would be the contractors for such major schemes.
Aho's Panel's second recommendation was that the target of expenditure of 3% of GDP on R&D, should not be an end in itself and there is a need to not only increase resources for excellent science, industrial R&D and the science-industry nexus but also the productivity of R&D must be increased and the proportion of structural funds spent on research and innovation should be trebled.
The third recommendation was that far greater mobility is needed in human resources which need a step change in mobility across boundaries; financial mobility that requires an effective venture capital sector and new financial instruments for the knowledge-based economy; and thirdly the mobility in organisation and knowledge which means cutting across established structures to allow new linkages to be made through the instruments of European technology platforms and clusters.
Aho suggested that in this context this would entail changes to the very heart of structures for research and innovation and that these should be replaced by intermediary structures to support the diffusion and successful application of innovation in existing industries, services and products because many of the existing structures in Europe were designed to support innovation under the traditional paradigm of an industrial resource based society that limits the mobility of people; finance; and organisations and infrastructure.
The panel noted that at the core to this were problems associated with:
The facility with which older people change jobs and in the context of innovation this includes those involved in careers in research that find it hard to transfer their skills because of issues relating to employment and pensions.
Mobility across the divide between science and-industry is a significant problem. Aho noted in particular that the flows of established researchers (as opposed to newly qualified students) are minimal and the lack of movement is largely due to structural barriers and lack of incentives. They also identified a particular problem of the difficulty for many academics to take up part time, or even full time but limited-term appointments in industry and be able to return to their tenured appointments once the relevant project is complete. To overcome this stagnation Aho's Panel suggested that to be effective a good target for mobility in this sector might be ten per cent of the workforce in each year should be moving with as high a proportion as is feasible engaged in cross-border movement.
In addition to mobility for personnel, Aho's panel recommended that there should also be increased financial mobility to ensure access to external sources of finance for firms at different stages of development which not only includes access to venture capital but also access to loans, guarantee mechanisms and other financial instruments including equity finance such as venture capital of which there needs to be an adequate supply if the European industrial ecology is to be dynamic and support the entry and growth of new entrepreneurial firms.
One of the observations about venture backed companies is that they are six times as R&D intensive per employee as the top 500 EU25 R&D spenders and every third employee works in R&D which

indicates that importance of this kind of funding in transferring technology across the boundary from discovery to implementation.
It is clear that such a strategy goes well beyond the narrow issue of R&D and innovation policy which suggests that the title of this paper "university – industry partnership on science and technology innovation" really only scratches the surface of a deep seated structural issue and the solution encompasses more than just the contribution of universities and their relationship with business. Having said that it would still seem that this relationship is a key part of the solution as it remains the bedrock on which any wider changes to society such as those proposed by Aho must be founded.
In 2002 the Lambert report[2] looked at business – university collaboration with the intention of meeting the following three objectives:

- Illustrating the opportunities that are being created by changes both in the way that business is undertaking research and development (R&D), and in the way that universities are opening their doors to new forms of collaboration with business partners.
- Celebrating the success of those businesses which are already collaborating successfully with university research departments, to their benefit and to the benefit of the economy more broadly. They are role models for the majority of companies which at present have no links with universities.
- Offering a wide range of ideas to stimulate debate and recommendations to help shape policy.

The review concluded that the biggest challenge in the UK lay on the demand side of the link and noted that, when compared with other countries, British business was not research intensive, and its record of investment in R&D in recent years had been unimpressive. UK business research is concentrated in a narrow range of industrial sectors, and in a small number of large companies. All of which helped to explain the productivity gap between the UK and other comparable economies.
However, what may have emerged from the Aho Panel's work is that the solution may need to go beyond this interrelationship and also involve policy makers, politicians and other groups in society in creating a pact that puts in place a friendly market for Europe's businesses because it appears that the lack of this market is the main barrier to investment in research and innovation by business across the wider business community.
The Aho report looked at this issue across the European Union which it must be recognised includes countries at varying stages of development and with quite widely varying systems of higher education. An example of this difference is in Germany where those employed in universities are civil servants while in the UK those in higher education are not, this difference has a significant impact on the ability of academic staff in Germany to create commercial enterprises and to act as consultants. Also in Germany the ownership of land by universities has an impact on how these institutions create and promote science parks.
Reviewing these variations is not the purpose of this paper; however, it is the intention of this paper to look at some of the changes that have emerged in the UK in relation to the university – industry partnership and comment on how these are seen from the perspective of creating an environment to foster innovation which in turn has an influence on those that operate science parks.

What is happening in the UK, how has this evolved and where is this going?

Over the last twenty five years it has been recognised that there is a need for universities to do more than the traditional activities of teaching and research if they are to reach their full potential in terms of supporting economic development. As a result there is an expectation that all universities should be actively involved in helping to develop their regional economy through knowledge transfer. Of course some entrepreneurial universities have had this third leg of activity in their core mission for many more years but these have been in the minority, while to others it is a relatively recent addition to their work and one which has only been undertaken because of encouragement by the government. It is true to say that the University of Surrey is one of those universities that is highly entrepreneurial.
In the UK there is already a large community of higher education institutions and other research laboratories including those that have grown out of the defence industry whose task is to support

innovation, particularly by SMEs. In addition there are over 703 formally recognised science parks and incubators, as well as regional and local government bodies and knowledge transfer organisations that are active in this area.
A brief review of the ways in which universities and these others centres of technology and skills interact with the commercial base of region to effect innovation suggests the following:

- Influencing the skills base in a region.
- Creating technology that may have the potential to be licensed.
- Creating spin-out companies.
- Provide consultancy services.

In the UK and most likely in many other parts of the world for these activities to be most effective these must involve both sides of the partnership, have direction and relevance to the needs of a region and be funded.
These different dimensions to this issue make the matter complex and suggest that there is no formula based strategy that will deliver universal success; however, there is a very strong interest in the UK in this issue and it is a matter that is exercising all the countries in the European Union[1, 2].
This paper focuses on initiatives and processes that are currently in place in the UK to create spin out companies from the supply side of the equation and on some of the programmes that are in place to assist with innovation for companies on the demand side of the partnership between universities and business.

Spin out companies

In the UK the interest in creating spin out companies was reinforced with a strong push from government in the white paper[4] that promoted the formation of regional development agencies to which organisations they delegated the responsibility to create economic strategies to promote innovation and technology transfer strategies from universities, research centres and innovative businesses into the community. Evidence gathered from working in science park movement was that pre 1998 virtually no government money went into supporting higher education knowledge transfer. However, since then there have been a number of initiatives with significant funding to support these.
Minshall and Wicksteed [5] noted that since 1998, the Government has launched a number of funding schemes to support higher education institutions (HEIs) in developing their capacity to commercialise knowledge generated through research activities. The most important are summarised below in Table 1.

Year	Initiative	Purpose	Details
1998	Higher Education Reach Out to Business and the Community (HEROBaC)	Funding to support activities to improve linkages between universities and their communities.	£20m per year allocated to provide funding for the establishment of activities such as corporate liaison offices.
1999	University Challenge Fund (UCF)	Seed investments to help commercialisation of university IPR.	£45m was allocated in the first round of the competition in 1999, (with 15 seed funds being set up) and £15m in October 2001. 57 HEIs how have access to this funding.
1999	Science Enterprise Challenge (SEC)	Teaching of entrepreneurship to support the commercialisation of science and technology.	SEC initially provided £28.9m in 99/00 for up to 12 centres. Additional funding of £15m increased the number of HEIs participating to 60.
2001	Higher Education Innovation Fund (HEIF)	Single, long term commitment to a stream of funding to support universities' potential to act as drivers of growth in the knowledge economy.	HEIF was launched in 2001 to bring together a number of previously independently administered third stream funding sources. This was then extended (HEIF2) in 2004 with £185m awarded.

Table 1: Example UK Government funding streams to support 'third stream' activities.

The main strategy behind these government funding initiatives has been the creation of spin out companies and they have given universities the opportunity to experiment on ways of creating commercial value from technology.
However, the analysis of Minshall and Wicksteed seems to suggest that simply relying on creating spin outs has not resulted in gaining the most economic value from technology; although, their work did indicate that creating spin-out companies is an effective strategy in the following sets of circumstances:

- For commercialising platform technologies.
- Where the inventors are very keen to commercialise the technology themselves.
- When an idea needs to attract substantial investment to develop IP relating to the technology for subsequent licensing.
- When the technology is not readily licensable.
- For a generic technology with many different applications.

In response to the findings of the Lambert report in 2002, and the apparent success of HEIF, the Government published alongside its 2004 Spending Review a ten-year Science and Innovation Investment Framework[6]. The foundation of this proposed framework included commitments to:

- Ensuring a financially robust network of universities and public research laboratories.
- Developing world class research: a part of this is to increase spending in specific areas of science i.e., spend £320 million in the three years 2005 to 2008 in the form of grants to support research and development in the technologies identified by the Technology Strategy Board; establish annual round for bids to the Department of Trade and Industry support systems which are Collaborative Research and Development programme and Knowledge Transfer Networks.
- Encouraging a continuing step-change in the responsiveness of the research base to the needs of the economy: one aspect of this is to engage experienced business leaders that will be asked to identify the new and emerging technologies critical to the growth of the UK economy.
- Raising business investment in R&D and innovation and encouraging stronger business engagement with the ideas and talent of the UK research base: the aim being to ensure that all elements of the UK innovation system are active in helping the development and widespread dissemination of technologies which are critical to the competitiveness of British business.
- Making the supply side of science and technology skills more responsive to demand: a key role for any Technology Strategy is to create a 'pull-through' of scientific advances into useful technologies that impact directly on business productivity. This can be supported by a Technology Strategy Board that is chaired by an industry representative and sets out the priorities for both the collaborative R&D programmes sponsored by the initiative, and related knowledge transfer networks to ensure communication between academia and industry.
- Encouraging greater flexibility within schools and universities to attract the skills they need.
- Encouraging greater understanding of, engagement with and confidence in UK scientific research and its innovative applications.

As part of this framework the government has committed to continue to develop the HEIF stream of funding and now HEIF4 is in place.
HEIF was designed to sit along side the teaching and research activities in universities as part of their role of enhancing the contribution of universities to the economy and society.
The HEIF programme also absorbed the Science Enterprise Centres and in 2004 around £119 million per year was being spent on this activity by government. Since then HEIF3 has seen a 27% increase in spend on HEIF2 with an investment of £235 m between 2006 and 2008 in England. In addition to this under the Government's Framework for Science and Technology that covers the period from 2004 to 2014 research funding is also planned to increase at 6% per annum in real terms through to 2014.
In 2006 a review by the Higher Education Funding Council for England (HEFCE)[7] reported that the investment by HEI through HEIF and the equivalent programmes in Wales, Scotland and Northern

Ireland had resulted in significant interaction between universities and their communities including business. Details of this are shown in table 2.

Years	2000-01	2001-02	2002-03	2003-04
Number of disclosures	2,159	2,478	2,710	3,029
Consultancy income (£M in real terms*)	112	129	172	211
Collaborative research income (£M in real terms*)	447	495	491	541
A required contracting system for all staff-business consulting activities (% of UK HEIs)	60%	65%	66%	68%
An enquiry point for SMEs (% of UK HEIs)	83%	85%	89%	90%
Regeneration income (£M in real terms*)	129	134	150	216
Facilities and equipment related services income (£M in real terms*)	28	53	68	80
HEIs providing short bespoke courses on companies' premises	62%	67%	78%	80%
HEIs providing distance learning for business	52%	52%	66%	66%

* All figures have been adjusted to 2003-04 prices

Table 2 Selected indicators 2000-01 to 2003-04

Additional results reported in the Financial Times[8] are noted below in table 3. Interpretation of these figures shows some areas of activities still need to be strengthened.

Universities Contribution to the Economy	2000 – 01	2001 – 02	2002 – 03	2003 – 04	Change 2002-03 over 2003-04
Number of Licences and options executed	728	614	758	2,256	+198%
Gross Income from intellectual property	£18m	£47m	£37m	£38m	+1%
Number of spin-outs (wholly or partially owned)	248	213	197	167	-15%
Contract research income from business	£259m	£328m	£289m	£287m	-1%
Consultancy income	£104m	£122m	£168m	£211m	+25%
Number of new UK patent applications	896	960	1,222	1,308	+7%
Number of UK patents granted	234	198	377	463	+23%

Table 3

This data indicates that much of the HEIF investment has produced an increase in interaction between business and universities. It is likely that some of this has led to innovation and may also indicate that there is a greater level of interaction between business and universities; however, despite this the rate of spin out companies from UK universities has fallen.
This data reflects what the majority of those in the UK Science Park movement have known for some time which is that universities and their academic staff are not great generators of companies.

A study undertaken by Wright[9] looked at a number of matters relating to this and raised a number of key issues concerning the development of spin-out strategies some of which appear to mirror at an institutional level the observations made by the Aho panel at a transnational level.
Wright's findings included:

- The key initial step of opportunity recognition and the skills necessary for this process and this raised the question of whether the necessary skills and expertise for this selection procedures was sufficiently developed in the university environment because the universities and academic entrepreneurs involved in creating university spin outs (USOs) were generally found to lack the necessary human entrepreneurial capital and social capital synonymous with commercial awareness and prior business experience. As a result, there is an inability to conceptualise how a technological discovery can be best applied to satisfy a market need.
- There was a lack by academic scientists and surrogate entrepreneurs did not become sufficiently emotionally and financially committed to championing the commercialisation of university scientific discoveries
- The need to resource this process effectively and in the traditional non-commercial environment of universities, the development of university spin-outs (USO) may be constrained by major deficiencies in resource endowments and capabilities[10]. In response to this deficiency Lockett et al[11] attempted to identify the resources required to facilitate the spin-out process and categorised these into human capital, financial, physical, technological and organizational. Their study also identified five phases in the development of a spin-out company: research phase, opportunity phase, pre-organization phase, re-orientation phase and sustainable high-growth phase. It was evident that each venture needs to pass through the previous phase in order to progress to the next stage of development. The study also found that moving between each phase was not always automatic and that a number of critical factors influenced the ability to proceed from step to step. These critical junctures were identified as opportunity recognition, entrepreneurial commitment, credibility and sustainability and were found to arise due to deficiencies in social capital, other resource weaknesses and inadequate internal capabilities.
- The study suggested that to overcome this difficulty, universities should devote more resources to developing and exploiting external partnerships, links and interactions with industry, venture capital firms and surrogate entrepreneurs so that academics and university technology transfer officers (UTTOs) may become better positioned to recognise entrepreneurial opportunities.
- A credibility gap exists with potential trading partners and financiers particularly arises from their intangible initial resources, the typical lack of commercial track record of the founding entrepreneur, the effect of the academic culture and values, and the absence of clear policies on the commercialisation of scientific discoveries.
- Having identified these barriers to progress Wright recommended that the process could be enhanced by professionalising the process which includes demonstrating the credibility of their university by presenting intellectual property as a potential portfolio of products, demonstrating proof of concept of technological assets to the market, clarifying the route to market and profitability for this IP, locating the venture off the university campus, and implementing mechanisms to attract surrogate entrepreneurs. In addition it was clear that the rigour exercised by universities in managing these assets does not always match that which is exercised by venture capital companies.

In the analysis Wright et al also noted a number of other factors that hindered the progress of USOs. These included:

- Availability of finance: a lack of seed funding was noted as a major hindrance to establishing spinout companies.

- The limited amount of time available for university staff to help spinout companies and the clash of commercial and academic cultures hindered company formation.
- A lack of availability of suitable space on a science park for spinout companies. The work suggested that a lack of suitable space outside the university to accommodate spinouts may have had an impact on how quickly these firms are recognised as credible business entities by suppliers, customers and investors.
- The availability of incentives and rewards for university staff was ranked as the fourth most important impediment to the creation of spinouts. In this category one of the factors that hindered the creation of spinouts was the ownership of intellectual property rights. Closely related to this was the problem of deciding on the distribution of equity in the spinout company. In some cases a further impediment was the availability of incentives and rewards to attract commercial management into spinouts.
- The availability of a clear process for spinning out companies was highly significant in distinguishing between the impediments to spinout development.

The conclusions of the work by Wright were that to enhance the effectiveness of spin out companies:

- Universities should focus more on how to overcome their existing culture, values and incentive which currently primarily reward academics for their research efforts. The study also showed that those universities that had attempted to address this issue, had managed to create a more accommodating culture for those academics that were entrepreneurially oriented, resulting in more technologies being commercialised.
- Second, Wright9 evidence showed a clear difference between universities in their ability to commercialise technologies due to the existence and quality of internal capabilities and organizational routines as well as clearly communicated policies and guidelines. This included resources of expertise and pre-seed finance. Their research also showed that to enhance the effectiveness of the process there was a need to ensure that the line managers of entrepreneurial staff were put in the context of universities' overall strategies.
- Third, the process was helped where UTTOs devoted more attention to identifying how ventures would achieve proof of market and proof of technology and to carrying out effective IP due diligence prior to submitting proposals to external financiers.
- Fourth, the process might be enhanced by the provision of greater career support and entrepreneurial training to those academics who wish to participate in the commercialisation of their academic research in order to gain their commitment to the commercialisation process in some form, otherwise the tacit knowledge necessary to make the technology function in the marketplace is likely to be missing.

The alternative to creating USOs to capitalise on products that might emerge from universities, is the option to licence IP. The data from HEFCE in table 1 shows a significant rise in this activity. In addition a number of companies such as ANGLE Technology, which is a tenant on the Surrey Research Park, announced[12] that it had taken options on IP that emerges from a number of UK universities. This strategy allows specialist companies such as ANGLE Technology to deploy its expertise to build value for its partner organisations. To support this process ANGLE has developed a methodology for helping them build this business base which is more fully explained in the recently published UKSPA book.

The UK higher education sector is diverse in terms of the relationships that have developed with the business community. Some, such as the University of Surrey have for many years had these links as part of its core mission while others are coming to this rather more recently. The effectiveness of these links are also influenced by regional settings, historical factors such as the reputation, the courses that are offered and whether individual universities offer courses that include formal periods of time for students to work in paid employment in business, reputation and the whether there are appropriate management mechanisms and structures in place that facilitate these links.

Links between businesses and universities – beyond spin out companies

Much of the interest by government and the investment that has followed this has focussed on USO and licensing, however, there are other significant groups of companies that with which universities engage. It is clear that businesses are not homogenous in size, mission or interest in collaboration and that different types of company have different motivations for wanting to interact with universities. In analysing this relationship Wicksteed[13] noted the following variation and influences on the interest and capacity of companies to link with:
Global (dominant) companies.

- Global companies may seek to gain wide influence by collaborating with universities.
- Can afford long term commitments.
- Often more concerned with growing the overall sector (through research-based innovation) than gaining competitive edge.
- Often have the capacity to distinguish goals of internal and external research.
- Will be interested in recruitment.
- Interaction with them can be straightforward (though they will tend to only have interest in a small number of globally excellent universities).

Large companies.

- Large companies may have a medium term research agenda which requires specific expertise found in universities.
- Will be interested in recruitment.
- Interactions with them are potentially complex (because of IP concerns and possible tensions in shaping the research to fit academic priorities).

Medium size companies.

- Medium size companies tend to be more interested in short term expertise that is consulting.
- Will be interested in recruitment.
- Interaction should be straightforward (though timescales may be an issue and companies may find that now universities are required to recover the full economic costs of research they are less cheap than before).

Start-ups (high tech ones).

- Start-ups want help with special infrastructure.
- Will be interested in recruitment.
- Interaction should be straightforward (especially if the start-up team members have personal links to the nearby university).

Wicksteed also noted other less technology focussed small firms which although not of great interest to universities are of interest to policy makers in the European Commission, the UK Government and the Regional Development Agencies. Many academics have no interest in these firms because they:

- Often are unable to state what help they need – only knowing they have a problem.
- Tend to seek outside help when a crisis occurs and a panic response is needed which puts them beyond the time frames in which academics can reasonably be expected to respond.
- Have quite unrealistic expectations of what university staff can do for them.
- Expect to pay next to nothing.
- Offer little prospect of a future relationship which would allow the, often considerable, ‘transactions cost’ to be spread over a number of assignments.

Taking these observations in the round reflects an approach to the links between business and universities that is becoming more professional and if coupled with science parks it is likely that entrepreneurial universities will be able to increase their contribution to economic development.

Business incubators and science parks

Business incubators have been part of the infrastructure to support business formation and growth for over 30 years. In that time a number of national and international organisations that support incubators have grown up. These include UKSPA and IASP, which see business incubation as just part of the work of their members: UK Business Incubation (UKBI), EBN (which supports the pan European BIC projects), and NBIA (National Business Incubation Association) in the USA. The collective members of these organisations have substantial experience of how these organisations operate, and fully understand how (and what) incubators contribute to economic development.

The perceived significance of these projects prompted the European Commission to fund a study on benchmarking European Incubators[14]. The final report, published in 2002, noted that there were some 900 incubators operating at that time, across the continent, and that these projects were generating some 40,000 new jobs each year. In addition, a clear conclusion was that business incubation adds value by accelerating the start up of new businesses, and helps to maximise their growth potential in a way that is more difficult for alternative SME support structures to achieve. The report also identified a number of best practices for these projects in order for them to meet their maximum potential.

The key finding was that business incubators are a cost effective method of promoting knowledge-intensive, new technology-based activities. However, for the best outcome incubators need to be:

- Integrated into wider regional technology strategies.
- Focussed on a clearly-defined target market with a set of appropriate admission and exit criteria that encourage a turnover of companies even if this makes revenue levels from rental income and other services less certain.
- Provide high quality support and be managed in a business like manner.
- The report was also clear that after care and networking with firms that have left incubators should be considered just as important as providing services to incubator tenants.

UKSPA's members have found that, in terms of a graduation policy, it is essential that there is appropriate accommodation provided, so that companies can continue to grow in a single location, if they so wish, and therefore be able to provide continuity for their employees and customers.

A study of nine incubators in Denmark[15] failed to explain which factors contribute to incubator performance; however, it concluded that incubators and entrepreneurship benefit from the accessibility of a multi-faceted and competent entrepreneurship infrastructure. In addition, the study revealed that incubators assume an important role in building infrastructure by taking an active part in maintaining and strengthening entrepreneurship infrastructures and by utilising this infrastructure to nurture the stock of companies. However, the study also suggests that the performance of incubators is influenced by the international connections that they develop which encourages tenants to internationalise.

The breadth of these issues and their influence has prompted a number of national standards to be set as a foundation for incubation. The French and EBN have both established standards, and more recently UKBI has created a comparable benchmarking framework with associated strategies on which to research, plan, develop and operate an incubator.

UKBI's[16] benchmarking framework for business incubation acknowledges that there is no single model for business incubation, and that the process (as it has emerged in business incubators) is made up of a combination of factors that include:

- Availability of resources to support these projects.
- The degree of maturity of the economic environment in which they operate.
- Aims and objectives of these projects which, like those for science parks, vary.
- Society's views on entrepreneurship.

- The socio-economic and politico-cultural conditions that prevail in the environment in which these projects operate.
- Funding streams and stakeholder involvement.
- Location including influences from sector based issues.
- Relationships within a regional and national economy.
- Influences of the incubator building and how this is managed.

Promulgation of this code is relatively recent, and therefore any measurement of its effect on the success of projects based on this is unlikely for sometime; however, UKBI has concluded that any evaluation process will need to use qualitative as well as quantitative methods and measures, and will need to take into consideration the specific context in which any incubation facility is positioned.

What has also emerged is the concept of pre-incubation; a number of science parks in the UK have now established these units. The thrust of these projects is to attract people that have ideas with commercial potential, but who need to set out their ideas in a business plan in order to attract funding. The operation of these units is still in its infancy, and so it is not yet clear how effective these projects will be in the longer term other than relying on the qualitative view, which is that they do serve a purpose. In addition, other questions about their operation are being asked to test whether they perform best as single technology projects with a bureaucratic regime of control, or by being very flexible and bending to meet what ostensibly are market conditions.

Practitioners within the science park movement have long recognised the importance of going beyond the processes of pre-incubation and incubation, and will therefore provide space for companies that emerge from this activity, but will also want to retain continuity for their staff and customers by remaining in a single location. Evidence to support this view is shown in data from a limited and self-selected sample of ten parks in 2006, of which seven had over 100 tenants, which noted that on average 27% of their tenants had graduated from their incubator[17].

In addition a study conducted on behalf of UKSPA[18], the Small Business Service of the Department of Trade and Industry, was undertaken to analyse some of the important issues that had emerged out of the extensive research, comment and observations that have been made about science parks over the last 20 years.

This study[18], which involved 876 companies that were matched between companies on science parks and off science parks, was conducted to evaluate the past and future economic contribution of the UK science park movement to company formation.

To better understand the findings of this study[18] it is useful to review the model (figure 1) of the regional knowledge economy that was developed in 2001 by SEEDA and Huggins[19].

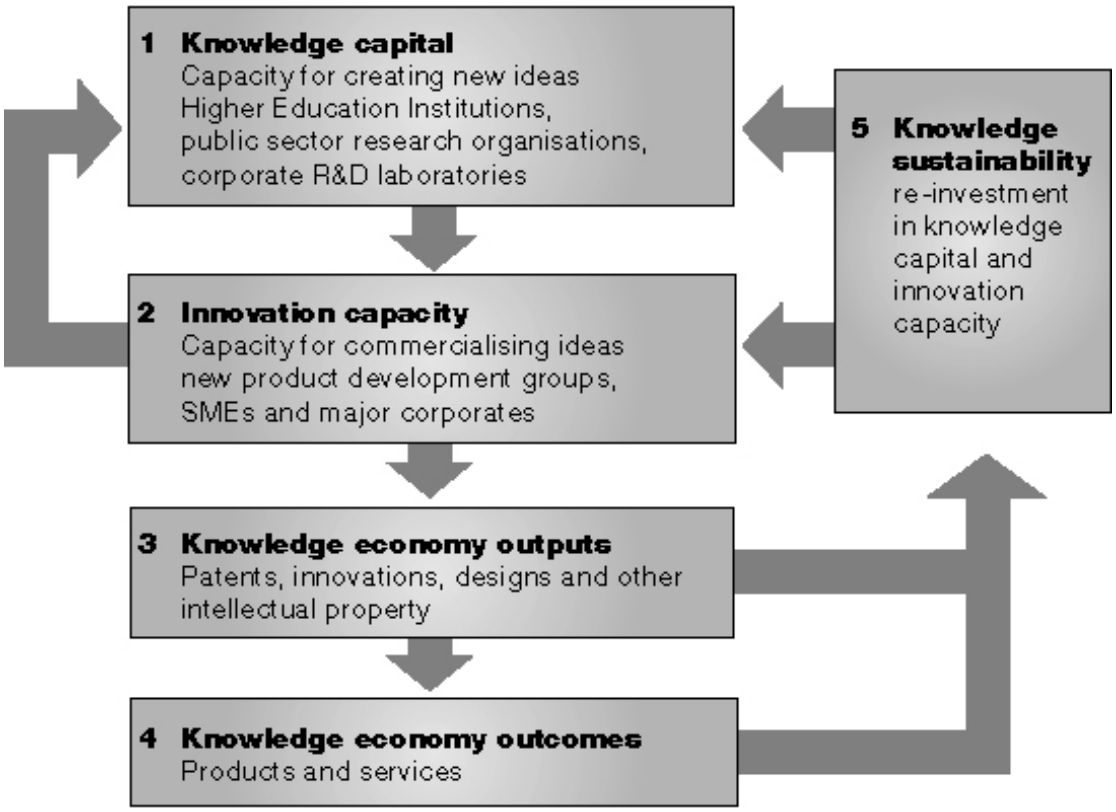

Figure 1 Model of the Sub Regional Economy

This figure characterises the knowledge economy as being in five parts that start with knowledge capital, which is the capacity to create new ideas. Those organisations that contribute to this include universities, public sector research organisations, and private R&D organisations such as corporate research laboratories and contract research organisations. However, for these kinds of organisations to have an impact in the knowledge economy, the environment has to encourage them and others to acquire, create, disseminate, and use (codified and tacit) knowledge more effectively[20]. To support this, the socio-economic and politico-cultural environment has to encourage:

- An economic and institutional regime that provides incentives for the efficient use of existing knowledge, the creation of knowledge, and entrepreneurship.
- An educated and skilled population that can create and use knowledge.
- A dynamic information infrastructure that can facilitate the effective communication, dissemination and processing of information.
- A system of research centres, universities, think tanks, consultants, firms and other organisations that can tap into the growing stock of global knowledge, assimilate this, and then adapt it to local needs to create new local knowledge.

The implications of this view is that a 'big push' on R&D or higher education does not guarantee success, as the other components may not exist and - even if they do – they may not be able to be influenced by policy and investment that flow from this.
The implication for science parks is that a role exists for them to create an infrastructure that encourages adoption and application of this viewpoint by encouraging entrepreneurs to form the necessary links to commercialise technology.
At the second level, figure 2 represents the regional innovation capacity that is capable of developing and commercialising new products. This capacity is made up from the number and quality of small, medium and large enterprises in the region that are driven to improve their competitive position in the market place, and includes the extent of groups concerned with new product development.

There is concern that many companies in the UK are neither committing sufficient resource to innovation nor absorbing new technologies that are necessary to maintain a competitive advantage. To counter this, there are a number of initiatives that are being delivered at a regional level; however, there is view that the number of initiatives on offer to businesses is confusing[21].

The third level of the model defines knowledge economy outputs, which include the number and value of patents, innovations, design and other forms of intellectual property that are either pushed or pulled through the innovation process.

The importance of protecting intellectual property in underpinning innovation has been recognised by the Government; however, there is a Government view that UK businesses, especially SMEs, may not have a grasped the importance of the need to protect IP. To improve awareness of the importance of managing IP rights, the Government is targeting SMEs to take more interest in this activity. At the same time, the UK Government is also looking to improve the measurement of IP protection and encourage the education sector to include IP management and exploitation in relevant courses[22].

If the flow exists across these levels, then there is a possibility that at the fourth level there are knowledge economy outcomes which include products and services generated by the linkages between each of the activities in the other parts of the model.

Current evidence suggests that despite regional variations in innovation performance, the UK's rate is at best average. The DTI has identified seven critical success factors for innovation performance. Those involved in the science park movement can clearly contribute towards developing an environment where these success factors can be better managed. These factors are:

- Sources of new technological knowledge.
- Capacity to absorb and exploit new knowledge.
- Access to finance.
- Competition and entrepreneurship.
- Customers and suppliers.
- The regulatory environment
- Networks and collaboration.

The final two pathways in the model represent feedback which, if successful, results in re-investment in knowledge capital and innovation capacity that in turn leads to a virtuous circle of success.

Using this model, the UKSPA study sub-divided the UK into three types of economic area. The first of these, classified as knowledge heartland economies, covered those areas where all the elements and linkages in the model were fully established and working well. The second category of developing knowledge economies described those areas where most elements and linkages were established; however, there were some pathways or capacity restrictions. The third category, defined as economic development priority areas, included all those where all major elements and/or pathways between the various levels in the model were missing or constrained.

Based on this subdivision, the UKSPA study showed, at a statistically significant level, that the most important single factor affecting the performance of individual science parks was the state of the sub regional economy within which they operate.

These findings about the performance of tenant companies on science parks indicate that where linkages between knowledge generation and knowledge utilisation are in place – and are working well – parks are likely to help their regions pull away from those regions that do not have the successful linkages. In fact, well connected regions will become increasingly more attractive to knowledge based businesses, which will in turn widen the gap in economic performance compared with those that lack the linkages.

This is an important finding in that it brings into perspective an existing concern by government with regard to the unevenness of the distribution across the UK's regions of building blocks of the knowledge economy, which are skills and employment, and how these are having an adverse effect on economic development. The effects of this include, for example, a brain drain that limits capacity building in those areas that see outward migration and under-employment of graduates As a consequence, a bottleneck in employment arises for those with intermediate qualifications[23]. The

question is: what role can science parks play in attempting redress this balance? The report on the Regional Perspective on the Knowledge Economy in Great Britain indicates that the business drivers in the knowledge economy are relatively weak, and that this sector of the economy is dominated by the sector which includes health and education. This suggests that science parks and incubators may have a role in attempting to encourage a business base that has more influence in driving the knowledge economy.
The other important findings of this study are set out below.
The study highlighted the comparative performance of companies in relation to whether they were located on or off science parks:

- Companies based on science parks have higher growth rates than similar companies at other locations.
- Park-based companies used venture capital, public sector, and angel finance to establish their businesses to a significantly higher degree than off-park companies.
- Those companies on-park reported that access to finance was less of a problem than for their off-park counterparts, and that those not on parks felt that the lack of access to finance was a constraint on their businesses.

In terms of innovation, again the study showed significant differences between matched companies on and off science parks:

- On-park New Technology Based Firms (NTBFs) launched significantly more new services than their counterparts over a period of three years.
- The on-park NTBFs also employed a significantly higher proportion of qualified scientists and engineers than off-park companies.
- On-park NTBFs located in knowledge heartland regions produced nearly double the number of patent applications than on-park NTBFs in the other categories of sub regional economic areas.

In terms of the perceived benefits of science parks, these developments:

- Attracted significantly more NTBFs than off-park locations.
- The physical attributes of parks are more important to companies than the services offered.
- 67% of the companies considered that their science park location added to their overall market image.
- Economic Development Priority Areas housed significantly fewer NTBFs on-parks than the other two categories of area.

It is clear that despite the mixed objectives and the diversity of science parks in the UK, the findings of the UKSPA study[1] also showed that:

- Science parks play a positive role in supporting the growth of technology-related businesses, and hence wealth creation, in the UK.
- They make a significant and distinct contribution to the UK's economic infrastructure.
- They are a distinctive and important feature of the knowledge economy and there is no substitute for what they do.
- The accommodation they provide is valued by tenants.
- They provide for the property needs of high growth NTBFs and the overall commercial performance of the companies based on them is better than similar firms located elsewhere.
- Also, when compared with other types of estates, science parks have low vacancy rates and science park based companies have higher growth rates, measured by number of employees and annual financial turnover, than similar companies at other locations.

The significance of this is that when planning, developing and managing a science park, it is important to consider the regional context of the development and ensure that where doubt exists about linkages between the various components that make up the sub regional economic model, careful attention

must be given to the informal part of the development plan. For example, consideration must be given to how financial support and appropriate partners are to be included from the outset, so that these linkages can be built as part of any project.

Support for driving technology up the value chain, innovation programmes, and links between industry and universities.

The Lambert Review and a recently published DTI report by Adams made it clear that without improvements in Knowledge Transfer in the UK, the rate of innovation is unlikely to keep pace with that of its international competitors. Unfortunately the Knowledge Transfer process is neither linear nor straight forward.

Adams suggested that this process needs to be addressed by strengthening the commercial orientation in the knowledge base, and by improving the interface between demand from industry and the academic base by creating an effective system of brokerage. Likewise, Adams suggests that by encouraging a desire in (and demand from) industry to innovate, this desire will be supported by the skills required to absorb the ideas and add value.

These observations are summarised in the table 4.

Knowledge base	Brokerage	Engaged industrial customers
Support the knowledge base by giving assistance to make business deals (e.g., assist with valuation of intellectual property).	Access to new technologies	Industry needs to know where to go secure academic input.
Give incentives to encourage an industrial orientation	Access to correctly skilled personnel	Industry needs a long-term view and desire to innovate.
	Access to physical infrastructure	Industry needs the skills to absorb input from academic side.
	Translation of industrial requirements to technical solutions.	Industry needs champions to drive innovation and change.
	Assisting with access to finance	

Table 4

Adams also characterised the mainly grant-based support for business from the Department of Trade and Industry for innovation in the following way (figure 3). This figure maps the various programmes that focus on companies and try to push their products and services up the value add chain Figure 2.

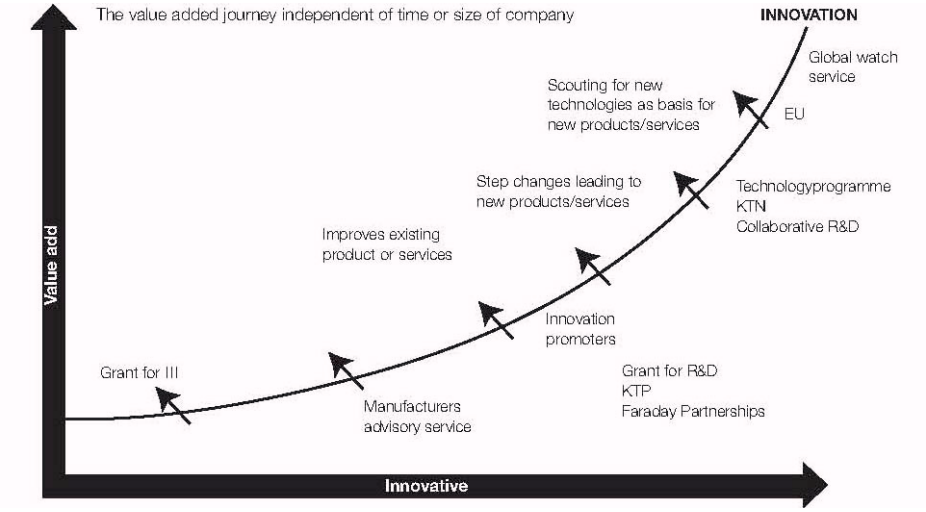

Figure 2 – the value added journey independent of time or the size of company.

These initiatives clearly range from those that are for early stage investigations, such as the Grant III (grants of investigating innovative ideas) a pilot scheme, through a whole range of other projects that are aimed at linking universities to business such as grants for R&D, Knowledge Transfer Partnerships (KTPs), and Faraday Partnerships. Full details of these support programmes can be found on the Business Link website[24]. It is clear from reviewing these many Department of Trade and Industry programmes that there is a major role for science park managers in helping to guide companies through the confusing landscape of these programmes.

Summary

The relationship between industry and universities and the dynamics of this process is now considered a priority across the European Union because there is clear recognition of the need to have a more effective interface through which to innovate. However, the performance of business needs to be encouraged and there is a strong suggestion that to achieve this there needs to be a change in culture that creates a market for a innovative goods and services, mobility of people and funds across Europe and an increase in R&D spend.

Universities have responded to this need by taking a proactive role in supporting government initiatives that promote these links. These include bidding for HEIF funding that is aimed at these links. There has been much work done on the barriers that still have to be overcome if the rate of innovation is going to reach levels that are likely to achieve economic growth. However, there are initiatives being taken by some private organisation to bring a business culture into the university environment.

Coupled with these are a number of initiatives that are being promoted by government to encourage innovation. The next years to 2014 will be critical if Europe is to see if these programmes are beginning to foster innovation.

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