COMMERCIALIZATION OF SCHOLARSHIP IN AUSTRALIAN UNIVERSITIES

Larry L. Leslie and Ross I. Harrold*

In their search for greater financial independence, Australian universities are encouraging academics to commercialize the application of their knowledge and research skills. While these commercialized scholarship (COS) activities generate significant direct financial returns, they also impact indirectly upon the mainstream activities of university life. There has been little research into these indirect effects on university teaching, research and service.

This article reports a survey of academic and administrative staff of two Australian universities which compared direct and indirect costs and benefits of academics' COS activities. A novel evaluation technique was employed to assess the extent to which interviewed staff believed that the indirect benefits of COS (such as closer relations with external bodies, prestige and spin-off effects on teaching and research) were in aggregate more significant than the direct financial effects. The technique was also used to assess indirect costs of COS, such as time lost to basic research, and the time and other university facilities consumed for which there is incomplete reimbursement. An aggregation of these indirect and direct benefits and costs suggested that COS projects could be more favourable to universities than a narrow financial analysis would suggest.

Keywords: Australian universities, commercialized scholarship, benefit:cost ratios, indirect benefits.

INTRODUCTION

Australian public universities are encouraging their academics to seek out and win commercial consultancies and research contracts in order to supplement inadequate government funding and thus to help overcome institutional financial difficulties. There is some question about the wisdom of this encouragement, however, for such entrepreneurial activity could be at the cost of not serving as well, the prime educational purposes for which universities are funded. When all the implications are taken into account, is it in a university's best interest to encourage its academics to engage in the commercialisation of their scholarship and scientific knowledge?

There is considerable debate but little empirical evidence on this matter. This article seeks to clarify some of the issues involved. It does

* The authors wish to acknowledge the support of the Australian-American Educational Foundation, which awarded the first-named author a Senior Fulbright Research Fellowship to Australia to undertake this work. The authors bear full responsibility for the findings and conclusions of their research.

this by identifying and assessing the direct and indirect effects of academics' involvement in commercial activities. The main data derive from interviews of academics and administrators in two Australian universities. These interviews sought to identify and evaluate the impact of commercial activities, not only directly on the finances of academic departments but also indirectly on their teaching and professional activities. A tentative evaluation was made of the indirect effects of each activity, by relating the perceived importance of each effect to a subjective evaluation of the importance of the revenues generated by that activity. This permitted the financial value of these indirect effects to be inferred.[1]

We mean by the term 'commercialization of scholarship' (COS) or commercialized scholarship, those activities funded by contracts or grants with business or with government agencies seeking solutions to specific problems. Such ventures capitalize on university research and academic expertise. This definition is intended to capture all activities which generate revenues for universities through entrepreneurial behaviour, including consulting, so long as the revenues enter university accounts, directly involve university expertise and are applied or developmental in nature. Efforts to generate university revenues through recruitment of full — or high — fee paying students are excluded as is basic research.[2]

The term commercialized scholarship could suggest that most earnings derive from science faculty research. This is not necessarily so. As is recounted below, two of the most impressive successes were identified in a variation of a physical education department and of a criminology unit. In the former the department had generated millions of dollars over the past ten years, primarily through swimming lessons and exercise and recreation videotapes. In the latter unit a single multimillion dollar grant to gather and maintain crime statistics had been obtained from government, and the small unit was essentially living off the interest of the block grant that had been paid 'up front'.

We assume that the supplementary revenues generated by commercialized scholarship are expended on the university's mission of teaching, research and service. We presume university rules ensure that any 'profits' generated from commercial activities can only be redirected to this corporate mission triumvirate. Except for the greater power of those who generate the profits to specify expenditure targets, conceptually such funds are the same as any other supplementary revenues earned by the institution.

Thus the aim of this article is to explore the benefits and costs of commercial scholarship activities undertaken by university academic staff. The first objective is to document the nature, amount and direct financial significance of these activities for universities and their academic organizational units. The second is to try to identify the indirect impacts on universities of commercialized scholarship, as they

are perceived by the surveyed academics. The third is to assess the perceived value of these individual indirect benefits and costs.

Empirical data were collected from university financial records and from interviews by the first-named author in early 1991 with a total of 111 academics and administrators of two universities, one metropolitan and the other non-metropolitan. The main information sought from administrators was the revenue brought to their universities by commercial scholarship activities. Then academics themselves were asked to evaluate and compare the direct and perceived indirect benefits and costs to their universities of the commercial activities in which they engaged.

FINANCIAL SIGNIFICANCE OF COMMERCIALIZED SCHOLARSHIP ACTIVITIES

The commercial application of the scholarship and research skills of academics contributes importantly to university income. The two universities studied were not major players in the commercialization of scholarship arena in Australia, yet the commercial revenues they generated were substantial. University records, supplemented by administrator interviews, revealed that commercial activities accounted for $16.3 million in 1989 in University A and $12.3 million in 1990 in University B. These figures represented a respective 10 per cent and 12 per cent of total university operating revenues. In the respective universities, commercial revenues were 18 per cent and 19 per cent as large as recurrent funding by the Commonwealth. Clearly these were important activities from the university revenue perspective.

There was a larger difference in the relative importance of the commercial activities within the two universities, however, than appeared from the gross figures. University A generated $6.8 of its $16.3 million in commercial revenues from a single centre having a very marginal relationship to the University whereas University B generated its entire $12.3 million from activities having direct relevance to its mission. Thus, more comparable figures were $9.5 million and $12.5 million, for University A and B, respectively, representing 6 per cent and 12 per cent of institutional total revenues. The relative magnitude of commercialization of scholarship therefore was greater at University B than at University A. University A was far more involved in basic research, ranking near the middle of Australian universities in terms of competitive Commonwealth research grants won, whereas University B ranked near the bottom.

There was considerable unevenness in the financial impacts of technology transfer and commercialization of scholarship among the organisational units of each university. Less than half the university departments were substantially involved in commercialization of scholarship, and major effects were highly concentrated in a few departments. Table 1 reports those departments and centres having substantial commercial activities.

TABLE 1
COMMERCIALIZATION OF SCHOLARSHIP REVENUES AND EXPENDITURES TOTAL AND BY DEPARTMENT IN TWO AUSTRALIAN UNIVERSITIES[1]

	University A		University B		All COS	
Revenues[2]						
	$(000)	%[3]	$(000)	%	$	
Agriculture Sciences						
Department 1	623	37	874	55		
Department 2	1148	49	1387	55		
Department 3	441	38	680	47		
Applied Natural Sciences						
Department 1	366	11	1308	52		
Department 2	1104	41	55	3		
Department 3	75	5	616	5		
Basic Natural Sciences						
Department 1	28	1	379	29		
Department 2	30	1	30	3		
Department 3	102	6	75	9		
Department 4	47	3	392	30		
Department 5	241	6				
Department 6	113	6				
Engineering						
Department 1	1478	30	100	16		
Department 2	1156	34				
Department 3			624	18		
Social Sciences						
Department 1	34	1	117	30		
Department 2	153	7	40	7		
Department 3	134	11				
Professinal Unit 1	260	9	81	7		
Professional Unit 2	981	29	93	6		
Professional Unit 3	440	100				
All teaching departments[4]	8954	22	6851	23	15805	22
Independent Centres						
Unit 1	6822	100	2407	100		
Unit 2			1018	100		
Unit 3			591	87		
Unit 4			204	100		
Unit 5			638	100		
Unit 6			323	100		
Unit 7			707	98		
All independent Centres	6822	100	5888	98		
TOTAL	15776	25	12739	45	28515	36

1. Data are for 1989 in University A and 1990 in University B.
2. Commercialization of Scholarship.
3. Total expenditures in relevant departments
4. Sum of revenues in the departments and professional units shown.

The humanities and social sciences were unlikely to have more than a few thousand dollars in commercial revenues even though government applied projects were included in the operational definition of scholarship commercialization. The same was true of most professional fields related to the social sciences although a few notable exceptions exist, such as the physical education and the criminology examples mentioned earlier. Somewhat surprisingly, the more 'basic' natural science disciplines such as chemistry, physics, botany, and zoology tended to generate fairly modest amounts, too; it was in the applied fields — applied natural sciences, agriculture sciences and engineering — where revenues from contracts and grants with businesses and governments were substantial. A similar pattern was observed by Fairweather[3] and confirmed by Levin *et al.*[4] from their survey of businesses regarding the relevance of various scientific fields to technical advances.

Overall, teaching departments identified as having substantial revenues from commercial activities averaged 22 per cent of their revenues from these sources, with shares running approximately 50 per cent and more in several departments in the applied sciences and agriculture.[5] Independently organised research centres and institutes often generated 100 per cent of their revenues through the commercialization of scholarship.[6] This concentration of commercialized research activities in only a few departments is hardly surprising, at least in hindsight.

RELATING DIRECT AND INDIRECT BENEFITS AND COSTS

The major challenge was to evaluate the worth of these identified commercial activities in terms of the total benefits and costs to the university. Weisbrod [7] defines a benefit as anything which pushes outward the institution's utility possibility function, and a cost that which contracts it. A benefit therefore includes anything which (i) increases production possibilities, (ii) reduces costs and thereby makes more resources available for more productive purposes, and/or (iii) increases welfare possibilities directly. A cost includes anything which contracts production possibilities, decreases the productive use of resources or reduces welfare possibilities. Because we consider the productive unit to be the whole university, we exclude benefits received at the cost of transfers from other parts of the university. An example would be an increased share of the institution's base operating grant awarded to a department because its research productivity index has included the value of commercial research contracts won.

Direct benefits or costs are those for which revenues are received or incurred for services or goods provided to or used by the scholarship activity. Indirect benefits and costs are all others associated with the process and product of the activity. These indirect benefits and costs can be further classified as follows:

Monetary/pecuniary/financial
Present
Future
Non-monetary/non-pecuniary/non-financial

Present	quantifiable
	non-quantifiable
Future	quantifiable
	non-quantifiable

In order to capture some sense of the relative importance of the indirect benefits and costs involved in the COS within universities, interviewees were asked to relate direct benefits and costs of the associated revenues to an indirect benefits and costs list compiled from the literature and from pilot interviews. (See interview schedule in Appendix) Always, the test was the extent to which, from the interviewee's perspective, the commercial projects impacted the university's mission. The process was first to gain the interviewee's scaled estimate of the direct benefit of the revenues themselves and then, using this estimate as a reference point, to gain a similarly scaled estimate of the indirect benefit associated with each item on the indirect benefits list.

The process is similar to that employed in economics to attach values to fringe benefits and to the non-precuniary benefits of various kinds of labour. Dunn,[8] for example, interviewed factory workers to eval.uate their perceptions of the worth of various possible fringe benefits. In a universities context, McMahon[9] and Haveman and Wolfe[10] used similar techniques to attach dollar values to the non-pecuniary benefits of higher education. Clearly, the results of such efforts are only suggestive of the monetary value of indirect benefits and specific estimates should not be taken literally: they serve as no more than crude estimates of values attached by the individuals directly concerned. So long as suitable qualifications are made about the subjectivity of the data, the results yield cost-benefit estimates which are more complete than the comparison of direct costs and benefits alone. It is worth noting in this regard that although it was necessary to explain the estimation procedure very carefully to each interviewee and sometimes to offer illustrations as to how the process was to work, only two individuals questioned the procedure and declined to participate.[11] As suggested by Yin,[12] field studies were conducted to validate aspects of the self-reported data.

Respondents in the two universities surveyed attached a high value to the direct benefits of the $28.6 million generated through commercial ventures, of which approximately $2 million came from private sources. These were the direct benefits associated with the contracts and grants:

individuals employed, departmental operating expenses contributed, travel paid for and so forth. Salaries and wages accounted for about 50 per cent and equipment about 4 per cent of expenditures in University A; expenditure breakdowns were not available for University B. On a 0-10 scale the mean value assigned to the extent to which the ventures contributed to university mission accomplishment was 7.0. The mean value for University A, the more standard university, was a slightly higher 7.1 in comparison to a 6.9 for University B, which was very modestly involved in engineering and more heavily involved in agriculture. These numerical differences were not significant statistically.

Analogously, the indirect benefits associated with the revenues were put by the faculty and departmental administrators at 1.83 times as important, or $52.3 million, for a total benefit of $80.9 million.[13] For University A the perceived indirect to direct benefits ratio was 1.66:1; for University B it was 1.98:1. This difference could have reflected the latter's relatively larger revenues from commercial activities, although to suggest this is to imply that the ratio of indirect to direct benefits increases as direct benefits increase. Again, these figures can only be taken as crude estimates, but they are illuminating.

The general view therefore is that indirect benefits of the commercialization of scholarship outweigh the direct, monetary benefits. Of 60 individuals responding to both questions, 47 considered the indirect or spillover[14] benefits to be equally or more important.[15] The pattern of responses was consistent across basic and applied researchers regardless of the degree of personal involvement in commercial projects.

When costs were taken into account, again analogously, net benefits declined to $64.2 million and the benefit to cost ratio was approximately 3:1. For University A the benefit-cost ratio was 3.7:1 and at University B it was 2.9:1, reflecting primarily larger perceived costs at the latter. The difference in cost perceptions may have reflected increased sensitivities at University B where the commercial activities were relatively dominant; in other words as a university becomes more heavily involved in commercial activities, some of the pitfalls may become more apparent. For the two universities total indirect costs were put at $16.7 million.[16] Only three of 59 respondents perceived the costs of science commercialization to be in excess of benefits. None of these three were themselves involved in commercial activities and all three were in departments where such activities were considerable but in which the financial fruits were not shared widely. Two of the three seemed to be disgruntled regarding related departmental policies, while the third simply thought that applied research shifted the university focus away from 'the more important' basic science objective.

DISAGGREGATING THE INDIRECT BENEFITS AND COSTS

Indirect Benefits

A primary study aim was to develop a taxonomy of costs and benefits

TABLE 2 — INDIRECT BENEFITS AND COSTS TO UNIVERSITIES FROM COMMERCIALISED SCHOLARSHIP

Indirect Benefits	Mean (/10)	S.D.	Relevant Literature*	Comments
Relations with external bodies	6.9	2.0	Blumenthal *et al.*, 1986a; Feller, 1989	Credibility and political base enhanced.
Prestige	7.0	2.2	Fairweather, 1988; Weiner, 1986	"It's not the money; it's to make your mark as a university".
Spillovers to research	6.5	2.3	Blumenthal *et al.*, 1986a, 1986c; Crean 1990; Geiger, 1989.	Commercial research creates or adds greatly to a unit's research "atmosphere".
Spillovers to teaching	5.8	2.7	Blumenthal *et al.*, 1986a; Crean 1990; Fairweather, 1989.	Some commercial problem solving provides material which is highly relevant to teaching and "field experience".
Future consulting opportunities	5.7	3.0	Fairweather, 1988; Ommen, 1982; Slaughter and Rhoades, 1990.	Success breeds success. Successful contracts lead to other consulting opportunities.
Employment of graduates	5.1	2.9	Feller, 1988a; Geiger, 1989; Gilley, 1986.	Involvement of students in contracts provides the practical experience useful to employers.
Student recruitment	4.0	3.0	Blumenthal *et al.*, 1986b; Fairweather, 1989; Stauffer, 1986.	More significant with post-graduates.
Services contributed by project personnel	4.5	2.8	Fairweather, 1989.	Project personnel work alongside and help induct students to practical problem-solving.
Equipment gains	4.5	3.3	Stauffer, 1986; Fairweather, 1989.	Project equipment remaining after project and/or donated by grantors.
Employment of students	4.2	2.9	Blumenthal, 1986b; Fairweather, 1988.	Out-of-semester jobs for students.
Recruitment of faculty from clients.	0.9	1.78	Fairweather, 1989.	Happened infrequently in Australia.
Indirect Costs				
Academic resources consumed	−3.1	2.6		Uncompensated secretarial time, fax and telephone costs, and space.
Loss of time for basic research	−2.8	2.8	Anderson and Sugarman, 1989; Blumenthal *et al.*, 1986a, 1986b; Geiger, 1989; Fairweather, 1989; Matkin, 1990.	Contracted time deflects resources from more basic, fundamental research. But commercial research can also stimulate basic research.
Time of higher support personnel	−2.1	1.9	Rosenthal and Fung, 1990; Feller, 1988b	Subsidization by department and central administration.
Revenue substitution	−2.1	1.9	Blumenthal *et al.*, 1986b; Fairweather, 1989; Feller, 1989.	May result in reduced subsidies from Commonwealth government in long run.
Equipment	−2.0	2.9		Uncompensated wear on university equipment.
Loss of teaching and preparation time	−1.8	2.13	Anderson & Sugarman, 1989; Blumenthal *et al.*, 1986a, 1986c; Fairweather, 1989.	Most likely to occur as contract deadlines approached.
Secretiveness, confidentiality	−1.4	1.9	Anderson & Sugarman, 1989; Blumenthal *et al.*, 1986c; Fairweather, 1989; Johnson, 1984.	Against university ethos. No respondent quoted personal experience.
Departure of faculty/staff to client organizations	−0.7	1.5	Dimancescu and Botkin, 1986; Matkin, 1990.	
Monetary losses	−0.5	1.5		Rarely happens as most commercial contracts prohibit losses to the university.
Legal fees	−0.5	1.0	Geiger, 1989; Blumenthal *et al.*, 1986a; Rosenthal and Fung, 1990; Weiner, 1986.	Mainly concerned with patent activity.
Patent/copyright application fees	−0.5	0.9	Blumenthal *et al.*, 1986a; Feller, 1988b.	
Product or process liability	−0.2	0.7	Anderson and Sugarman, 1989.	University generally insures against such liabilities.

DETAILS OF RELEVANT LITERATURE

Anderson, Richard E. and Barry Sugarman, "Options for Technology Transfer", *Capital Ideas*, 4(1&2), July 1989, 1-15.

Blumenthal, David, Sherrie Epstein, and James Maxwell, "Commercializing University Research: Lessons from the Experience of the Wisconsin Alumni Research Foundation", *New England Journal of Medicine*, 314(25), 1986a 1621-1626.

Blumenthal, David, Michael Gluck, Karen Seashore Louis, and David Wise, "Industrial Support of University Research in Biotechnology", *Science*, 231, January 1986b, 242-246.

Blumenthal, David, Michael Gluck, Karen Seashore Louis, Michael A. Stato, and David Wise, "University-Industry Research Relationships in Biotechnology: Implications for the University", *Science*, 232, June 1986c, 1361-1366.

Crean, Simon, "Science Policy", Conference Papers, The Australian Tertiary Institutions Consulting Companies Association, Canberra, June 1990.

Dimancescu, D. and J. Botkin, *The New Alliance*, Cambridge, MA: Ballinger, 1986.

Fairweather, James S., *Entrepreneurship and Higher Education*, Washington, D.C.: Association for the Study of Higher Education, 1988.

Fairweather, James S., "Academic Research and Instruction: The Industrial Connection", *Journal of Higher Education*, 60(4), July/August 1989, 388-407.

Feller, Irwin, "Evaluating State Advanced Technology Programs", *Evaluation Review*, 12(3) June 1988a, 232-252.

Feller, Irwin, "Universities as Engines of R&D-based Economic Growth: They Think They Can", Paper prepared for the Association for Public Policy Analysis and Management's Annual Research Conference, October 1988b.

Feller, Irwin, "The Impacts of State Technology Programs on American Research Universities", Paper prepared for the Anglo-American Conference on Research Universities, University of York, September 1989.

Geiger, Roger L., "The Ambiguous Link: Private Industry and University Research", in William E. Becker and Darrell Lewis, Eds *Higher Education and Economic Development*, 1989.

Gilley, Wade, "Higher Education and Economic Development: A Symbiotic Relationship", *Issues in Higher Education and Economic Development*, Washington D.C., 1986, American Association of State Colleges and Universities.

Haveman, R.H., and B.L. Wolfe, "Schooling and Economic Well-Being: The Role of Nonmarket Effects", *Journal of Human Resources, 19(3), 1984, 377-407.*

Johnson, Lynn G., *The High-Technology Connection: Academic/Industrial Co-operation for Economic Growth*, Washington D.C.: Association for the Study of Higher Education, 1984.

Matkin, Gary W., "Commercializing the University: The Practical Consequences of Overturning University Tradition", Paper presented at the Fifteenth Annual Meeting of the Association for the Study of Higher Education, Portland, Oregon, November 1990.

Ommen, G., "Taking University Research into the Marketplace", *New England Journal of Medicine, 307(11), 1982, 694-700.*

Rosenthal, Kenneth, and Christine A. Fung, "Technology Survey of 20 Universities", *les Nouvelles*, 25(3), September 1990, 133-137.

Slaughter, Sheila A., and Gary Rhoades, "Reforming the Social Relations of Academic Science: Technology Transfer", *Educational Policy*, 4(4), 1990, 341-361.

Stauffer, Thomas, "The Responsibilities of Public Universities for Economic Development", *Issues in Higher Education and Economic Development,* Washington, D.C.: The American Association of State Colleges and Universities, 1986.

associated with the commercialization of scholarship. Much has been said in the literature, particularly about likely costs or negative outcomes of these activities, but little empirical evidence has been offered. The following table reflects respondent assessments of the costs and benefits identified in the referenced literature and added to by the interviewees in the pilot study. Items are arranged in descending order of importance, as indicated by mean ratings of respondents. Standard deviations (SD) of these ratings are included to indicate the dispersion of responses. Statistically significant differences of respondent ratings between universities are noted.

Table 2 reveals that in academic respondents' eyes, COS activities are important means of enhancing their departments' prestige and their contacts with industry. Comments suggest that this is partly a matter of pride, but the contracts are also seen as potentially useful for internal political reasons as well as for gaining future commercial contracts. Respondents also valued the activities for the positive effects on their mainstream teaching and research duties. Efforts to solve practical industrial problems often provide good lecture material as well as sometimes posing specific challenges for fundamental research. Apart from these benefits, the closer contacts with business sometimes strengthened student and staff recruitment and provided employment opportunities for graduates.

On the other hand, some academics interviewed saw a down-side to COS activities, although part at least of what they saw as uncompensated additional costs of their own time, of the time of administrative and other staff, and of departmental equipment, could probably be traced to inadequate costing when tenders were developed. Among other potential costs was the worry that any department which was too successful in gaining income from outside sources might find that its financial support from government and central administration could be reduced.

Overall the indirect benefits were seen to greatly outweigh the indirect costs.

IMPLICATIONS FOR ANALYSIS AND POLICY

This paper has sought to identify financial and non-financial, direct and indirect benefits and costs of the commercialized scholarship research activities of universities. It has found that the net revenues attracted by these activities were significant for the two universities whose staff were surveyed, and the financial benefit:cost ratios were favourable. These ratios became substantially more favourable when indirect benefits and costs of the activities were included.

This has been an exploratory study only. Analytically it has sought to widen the artifically narrow conception of explicit benefits and costs

as only those for which incomes are received or payments made. Widening has been attempted by translating the monetary aspects on to another perceptual scale, then expressing other non-monetary benefits and costs on that scale. The reader is reminded that the survey findings rest on respondents' own perceived ratings rather than 'objective' market valuations. We argue however that the exercise has been a worthwhile attempt to account as fully as possible for all the benefits and costs of COS, as they affect those who are involved in the commercial work. We believe that our main finding is robust i.e. that the full university benefit:cost ratios of COS as perceived by those directly involved in and those associated organizationally with the activity are more favourable than those suggested by analysis of solely monetary benefits and costs.

University policy makers could take particular note of two findings of this paper. Firstly, financially-strapped universities are considering ways of benefiting more from incomes generated by the COS activities of their staff. The high indirect benefits, many of which contribute to the researchers' job satisfaction, suggest that while these academics would undoubtedly protest against their shares of the monetary rewards of COS being reduced, they are unlikely to cut back on their involvement in these activities.

Secondly, the findings suggest that less than half of all departments in the surveyed universities are significantly involved in COS activities. Among those with little involvement are departments in the more 'basic' natural science disciplines such as chemistry, physics, botany and zoology. While this lack of involvement may not be surprising, it does suggest that more departments could be encouraged to seek out and tender for appropriate government or private contracts. The interview results suggest that those departments which do respond positively could not only improve their financial health but also raise the general standard and status of their teaching and research activities.

NOTES AND REFERENCES

1. Inevitably, these valuations were impressionistic, based as they were on the opinions of those who were actively engaged in commercial activities and those not engaged. Further, the choice of the two universities was opportunistic, so that generalizations cannot easily be made. Nevertheless, the information collected provides illuminating descriptive data about the role which commercial academic activities play in higher education institutions.
2. Distinguishing between applied and basic research is always a troublesome matter. We employ the National Science Foundation (US) definition of basic research: Original investigation for the advancement of scientific knowledge . . . which do(es) not have immediate commercial objectives (NSF, 1959, p. 124).
3. James S. Fairweather, *Entrepreneurship and Higher Education,* Washington, D.C.: Association for the Study of Higher Education, 1988.
4. R. Levin, A. Klevorick and R. Nelson, 'Appropriating the returns to industrial R and D,' *Brookings Papers on Economic Activity,* No. 3, Washington D.C.: Brookings Institution, 1987.

5. In University A all centres and institutes were amalagmated with departments, whereas in University B most centres and institutes were free-standing. Had university policies been consistent, shares of department expenditures related to commercial activities would have been much higher in University B.
6. University policies differed in regard to the organization of research centres and institutes. In University A research centres and institutes were organized within a department, whereas in University B there had been an apparent effort to separate these units from the departments. The difference greatly affects the interpretation of the data in Table 1. In University B the utility of the centre — or institute-based revenues to departments ranges from only moderate to almost nil. From the University perspective the centres and institutes probably contribute to research and service in much the same ways as do department-based efforts.
7. B. A. Weisbrod, 'External effects of investment in education', in M. Blaug (ed.) *Economics of Education,* Harmondsworth, Penguin, 1968, p. 158.
8. L. F. Dunn, 'Quantifying non-pecuniary returns', *Journal of Human Resources,* 12(3), Summer 1977, pp. 347-359.
9. Walter W. McMahon, 'Externalities in education', Faculty Working Paper No. 877, Urbana-Champaign: University of Illinois, 1982.
10. R. H. Haveman, and B. L. Wolfe, 'Schooling and economic well-being: The role of nonmarket effects,' *Journal of Human Resources,* 19(3), 1984, pp. 377-407.
11. Although the interviewees appeared to assign values to the total indirect benefits with care and thus the monetary values probably are generally valid, interviewees seemed to be more liberal in assigning values to individual indirect benefits.
12. R. Yin, 'Studying the implementation of public programs,' in W. Williams and R. Elmore (eds), *Studying Implementation,* Chatham, NJ, Chatham House, 1982.
13. One very large outlier was eliminated both from the benefit and cost data. If the very large values are included, the indirect to direct benefit ratio rises to almost 2.0:1 and the benefit:cost ratio changes from 5:2 to 3:1.
14. The use of the term 'spillover' in this article refers to interactions among activities undertaken by the same person. It is thus not directly analogous to the economists' conventional use of the term. A synonym could be 'spinoff.'
15. Since respondents were selected because they were voluntarily involved in commercialized activities, it is not surprising that most think positively about the impacts of what they do on their other work responsibilities.
16. Only indirect benefits to costs are reflected. Since all revenues generated (direct benefits) are expended (direct costs) in the non profit universities, only the indirect benefit to cost ratio has a clear implication for policy affecting academics' behaviour.

APPENDIX

TECHNOLOGY TRANSFER QUESTIONNAIRE

This instrument is one component of an attempt to gain information about the value, to your university, of technology or knowledge transfer to the commercial arena, whether to business or to government. The questions concern your views of the costs and benefits of that technology or knowledge transfer to commercialization activities within your unit.

A major difficulty in this research is in assigning values to non-monetary costs and benefits. In some cases, such as teaching time donated by individuals funded separately through the commercial activity, it is possible simply to calculate the value of that individual's time. There are, however, more difficult cases, and this is where we seek your assistance.

DIRECTIONS: Using values from 0 (no benefit) to 10 (highest benefit), please assign a value to each of the following items, using as your basis,

the extent to which your unit's technology/knowledge activity contributes to your University's mission of teaching, research, and service.

Begin by assigning a value to "revenue generation" and *using this value as a reference point,* proceed to the other items.

_____ revenue generation
_____ relations with external bodies (e.g., govt., industry)
_____ recruitment of faculty/staff from clients
_____ student recruitment
_____ equipment gains
_____ prestige
_____ future consulting opportunities
_____ services "contributed" by project personnel (e.g., teaching, advising)
_____ employment of your graduates
_____ employment of your students
_____ spillovers to teaching
_____ spillovers to research
_____ Other, specify_____
_____ Other, specify_____

_____ Recognizing that there are some overlaps in the above, what value would you assign to the *total* of the non revenue items in comparison with the value of the revenue generated (e.g., 30%, as important, 150%, 350%)?

Using values from (-)10 (highest cost) to 0 (no cost) please assign a value to each of the following costs, again using as your basis, *the extent to which the activity represents a cost to your University's mission of teaching, research, and service*

_____ legal fees
_____ patent/copyright application fees
_____ departure of faculty/staff to client organizations
_____ loss of teaching time
_____ equipment (e.g., wear and tear, increased demand)
_____ academic resources consumed
_____ time of higher support personnel (e.g., administration)
_____ loss of time for basic/generic research
_____ secretiveness (e.g., publication delays)
_____ product or process liability
_____ monetary loss
_____ revenue substitution (i.e., loss of "regular" revenues because of success in raising commercial funds)
_____ other; specify_____
_____ other; specify_____

_____ Recognizing that there are some overlaps in the above, what value would you assign to the *total* of the non monetary costs?