# TECHNOLOGY TRANSFER IN NORTHERN IRELAND: THE DEVELOPMENT OF UNIVERSITY POLICY

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## Abstract

It is generally acknowledged that global competitiveness is very dependent on the level of technological innovation. Peripheral regions, such as Northern Ireland (NI), are not generally renowned for high levels of technology innovation. This is due to the influence of many factors, one of which is the general level of support and encouragement available to stimulate entrepreneurial activity. This paper examines the factors which encourage/inhibit links between universities and local industry, investigated via a survey carried out in 1998 within NI universities, which indicates a complex contingent relationship between academics, their background, and the policies of the universities. The results indicate that the level of involvement by academics in technology transfer is heavily dependent on university policy, which in turn is strongly influenced by government policy. Hence government support for technological innovation within industry must be effectively co-ordinated with university policy in this area, as discussed here.

## Introduction

The economic development of a region is directly related to the level of innovation and technological activity present, and universities are perceived to be a significant source of such innovation. In this context universities play an important role by supporting R&D in industry, as well as through solving industrial problems, and the establishment of

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new companies via 'technology transfer'. Peripheral regions, of which Northern Ireland (NI) is considered to be one, are frequently found to be regions of relatively low economic power. To what extent is this attributable to under-performance in this area by the universities, and how can innovative activity be encouraged and built upon?

Despite the existence of two well established universities in the region, the NI Gross Domestic Product per capita in 1997 was 80% of the UK and EU level (*Social Trends 30*, 2000), the lowest economic output among all UK regions. With 23.5 university students per 1,000 inhabitants the NI rate is somewhat lower than the UK average of 29 per 1,000; although this discrepancy can largely be attributed to a 'brain drain' of students particularly to Britain (HESA, 1997).

The aim of this study was to investigate, within the two NI universities, the mechanisms that foster academic links with industry and encourage the transfer of technology; and benchmark against 'best practice' in other countries within Europe and the USA. The results would then help inform the debate on the subject, and lead to a judgement on what changes in academic or government policy would best serve the objective of promoting entrepreneurial activity in NI.

## Background

### *USA*

When most American universities seek to transfer their technology, they emphasise that this must be carried out with due regard to their primary institutional objectives. Their formal statements of policy to staff and to sponsors state their position on all key matters such as publication rights, commercial confidentiality, investigators' rights and responsibilities and the position of students. In 1982, the US government passed the Advanced Technology Job Creation Act (Schmandt, 1991). The bill provided state funding for joint university–industry R&D projects with a high potential for job creation. The main thrust of the policy was that technology transfer, while important, remained secondary to education and research. Delay of free dissemination of information had to be minimal, and hence members of staff were advised to notify the Technology Licensing Office of an idea or invention at an early stage, when they thought it might have commercial possibilities. Tight time limits were specified within which the institute must decide whether to patent an invention, and to make the application. A few weeks after notification the inventor would be free to publish if she/he chose to do so.

### *Europe*

The European Commission has recognised the emphasis it has to put on issues related to the exploitation of research results, and has pointed out that its member states must rely on high value added activities, and support employment through new business 'start-ups'. Storey and Tether (1998) focused on the support national and regional governments of European member states provide for small businesses in the new technology sector. In terms of financial support exclusively for new technology based firms (NTBFs), Germany, Sweden and the UK operate such schemes. The German scheme, called BTU, provides incentives for investors and additional support for the birth and development of NTBFs. In Sweden, NTBFs are supported by the National Board for Industrial and Technical Development (NUTEK), which targets the seed financing of product development, providing easy access to funding as well as subsidised interest rates. Denmark does not operate schemes for the support of SMEs, and Belgium's industrial policies are delivered on a regional rather than national level. The remainder of the member states run schemes that support SMEs in terms of grants, interest relief or tax incentives, without focusing specifically on new technology based enterprises. The authors concluded that NTBFs are generally perceived as far riskier and much more long-term oriented than other SMEs.

### *Sweden*

In 1992 NUTEK took initiatives to establish 28 competence centres related to the universities/institutes of technology. The aim was to build up strong research groups in the country with an interdisciplinary approach in collaboration with industry (Andersson and Klofsten, 1998). In particular, Chalmers University in Gothenburg has consciously adopted policies which are intended to minimise barriers in establishing spin-off companies, for example through granting flexible staff contracts. Researchers can often negotiate part time contracts, allowing them to retain their academic posts while also working in spin-off companies (Downes and Eadie, 1998).

### *Finland*

National and local governments of various regions in Finland have invested in the attraction, development and fostering of small technology based firms. TEKES is a funding agency concerned with improving infrastructural arrangements by forming clusters of small firms within defined regions near universities all over Finland, and

organising a local support programme, SPINNO (Autio and Klofsten, 1998). The biggest and most successful of such clusters emerged next to the University of Oulu (Ahokangas and Räsänen, 1998).

### *Switzerland*

Traditionally, there has been a philosophy of government non-interference with large companies in Switzerland, as expressed in governmental support of only 1% of R&D costs (Haour, 1995). However, this situation is said to have changed somewhat of late, other than in the chemical industry. Smaller companies have traditionally been more open to public financial help. The bulk of public support is channelled through the Federal Institutes of Technology, which aid research, collaborative work between academia and industry, as well as diffusion and application of results. Public support among such programmes amounts to 50% of the project costs. According to Haour (1995), in 1993 Switzerland launched its first Technology Assessment Programme, in order to evaluate and anticipate the social, legal and ethical impact of scientific and technological development. This programme was set up to focus on the priority subjects – advanced materials, biology, medicine, environment, and information technology – and thus potentially to introduce changes if required.

### *Northern Ireland Policy*

In Northern Ireland, both The Queen's University of Belfast and the University of Ulster claim to be committed to assisting social and economic redevelopment, and have underlined this with the establishment of a number of specialist R&D and technology transfer centres. Despite pointing out the importance of boosting the local economy through technology transfer activities, it has been emphasised by both universities that the core funding for research, as in all UK universities, is based on the outcome of the four-yearly Research Assessment Exercise (RAE). This assessment is meant to ensure that wherever possible the quality of research is maintained at the highest standards of national and international excellence. Both universities started programmes in the early 1990s to develop their research by focusing on quality and relevance to Northern Ireland, and this focus contributed significantly to the improved research grades achieved by both universities in the 1996 RAE (Beatty, 1997). However, this focus of the RAE is often seen as an inhibitor in relation to industrial liaison, which due to confidentiality constraints limits the opportunities to publish.

The licensing of university patented inventions has been a traditional way of transferring technology and developing collaboration. It continues to be successful, but mostly involves collaboration at an international level. With the exception of licensing university IPR (intellectual property rights) to campus spin-off companies, there has been little interaction in this area with indigenous local companies.

The question remains as to which extent the policies introduced by government and universities are effective, and if new measures would need to be introduced in order to support the local economy proactively. Staff in both universities in Northern Ireland were asked to provide the answers to a variety of questions leading to this aim.

## Methodology

To ascertain the effectiveness of technology transfer activities within NI universities, a questionnaire was designed and circulated to the academic staff of both universities. This sought to determine perceptions on the nature and effectiveness of the support infrastructure for technology transfer activities. The questionnaire contained 12 questions within four sections and was forwarded to respondents who were either predominantly teaching staff or leaders of research teams. The target group surveyed consisted of 106 professors (QUB) and 37 professors (UU), 198 readers/senior lecturers (QUB) and 74 readers/senior lecturers (UU), 222 lecturers (QUB) and 179 lecturers (UU), as well as 274 researchers (QUB) and 110 researchers (UU) (research fellows, research officers and research assistants). The total number of academics targeted was 1200, of whom 800 were from QUB and 400 from UU. Within 4 weeks 45% of all the questionnaires were returned.

## Results

Section 2 stated that a variety of different influencing factors are expected to affect technology transfer and entrepreneurship activities. Hence, hypotheses were set up and tested using the results of the survey described above.

### *Perception on Support toward Academic Entrepreneurship by the University*

Two hypotheses were set up to test whether previous industrial experience affected the opinion of academic staff regarding the effectiveness of the technology transfer support mechanism.

*Hypothesis 1*

*Experience gained through previous employment in a small business has a direct influence on academics' perceptions regarding the level of support provided for entrepreneurship activities within their university.*

FIGURE 1: RESPONDENTS' PERCEPTION OF THE UNIVERSITY ENVIRONMENT BY TYPE OF PREVIOUS BUSINESS EXPERIENCE

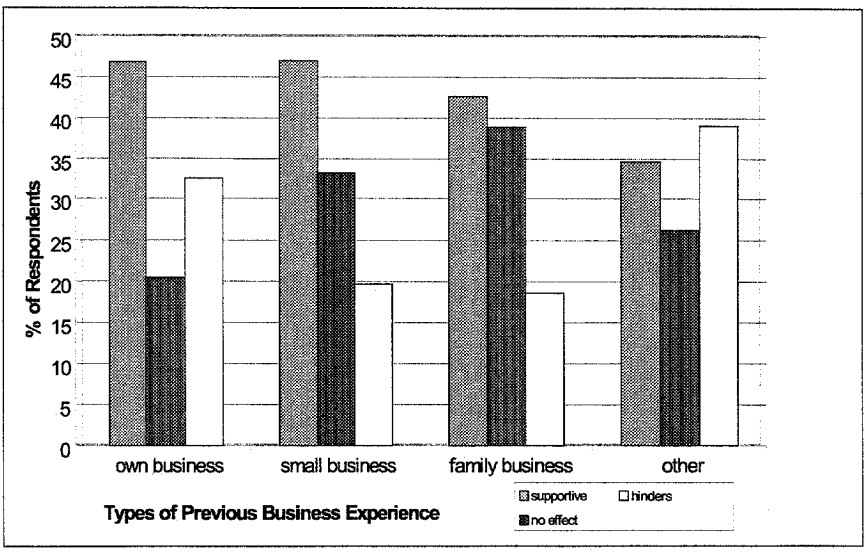



Figure 1 shows the results from this investigation, revealing that the largest number of respondents regard the environment as supportive of entrepreneurship. Those with family and/or small business experience were twice as likely to regard their university as being supportive rather than hindering, while around 1 in 3 were neutral in this respect. Of those who had gained experience by starting their own business, the proportion who were neutral in their opinions dropped to 20% or less, and those who thought it hindered entrepreneurship increased to 30%. It may be that, having started up a business themselves, they had a much better awareness of what is required in a non-academic environment than those who had worked for someone else. In some instances, 'no effect' could be interpreted as not knowing whether the university environment was predominantly supportive or hindering. Although the proportion perceiving the university environment as supportive fell into the same ball park for all three groups,

the variation in the levels of the other two responses across these groups indicates that hypothesis 1 is probably correct.

*Hypothesis 2*

*Position in the hierarchy of the university has a direct influence on academics' perceptions about the level of support provided for entrepreneurial activities.*

FIGURE 2: PERCEPTION OF THE UNIVERSITY ENVIRONMENT BY JOB CLASSIFICATION OF RESPONDENT

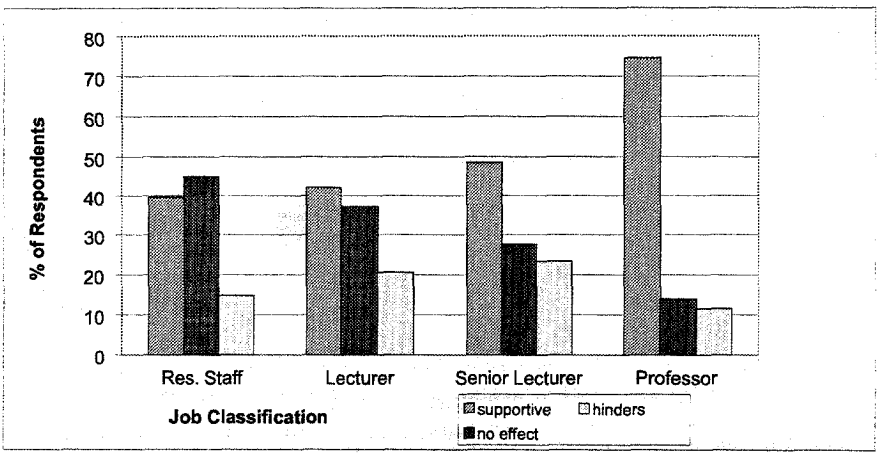



Figure 2 again confirms that the majority of respondents believe that the university environment is supportive of entrepreneurial activities. This perception is highest among professors (74%), of whom only 11.5% (the smallest proportion within all job categories) found the university environment to be hindering, with the remaining 14.5% regarding it as neutral. In contrast, the proportion of research staff who regard it as neutral is 44.8%, though this could be due to a lack of knowledge about the existence of the ILO and its functions. Since researchers are mainly concerned with the technical aspects of development, and do not generally get involved with administration tasks, this is understandable.

The job category with the highest proportion of respondents who perceived the university environment as hindering entrepreneurial activities was that of senior lecturer at 23%, closely followed by lecturer at 21%. It is interesting to note that with a rise in the career ladder, the percentage of those with the perception that the university

environment had no effect on entrepreneurship steadily reduced. This suggests an increasing involvement in wide ranging university matters and with it a greater awareness of university mechanisms. Furthermore, the perception that the university environment is supportive was found to increase with status in the university. A closer look at this increase among research staff, lecturers and senior lecturers reveals that the decline in the "no effect" perception dissolves into the "support" and "hinder" perception in approximately equal proportions. Hence, the increased awareness of university mechanisms which accompanies progression and promotion within the organisation, results in a fairly even split between those whose experience is positive, and those who view these mechanisms as obstructive.

Among professors, the previous upward trend in the proportion of respondents with a positive view of the support provided is accelerated appreciably. Similarly, the decline in the proportion indicating 'no effect' continued into this category. The combined effect here, though, is a significant reduction in the proportion viewing the system as hindering entrepreneurial activity, which is a reversal of the previous trend. Possible explanations for such an outcome include:

- A university support system which is highly status sensitive.
- Experience of working with the university systems gradually over time increases the competence and understanding of users.
- The system has been specified and developed predominantly by professorial staff who are therefore more comfortable with the resulting system.
- 'Ownership' of the system by professorial staff results in a supportive perspective, where deficiencies are minimised or ignored.

A chi-square test within SPSS was used to determine the strength of the relationship between job classification and perception of the university's support level for entrepreneurial activities. A value of $\chi^2 = 38.108$ was obtained, corresponding to a p value of 0.000; confirming that at the 99% confidence level, a statistically significant relationship exists between these two factors. Hypothesis 2 was thus found to be valid.

### *Industrial Contacts through University Personnel*

The following set of hypotheses (3–9) were set up with the aim of assessing the commitment of academic staff to being actively involved

in technology transfer to industrial partners, and the effectiveness of current university policy in supporting this interest.

*Hypothesis 3*

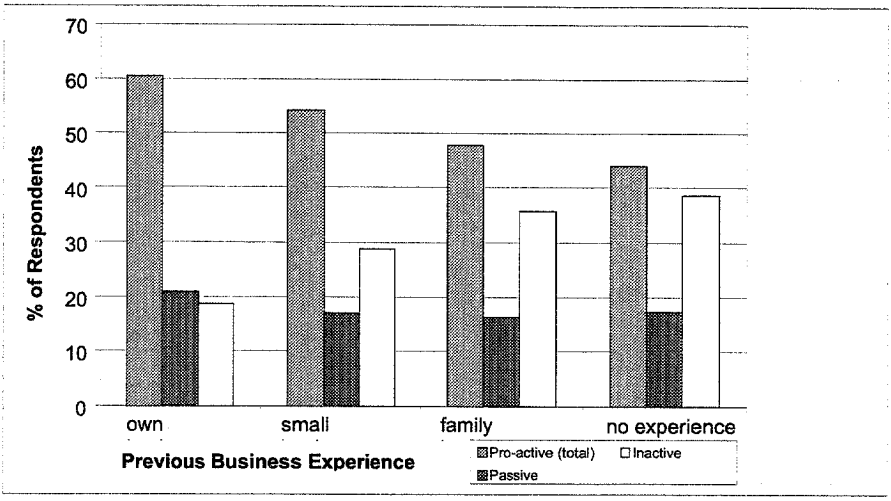
*Previous small business experience has a positive effect on the influence and the likelihood of academics engaging with industry.*

Figure 3 shows that, in the three categories with previous business experience, the highest proportion of respondents with a proactive approach to collaboration (at 60%) were those who had previous experience of starting their own business. Next highest (at 54%) were those who had worked in small businesses which were not family owned, while least proactive (48%) were respondents whose experience was limited to working in a family business. Those with no previous experience of business at all had the lowest level of all (43%) for this type of activity.

Interestingly, the proportion in each group who were 'passive' in their approach to developing industrial contacts was very similar at around 17–18%, with the exception of the 'own business' category which was slightly higher at 21%.

The high level of proactivity exhibited by those who were previously small business owners may suggest that their broad management experience better equips them to see the benefits accruing from fostering industrial liaisons. In addition, contacts made during their previous employment may in many instances form the basis for such collaborative arrangements. However, it could also be argued that those who have already shown initiative by starting up their own business have brought an enthusiasm for entrepreneurship with them, which they are exhibiting in their new profession. Based on this argument, a correlation between previous experience and current activity becomes apparent. However, no clear indication could be provided as to whether the level of industrial activity was related to the type of previous employment with the training and experience gained in it, or whether the character of the individual was in fact pivotal in the path of his/her career.

FIGURE 3: NATURE OF RESPONDENTS' INDUSTRIAL CONTACTS VS PREVIOUS BUSINESS EXPERIENCE

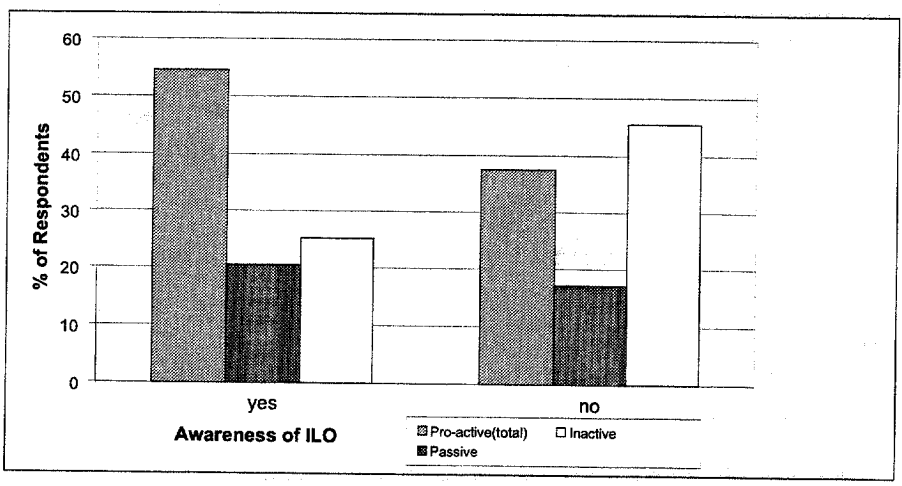



The findings show clearly though that collaboration with industry, whether actively or passively pursued, is significantly greater among those who have had previous non-university employment. It is, however, by no means guaranteed that a member of staff with a previous history of non-university employment will develop contacts with industry, and/or bring industrial contacts with him/her and use them, since around 28% of this group were inactive in this respect. For the two most participative categories (own and small business) the 'inactive' proportion is much lower (24%), compared with the 40% of those with no previous external employment experience who are inactive in developing industrial contacts during their university career.

*Hypothesis 4*

*An awareness/use of the Industrial Liaison Office (Research Office) has a positive effect on the likelihood of academics engaging with industry.*

FIGURE 4: NATURE OF RESPONDENTS' INDUSTRIAL CONTACTS VS AWARENESS OF ILO




Considering all those who were aware of an ILO in their university, a smaller proportion was inactive with respect to industrial activities (25%) compared to the group that was not aware of such an institution and its functions (45%). In turn, those who were aware, were proportionally more pro-active (54.4%) as compared to those who were not aware (37.4%). This indicates that the ILO may indeed play a significant role in promoting activities among the university staff toward fostering industrial links.

## *Hypothesis 5*

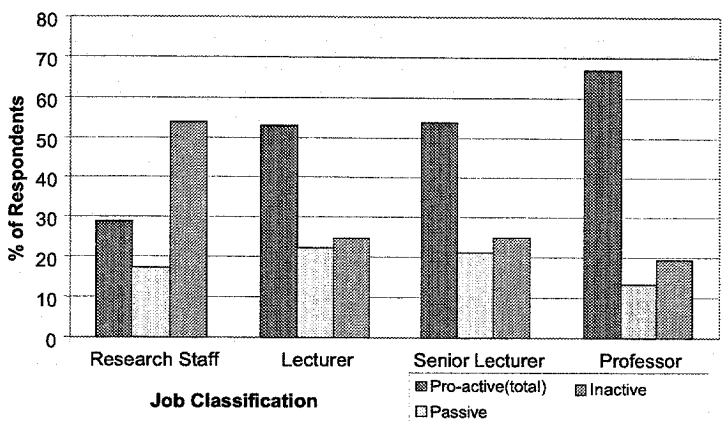
*Position in the academic hierarchy influences the likelihood of engaging with industry.*

Figure 5 shows that the level of pro-activity varies considerably with position on the academic ladder, being more than twice as high among professors as among research staff. This is not surprising, as research staff are required to focus on their detailed research work in the short term, while the other target groups have rather more opportunity to pursue future research possibilities. In particular, it is to be expected that professors would be the most pro-active in this matter, as they often head up research groups responsible for the funding and management of projects. However, there is no percepti-

ble difference in the pattern of involvement with between lecturers and senior lecturers.

Some types of industrial contact engaged in by lecturers and senior lecturers may be in relation to the arrangement of student placements, through which industry may become aware of an academic capacity for potential future problem solving, for example.

FIGURE 5: NATURE OF RESPONDENTS' INDUSTRIAL CONTACTS VS JOB CLASSIFICATION




According to the findings in Figure 5, with a chi-square value = 63.421, p = 0.000 a statistically significant relationship exists between job classification and a pro-active approach to industrial liaison. Hence, hypothesis 5 can be deemed to be valid.

### *Significance of Entrepreneurial Categories*

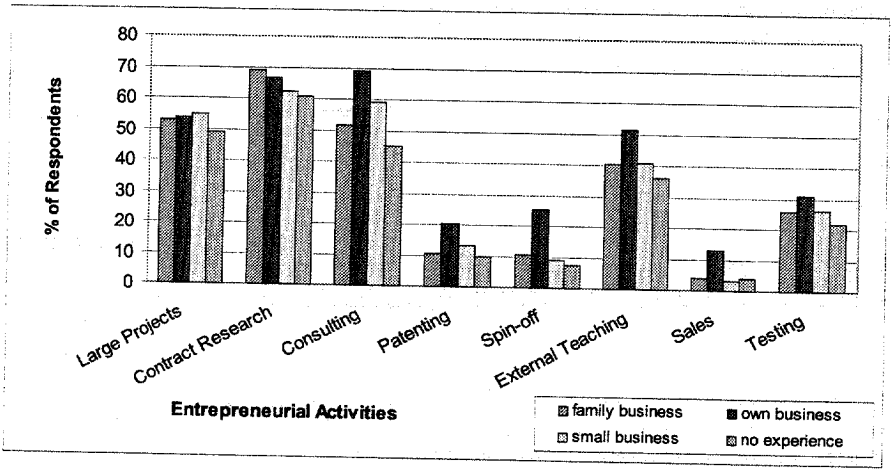
Hypotheses 6–9, which follow, focus on the nature of external activities undertaken by university staff, and investigate the relationship between the types of activity undertaken and the background of the staff involved. The eight activities chosen were Large Projects, Contract Research, Consulting, Patenting, Spin-off Company Creation, External Teaching, Sales, and Testing.

## *Hypothesis 6*

*Previous small business experience has an influence on the type of entrepreneurial activity undertaken*

By comparing target groups of respondents with and without previous work experience outside the university, it was found that in general there was no significant difference in the proportion of activities which were predominantly undertaken, as illustrated in Figure 6. However, for six of the eight selected activities, those university employees who have previously started their own business exhibit a dominant level of involvement. These activities are consulting, patenting, spin-off company creation (very dominant), external teaching, sales (very dominant), and testing. Considering those activities in which this category were found to be very dominant, namely company creation and sales, it is evident that these are activities in which they would have been heavily involved prior to joining university employment. Those who have previously started a business would obviously feel relatively at ease starting a further business, compared to those who have not had this experience and would not quite know how to approach this matter. Although sales was the least popular of all the entrepreneurial activities across all categories, those who run their own business are unavoidably occupied with promoting and selling their products, and thus with this background would be more likely to pursue this particular activity than the others.

FIGURE 6: RELATIONSHIP BETWEEN THE NATURE OF PREVIOUS BUSINESS EXPERIENCE AND THE TYPE OF ENTREPRENEURIAL ACTIVITIES UNDERTAKEN



In consulting activities, involvement by those with previous business experience (particularly in non-family businesses) was significantly greater than for those lacking such experience. This is not surprising, since an intimate practical knowledge of business operations is necessary to generate confidence in potential consultancy clients. A similar argument would appear to apply to 'testing' activities, where the same pattern is evident, though to a less marked degree. Rather more difficult to explain is the situation with 'external teaching', where one might have expected those with no previous business experience to have found a particular niche and to dominate, but this is not the case. This may be explained by some external teaching posts, particularly on vocational subjects, stipulating practical experience as a desirable, or even necessary, requirement for appointment.

Activities such as conducting large projects, and performing contract research, were very popular among respondents in general, with no dominance evident by any of the categories of employee being compared. It may hence be concluded that skills for these activities are largely university specific and can be acquired during a university career.

Concerning the validity of the hypothesis this cross-tabulation attempted to prove, it can be said that small business experience can indeed have an effect on entrepreneurial activities in the university, particularly if that experience was gained through the establishment of a business. Business experience gained through working as an employee in someone else's business, or in a family business, did not appear to generate the same degree of drive for establishing spin-off companies, for example.

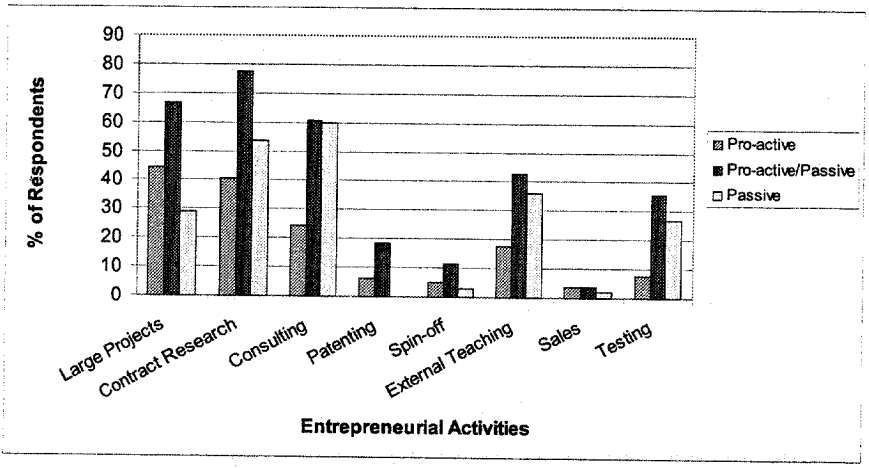
### *Hypothesis 7*

*The nature and type of contact with industry has an influence on the number and type of entrepreneurial activities that academic staff become involved in.*

In Figure 7 respondents involved in entrepreneurial activities have been categorised as proactive, proactive/passive and passive. Proactive individuals actively seek out collaborative opportunities; passive participants respond to approaches and opportunities as they arise. The chart highlights that those individuals involved from both perspectives, actively contacting industry as well as being pursued by industry, are the most active in terms of large projects, contract research, patenting, external teaching and testing. They are also very

active in consulting, though matched in this regard by the 'passive' group. They also produced the highest proportion of spin-off activities, although the overall number of spin-off activities was generally small.

FIGURE 7: RELATIONSHIP BETWEEN NATURE OF INDUSTRIAL CONTACTS AND THE TYPE OF ENTREPRENEURIAL ACTIVITY UNDERTAKEN



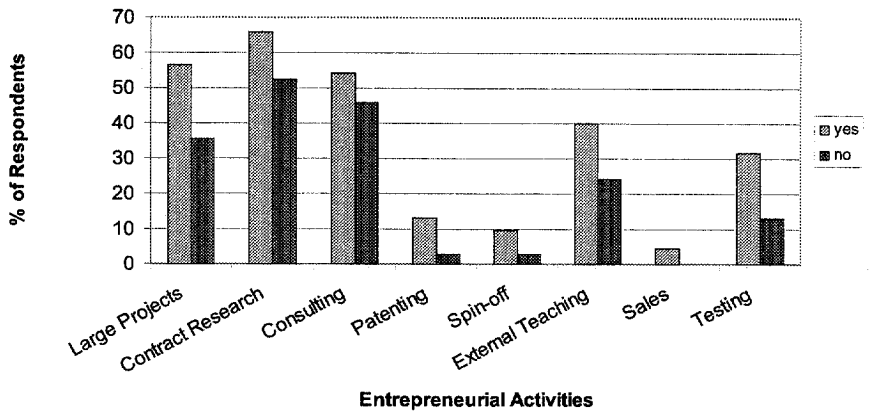

These statistics provide evidence to suggest that hypothesis 7 is valid, though they do not explain why respondents may be pro-active, passive or inactive in the first place.

*Hypothesis 8*

*An awareness/use of the Industrial Liaison Office (Research Office) influences the number and type of entrepreneurial activities engaged in.*

Figure 8a shows that those respondents who were aware of the existence and purpose of the ILO undertook every type of industrial collaboration more frequently than those who were unaware. For example, overall (across all activities) this involvement was at a level almost 60% higher, while for entrepreneurial activities such as patenting, spin-off company creation, sales and testing, it was between 100% and 300% higher. In attempting to find an explanation for these relationships, two possibilities present themselves:

FIGURE 8A: RELATIONSHIP BETWEEN AWARENESS OF ILO AND TYPE OF ENTREPRENEURIAL ACTIVITY UNDERTAKEN




- On the one hand, those who have been pro-active in seeking out sources of funding for collaborative research, will inevitably have had contact with the ILO at some stage and thus be very aware of the role they have to play. The key driver here is the degree of pro-activity among the respondents, rather than their detailed knowledge of the ILO.
- Alternatively, the ILO may have originated many projects following approaches from outside the university, in which academic staff have subsequently become involved. In this case the key driver is the level of awareness within the ILO concerning the research capabilities and interests of key staff members.

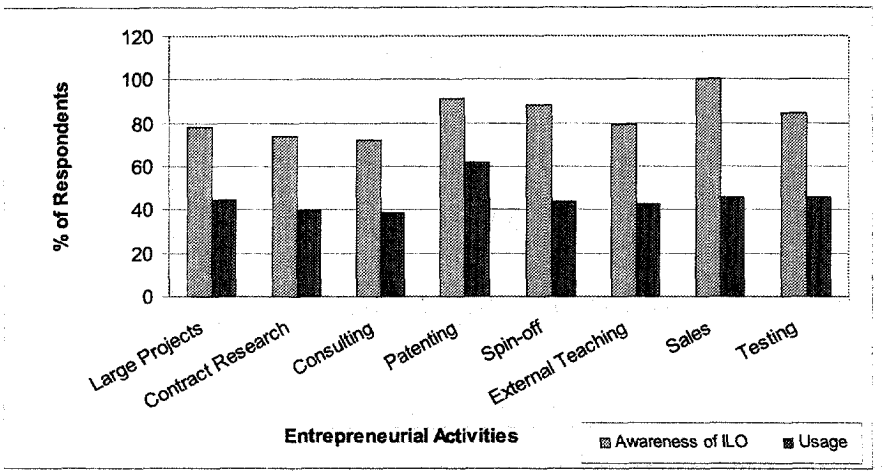
This leads to the questions of why certain individuals may be more pro-active than others, and whether the level of entrepreneurial activity can be substantially increased by an ILO. Answering these questions is outside the scope of the current project, but has important implications for planning future strategic research initiatives.

Viewed from a somewhat different angle (Figure 8b), involvement in the same range of entrepreneurial activities was investigated from two perspectives, namely:

- those who were aware of the activities of the ILO, but had not found it necessary to make use of any of the support services provided.

- respondents who had availed themselves of the facilities provided by the ILO, in contiguous operation with one or more of their enterprises.

FIGURE 8B: PROPORTION OF RESPONDENTS AWARE AND USING ILO VS TYPE OF ENTREPRENEURIAL ACTIVITY UNDERTAKEN




In general it may be stated that, within each category, approximately half of those aware of the ILO also make use of it. It is also evident that certain activities exhibit a significantly higher level of involvement than the average. Patenting was found to be such an activity, which is to be expected since it requires specialist knowledge of the complex procedures involved, a skill which is unlikely to be acquired in previous small business experience. The category 'sales' demonstrates a converse situation, with a much lower proportion of participants making use of ILO expertise and specialist knowledge. This is understandable, since knowledge in this area is much more likely to have been acquired during previous business experience.

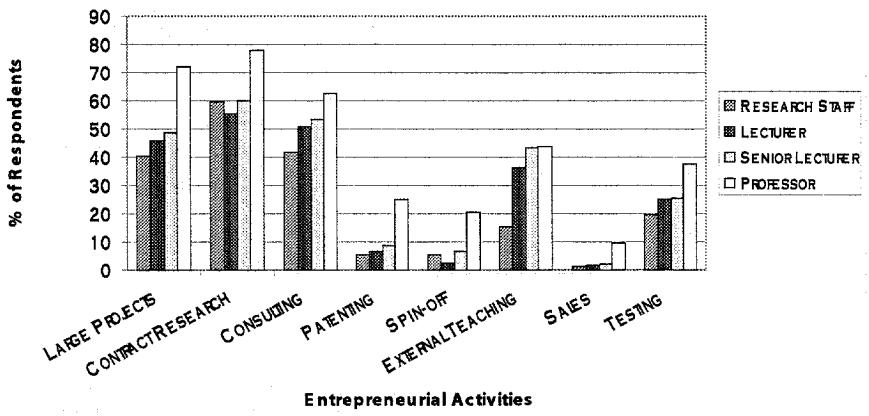
## *Hypothesis 9*

*Position in the university has an influence on the number and type of entrepreneurial activities that academics develop.*

Figure 9 shows that there is a distinct upward trend in participation levels across almost all activities, ranked from research staff to professor level. While professors are the group of respondents with highest involvement in entrepreneurial activities, such involvement often occurs on a managerial level. Often assisted by research staff,

professors can be involved in several activities simultaneously, while there are more restrictions on the other respondent categories. These restrictions can be due to a lack of availability of time because of the daily workload, e.g. teaching for lecturers and senior lecturers, and the dedicated and detailed nature of research projects performed by research staff. Thus the hypothesis can be concluded to be true here.

FIGURE 9: RESPONDENTS' JOB CLASSIFICATION VS TYPES OF ENTREPRENEURIAL ACTIVITIES UNDERTAKEN




## Conclusion

### *Encouraging Technology Transfer*

The results of the survey have revealed a complex interaction between types of previous experience and their influence on academics' level of activity in working with industry, as well as their potential to create start-up companies. The marked difference in involvement level between those with previous business experience and academic staff with no such experience may justify attempts to increase the proportion of staff from a business background being recruited to university posts in future. Particularly worthy of attraction are those who have experience of running their own small enterprise. The implications of such experience for university recruitment policy are:

- could be stipulated as a minimum requirement for some academic posts
- should be stated as a desirable characteristic in all academic posts

- should be reflected in the starting point on the salary scale which is offered.

Regarding government policy, which is perhaps most visible in the application of the RAE (Research Assessment Exercise) within universities, some important shifts in emphasis are desirable to encourage technology transfer:

- collaboration with industry should be ranked equal in importance to research publications
- research funding received from industry should be regarded as equal to Research Council grants
- Research Councils should be required to reserve a significant proportion of their budgets for applied research
- achievement of applied research objectives should be assessed, and ranked equal with high quality publications where fully met.

In this way government and universities together can actively encourage the involvement of academics with industry and commerce, to the mutual benefit of both the local community and the academic community.

### *Maximising the Contribution from the ILO*

The findings also indicate that pro-active members of university staff are more aware of the existence of the ILO and make more use of the support it provides. Hence, university policy could be aimed at encouraging greater use of this facility by:

- more active promotion of the profile of the ILO within each university
- encouraging suggestions from staff (two-way communication) in the development of improved policies
- adequate, flexible arrangements and remuneration for staff involved in consultancy, 'start-ups', etc.
- providing opportunities to take career breaks for business involvement, with such activities rated equally with politics and academic development.

With respect to government policy, to encourage contract research, consultancy, and large projects undertaken with industrial partners, it

would be of undoubted assistance to both the ILO and individual academics if such activities could be incorporated into and recognised by the RAE. Currently this exercise is dominated by evaluation of published academic output which, although it increases the rating of a department for the following years, does little to encourage the generation of increased funds through the medium of technology transfer in particular. By broadening the methods of assessment to include such activities directly, a much greater flexibility could be obtained, reducing the present overwhelming bias towards academic knowledge generation.

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