

Scottish universities in the marketplace

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Introduction

The relevance and importance of the university/business interface has been recognized by economists, politicians and policy-makers as being key to economic growth. The development of the ‘knowledge economy’, where value is increasingly derived from the intellectual or knowledge-based elements of products and services, has increased the value placed on knowledge flows between universities and businesses in the marketplace.

While much has been said about the value of knowledge transfer and commercialization, much less consideration has been given to the objectives, incentives and measures necessary for successful knowledge transfer. We argue that unless these are understood and articulated, it is impossible to design and deliver knowledge-transfer activities optimally.

This chapter looks at three aspects of this topic: (i) the motivation for knowledge transfer in the universities; (ii) the range and objectives of university knowledge-transfer activities; and (iii) examples of knowledge transfer at the interface in Scotland.

Why do universities engage in knowledge transfer?

As universities exist to create and disseminate knowledge, knowledge transfer is core to the university mission rather than a new ‘third leg’. Knowledge created by universities through research is disseminated to various constituencies by the following means:

- Publications disseminate knowledge to academic peers and the science and knowledge base, in order to help us understand the universe and improve the world in which we live.
- Teaching disseminates knowledge to and through students, creating more capable and employable people.
- Knowledge transfer is simply the channel for the dissemination of knowledge to business, industry and society, providing companies and organizations with the means to increase capability and competitiveness.

These clear parallels between knowledge transfer and the other dissemination mechanisms explain why knowledge transfer is entirely compatible with

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the core mission of a university. In creating a knowledge economy, more emphasis is placed on knowledge transfer. This increases expectations for universities to act as economic engines by means of new knowledge creation and innovation. The emerging consensus is that universities could engage more effectively with industry and commerce; however, the means, mechanisms and motivations for this engagement are neither obvious nor agreed.

The range and objectives of university knowledge-transfer activities

University knowledge transfer, often wrongly regarded as fairly homogeneous, actually includes such long-standing and widely based activities as: student placements and enterprise; consultancy, research and training with and for industry; and licensing of technology and spin-out company formation. These have multiple objectives, participants, timescales, costs and returns; their only common theme is transferring knowledge into the social and economic base. The advent of the knowledge economy has merely emphasized the increasing importance of knowledge-transfer activities, particularly for politicians and policy-makers, bringing them under closer scrutiny and requiring increased clarity from universities about efficiency, efficacy and cost/benefit profiles.

What then are universities trying to achieve, and are they succeeding?

Objectives of knowledge transfer

The purpose of knowledge transfer to transfer knowledge into the social and economic base has different objective-dependent drivers. There are three key objectives for universities in their engagement: public good (contribution to society, community and economy); academic (creation of new knowledge) and financial (revenue generation). We argue that each of these is a justifiable reason for engaging in knowledge transfer and, while we would like our activities to achieve all three objectives, we believe this to be impossible for any given project in a reasonable timescale (see Table 1 for a detailed analysis).

The spectrum of knowledge transfer

Our view is that knowledge creation and knowledge-transfer typography (see above) occurs across a spectrum of highly variable objectives, motivations and activities. Figure 1 shows knowledge creation (centre of the spectrum), followed by a decision on dissemination, either:

- to the left of the spectrum: dissemination for public good, usually involving students, local entrepreneurs and SMEs (small- and medium-sized enterprises). The driver here is societal, seeking to deliver benefits to society and the economy. Note that the university is not a direct financial beneficiary. This mode of knowledge transfer typically requires support through public funding in order to deliver social and economic benefits. We call this the 'outreach' mode; or

Activity type	Public good	Academic reasons	Revenue/profit
Student placements	Yes	?	No
Economic development	Yes	?	No
SME networks	Yes	?	No
Contract research	No	Yes	Yes
Licences	No	No	Yes
Spin-outs	No	No	Yes

Table 1

Common reasons for undertaking knowledge transfer: activity types versus primary objective

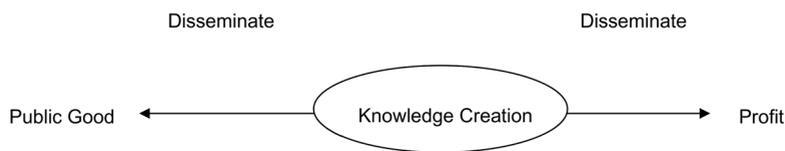


Figure 1

Outreach

e.g.
student enterprise
SME support

Outcome

e.g.
licensing
Spin-outs

Knowledge creation/dissemination spectrum

- to the right of the spectrum: dissemination for financial return, usually involving entrepreneurs and investors. The driver here is capitalist, seeking to generate a return from a valuable asset, typically IP (intellectual property). This mode generally involves the use of private funding, with investors and entrepreneurs investing their own resources with a view to making a return. We call this the 'outcome' mode.

The driver distinction noted above is extremely important. In moving to the left, the university acts as an agent of economic development. In moving to the right, the university acts as a venturer. These roles do not necessarily sit comfortably together. This is the outreach/outcome spectrum of knowledge-transfer activities with its intrinsic tensions that pose a problem for universities and their knowledge- and technology-transfer offices. Whereas economic development agencies are asked to undertake economic development (rather than make money) and entrepreneurs are expected to make money (rather than undertake economic development), the university is asked simultaneously to perform sustainable economic development and to make money from it.

This illustrates the current critical importance of clearly defining the role of and success measures for university knowledge transfer. The expectation

that university knowledge-transfer professionals simultaneously combine the roles of economic development agencies and entrepreneurs simply isn't credible. Nevertheless, expectations persist where the university undertakes outreach work, expecting sustainability over a period of three years. This does not happen, for the reasons described above. Economic development is not a financially sustainable activity.

Elements in the outreach/outcome spectrum

A range of activity lies between outreach and outcome on the spectrum. While it is impossible to categorize fully all knowledge-transfer activities, we believe that the five key areas are:

- Outreach
- Research and technology development
- Contract research
- Licensing
- Venturing (including company formation)

An outline of the key and contrasting characteristics of each of these areas (reasons for undertaking, costs, returns etc.) are summarized in Table 2.

Outreach activities

Outreach activities involve the university playing the role of an economic or social developer, working in a public sector partnership for the public good. SME support is an outreach activity. Funding is provided to the university to develop links with SMEs, with a view to helping the SME become more competitive. It is extremely rare for SMEs to be able to fund the work with the university, and so public funding is necessary to support it. In comparison with large companies, SME interactions are typically high cost, high maintenance, high risk and low return. These links are not sustainable without public funds and therefore universities would choose not to work with SMEs on a commercial basis.

This is not to say that universities should not work with SMEs. On the contrary, I and others strongly believe that university/SME partnerships are critically important to the economy and should be encouraged, but not for commercial reasons. SMEs represent an important knowledge-transfer channel: universities see knowledge dissemination to SMEs as a means of delivering public good and fulfilling our social and local responsibilities by making SMEs more competitive. As a result, universities can generally access public funds to offset or cover the costs of working with SMEs. Thus university/SME relationships can and should be win/win. The 'win' for the university is delivering their mission, and SMEs 'win' by acquiring new knowledge to convert into their competitive and financial advantage.

Similar logic can be applied to student enterprise in Glasgow, where we take no equity or royalty interest in companies created by our students. Effective student enterprise achieves the university mission, but the key beneficiaries are the students, the economy and society. The university is not a financial beneficiary.

Table 2

	← Outcome Objectives	Outcome Objectives →
	Outreach activities	Venturing activities
Reasons for doing	Public good, economic development, business development, marketing, engagement with the community	Development of channels to market for technologies, financial returns
Types of costs	Research and technology development Knowledge creation, infrastructure-building	Development of channels to market for technologies, financial returns
Financial returns	None	Development of technology to markets, financial returns
Scale of returns	Research costs	IP protection costs, business planning, legal costs (licences and arts), marketing costs
Financial risks	People, events, travel	IP protection costs, business planning, legal costs (licences and arts), marketing costs
Examples	None (cover costs at most) Negligible Student placements, SME networks, student companies	Equity gains, dividends, royalties Can be significant
	Funding for research, RAE (indirect and longer term) Cover costs at most	IP protection costs, marketing costs, legal costs (licences)
	Low Charity-funded research, collaborative research	Licence income, upfront payments, milestone payments Often modest, can be significant
	Modest Company-funded research	Modest/significant Licences with companies

Contrasting characteristics of outreach/outcome activities

Research and technology development

The area most closely aligned with the university research mission is research and technology development, which involves both knowledge creation and knowledge transfer in equal measures. Here the university undertakes research designed to develop an understanding of a technical area that has knowledge transfer/commercialization potential. The two most important areas of activity are collaborative research with industry and proof-of-concept work. In the former, university and industrial researchers collaborate on fundamental (or applied) research with a commercial focus, but which generally has no direct commercial outcome. The university and company work together to develop 'enabling' science, bringing the benefit of industrial collaboration to the university. There are few commercial pressures, milestones or potential infringements of academic freedom. It is generally a scientist-to-scientist relationship, with university scientists contributing leading-edge knowledge and wide-ranging thinking and industrial scientists contributing leading-edge knowledge and state-of-the-art equipment.

In contrast, proof-of-concept is a relatively new area of funding/research, with academics carrying out work to confirm/underpin an area of research identified to have commercial potential. The research is generally sufficiently remote from direct commercial exploitation to ensure researcher comfort in collaborations without being conflicted by the commercial imperative. The common elements of research collaboration and proof-of-concept are the lack of a direct commercial objective (although there is a general commercial direction) and a university financial contribution.

For both collaborative research and proof-of-concept activities, universities are expected to contribute financially towards these activities; however, the reasons for this contribution differ. In collaborative research, companies view themselves as contributing to the university's knowledge-creation mission and, while they are prepared to put money into this, expect a university to contribute. In proof-of-concept, on the other hand, funders generally see themselves as contributing towards the development of technology that will eventually bring financial benefit to the university and so expect the university to contribute towards this. These are fair and reasonable expectations. However, from the university perspective, each represents a cost that has to be met.

Contract research

Like collaborative research, contract research can have an element of knowledge creation as well as knowledge transfer, although to a lesser extent than collaborative research. Contract research differs from other knowledge-transfer activities in that the university receives funding from external bodies in return for delivering specific, measurable outcomes.

Contract research is usually designed to answer specific questions or to conduct a well-defined set of experiments or procedures on behalf of the funder. No significant new IP is expected and the university will usually be content for the funder to own any foreground IP. This is the point (see below) at which the university's activity across the spectrum will break-even, as contract research will generally be fully funded. There is a balance between the public and private benefits that nets out at zero financially.

We argue that consultancy and CPD (continuing professional development), often the forgotten or neglected knowledge-transfer channels, fall neatly into the contract research classification. In each case, a fairly well-defined piece of work is undertaken in return for cash, with the full cost to the university generally being covered by the funder.

Licensing

Licensing involves the university providing a company with access to use a well-defined piece of knowledge or IP in return for financial compensation. Usually, the university will licence patent(s) to a company in return for up-front payments, royalties, some other cash return or, increasingly, equity in the company. Licensing is clearly about knowledge dissemination with little or no further knowledge creation, providing access to existing, codified, protected knowledge. Here the university can begin to be viewed as a venturer. The university identifies areas of knowledge it believes to have commercial value and invests money in protecting and marketing that knowledge for a putative financial return.

A university with a successful licensing portfolio will, across that portfolio and over time, generate more revenue than the costs associated with protecting and marketing the IP. This is an area, therefore, where the university could be expected to make money; although it must be noted that major licence deals, generating more than £1 million in total royalties, are quite rare.

Venturing

In venturing, as in licensing, the university engages in risk investments in its own IP, with significant expenditure on business planning, market research and building a management team in order to create a high-value venture. The most obvious examples in this area are spin-out companies, which have been the politically dominant form of commercialization in the U.K. for a number of years. Venturing increased in significance during the mid to late 1990s, when the perceived value of technology and IP was driven up by a technology 'bubble' and the dot.com boom.

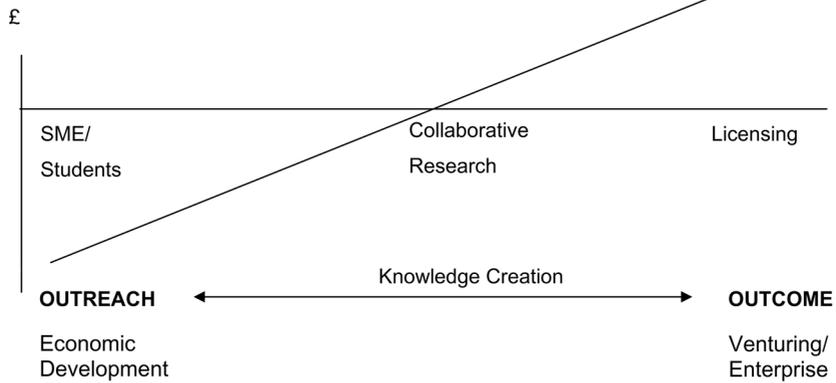
The financial profile across the outreach/outcome spectrum

Figure 2 highlights the very different motivations involved in undertakings across the spectrum. Perhaps the most critical element is the cost/return profile. It illustrates the vital need for clarity on objectives and motivation. Any university seeking to develop a financially sustainable model based on outreach alone will have severe difficulties.

While Figure 2 also suggests that universities could develop a financially attractive model by concentrating only on the right-hand end of the spectrum, this would have a number of unwelcome consequences including major reductions in the number of projects, since only a small proportion of university technology or IP has sufficient commercial value to justify the investment in/risks associated with commercialization.

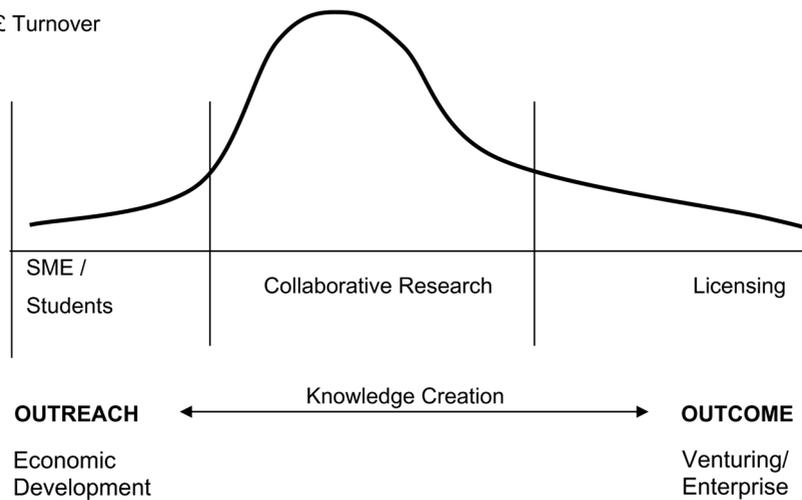
We believe that approx. 5% of university technology or IP has significant commercial value. To concentrate only on this would neglect the remaining 95%, an act contrary to the university mission. There are also political considerations: if

Figure 2 Financial Return to the University



Variation of institutional returns with knowledge-transfer type

Figure 3 £ Turnover



Variation of financial turnover with knowledge-transfer type

a university, receiving significant public funds, decided only to work on profitable knowledge-transfer projects, pressure from politicians would be considerable. Thus universities seek to ensure that they are operating across the spectrum.

Another important aspect of the financial profile is the overall turnover across the spectrum. Figure 3 shows the typical spectral spread of income for a research-intensive university such as Glasgow. There are generally significantly fewer outcome than outreach projects, as only approx. 5% of university IP or technology justifies commercialization or outcome-oriented activity, and turnover on outcome projects (far right-hand side) tends towards a small number of high-value projects. Conversely, outreach typically involves large numbers of low-value

projects. In a university such as Glasgow, the total turnover from outcome activities is roughly equal to that of outreach activities.

Financial profiles vary by institution type. The curve in Figure 3 represents the profile for a traditional, broadly based, research-intensive university. A technology-focused institute might be expected to have a curve skewed somewhat to the right, whereas a mainly teaching institution with more a regional agenda might skew more to the left. Moving either way from the centre, the university role changes from research institution to agent of economic development (left-hand side) and venturer (right-hand side) respectively. These roles are less well understood and lie at the heart of the debate around universities and economic development.

The curve in Figure 3 is real, empirically based on Glasgow's own figures. It shows that the knowledge-transfer activities that are most often discussed, such as SME support, licensing and spin-outs, lie furthest from the university's core activity. This does lessen the importance of these activities, but it does help to explain the residual view of knowledge transfer as less important than university research. On the other hand, when we accept that collaborative and contract research are important knowledge-transfer mechanisms that complement and feed outreach and outcome, then the scope and scale of the university's role and, more importantly, contribution can be seen to be much greater.

To optimize knowledge-transfer activity, it is important to maintain an appropriate relationship between it and research. Investment in knowledge-transfer activity, though desirable, must not be at the expense of research. Although the curve is real, it is not yet clear just how 'natural' the statistical relationship is. It might be suggested that the most effective means of increasing knowledge transfer is by increasing research funding (centre of curve). That is, however, a topic for a future paper.

Examples of knowledge transfer at the interface in Scotland

This new knowledge-transfer taxonomy provides us with the ability to examine existing knowledge-transfer projects and programmes and assess where they sit within the outreach/outcome spectrum. This also enables us to assess their performance against knowledge-transfer objectives.

Outreach activities

As already described, outreach projects typically have economic development objectives. This area of activity tends to be the most diverse, as the range of projects, actors and beneficiaries is large. We will describe here three projects:

- Dialogues: developing innovations with SMEs;
- Interface: linking SMEs with the university research base; and
- Student enterprise: supporting student business creation.

These three very different projects all demonstrate the application of public funding to deliver various types of public good and economic development, with the SMEs and students as the primary beneficiaries and the university as an agent of economic development.

Dialogues: developing innovations with SMEs

Established in 2002, the award-winning Dialogues project helps SMEs tap into the knowledge and expertise available at the University of Glasgow and become competitive players in the global economy. It provides a range of services to business, such as research expertise, access to funding sources, facilities and equipment and student placements. Since its inception, more than 150 SMEs from disciplines including aerospace, IT (information technology), engineering, environmental, pharmaceutical and medical sectors have interacted with the initiative to see how they can help match their needs.

The Dialogues project is supported by the public sector European Regional Development Fund, Scottish Enterprise Glasgow and Glasgow City Council. In 2005, the project received a commendation award from the Chicago-based IEDC (International Economic Development Council) for its work to help build links between Glasgow University and SMEs in the West of Scotland. The IEDC is a non-profit body dedicated to improving the work of business support agencies worldwide. Their annual Excellence Awards are recognized as the most prestigious in the field of economic development, with thousands of members over dozens of countries.

Key measures are the number of linkages made and the number of projects initiated (and the quality of the project as determined by external bodies), rather than the value of deals done. Here the measures are of the volume and quality of the university/SME interaction; in other words, economic development measures rather than commercial measures.

Interface: linking SMEs with the university research base

The sharing of expertise and resources can prove mutually beneficial to companies and universities. Through Interface, businesses can increase their competitiveness, develop new products, and exploit new market opportunities by connecting with the skills, knowledge, research and resources in Scotland's universities and research institutes. Interface focuses on increasing knowledge-exchange links between academia, industry and SMEs. Supported by the public sector, the initiative's key aim is to develop interaction and stimulate innovation to benefit Scottish companies and the Scottish economy.

Organizations can approach Interface to discuss their technology/knowledge requirements. The Interface team then translates this into an enquiry, sourcing the appropriate expertise required through their links with the 20 partner universities and nine research institutes. Organizations no longer have to search through individual university websites or databases.

The key measures are the number of linkages made and the number of projects initiated, rather than the value of deals done. Here again, the measures are of the volume and quality of the university/SME interaction; again, economic development measures rather than commercial measures.

Student enterprise: supporting student business creation

GSE (Glasgow Student Enterprise) was set up in 2004 as part of the Research and Enterprise department of the University of Glasgow. GSE seeks to promote the goals of the Scottish Institute for Enterprise, whose mission is to stimulate,

educate and facilitate enterprising individuals with the skills to contribute to a smart, successful Scotland. Rather than concentrating purely on entrepreneurship, GSE works on developing enterprise skills (confidence, creativity, innovation and problem solving) that will aid all students by providing hands-on learning, events and competitions.

The aim of GSE's programme of activities is to stimulate interest in enterprise among students and lead them to develop ideas that could be turned into high-growth businesses on graduation. Business ideas are then nurtured and developed, with students receiving business development advice from a member of staff. This policy has led to an outstanding level of success over the past four years: 38 businesses, currently employing 85 staff, have been created by students or new alumni.

Glasgow students have won the past three Scottish Institute for Enterprise Business Plan competitions and have taken the winner and runner-up spots in the past 2 years in the U.K. equivalent. This initiative is funded by the public sector.

The key measures here are the number of students engaging, the quality of their outputs or plans (as measured by competition success) and the number of companies formed, not the value of the companies. These are classic economic development measures, rather than commercialization measures.

Research activities

Research collaboration is the single biggest area of knowledge transfer as described by our model. In financial terms, collaborative research makes up approx. 40% of Glasgow University's knowledge-transfer activities. One of our recent projects with a major pharmaceutical company provides an excellent example of university and industry collaboration. The project is working so well that we plan to use the process as a model for future collaborations.

The Translational Medicine Research Centre

Scotland has strong claims to be a major centre for translational medicine as a result of its academic research base, ongoing programme of investment in its clinical infrastructure, patient databases and its world-renowned high-quality teaching hospitals and state-of-the-art clinical research facilities. In April 2006, a \$100 million project with the U.S. pharmaceutical giant, Wyeth, the 11th biggest pharmaceutical company in the world, led to the creation of the world's first translational medical research collaboration in Scotland. This collaboration comprises four of Scotland's leading universities (Glasgow, Aberdeen, Dundee and Edinburgh), Wyeth Pharmaceutical, Scottish Enterprise, and NHS (National Health Service) Scotland Grampian, Greater Glasgow, Lothian and Tayside, and provides a new impetus for Scotland to lead the world in the development of personalized medicine, bringing new treatments to patients suffering from a range of serious illnesses.

The development of this exciting collaboration is a reflection of the world-class reputation for research in medicine and life sciences at the four Scottish universities. Scotland was also hailed for the close working relationship between the universities and the NHS in Scotland. The project is funded by a mixture of public and private sector funding. The key measures of success here are research

income (not profit) and the quality of research being undertaken. These are classic research measures, rather than knowledge-transfer measures.

Outcome activities

The outcome end of the knowledge-transfer spectrum is dominated by IP transactions, typically licensing and spin-out company activity. Here we will describe two projects, one based on promoting licensing activity and the other based on creating spin-out companies:

- Licensing: ILT (Innovative Licensing and Technologies); and
- Spin-outs: IP Group partnership.

Licensing: ILT

ILT was run as a pilot project for 18 months and was funded through the Scottish Innovative Actions programme and the Scottish Government's SEEKIT (Scottish Executive expertise, knowledge and innovation transfer) initiative. The project was set up to encourage SMEs to licence Glasgow University technology through ready-made licence agreements. By creating a website which provided organizations with user-friendly technology descriptors and simple, ready-made licence agreements, we hoped to decrease the cost of licensing university IP to SMEs by cutting out the need for lengthy and expensive negotiations. Although no deals were done via the website, the response from companies was very positive and we plan to continue using the model. We are currently exploring ways to apply the model to material transfers and we are focusing on software licensing. The key measure will be the eventual revenue streams generated through this project and the commercial return from it. It is fair to say, at this stage, that this is a commercial experiment that has not yet worked.

Spin-outs: IP Group partnership

With the aim of improving the rate and success of spin-out commercialization of its world class research, the University of Glasgow recently entered into a partnership with the IP commercialization company, IP Group plc. Founded in 2001, the IP Group specializes in commercializing university technology and has formed long-term partnerships with ten universities including Oxford, King's College London, Southampton and Bristol. The IP Group are leaders in the field of research commercialization, with an outstanding track record, a strong network of investors and a proven ability to raise capital for university spin-out companies.

The 25 year partnership will see the IP Group make available an initial £5 million to accelerate Glasgow University spin-out projects towards the marketplace. They will also provide an expert to work with the university commercialization team and assist the spin-out process. The initiative is funded by the private sector and is working well with results to date of:

- three spin-out ventures;
- two Scottish Executive SMART grants with a value of approx. £120 000;
- one Scottish Executive SPUR award with a value of approx. £144 000;
- £1.23 million seed investment from the IP Group; and
- £120 000 seed investment from external funders. The key measures, as shown above, are commercial and income related.

Conclusion

This chapter has demonstrated that the university interface with the market takes a wide range of different forms, which must be understood, funded and managed in different ways.

- Public sector funding supports public good, in the form of economic development. These are activities that would otherwise cost the university money to undertake and are unsustainable.
- Research collaboration, involving public and private sector funding, maps on to the classic research mission of the university and traditional research measures must be applied.
- Private sector funders (including the university) invest in projects that are designed to make a financial return and are subject to commercial measures.

It is possible for a university to operate a portfolio of projects across this spectrum of knowledge-transfer types, as long as the objectives and measures are clear and distinct. Failure occurs when the objectives, funding and measures of the different activities are confused.