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The role of university-based industrial extension services in the business performance of small manufacturing firms: case-study evidence from Western New York

By Michael Ziolkowski

Canada-U.S. Trade Center
Department of Geography
State University of New York
Buffalo, NY 14261-0023

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By Michael Ziolkowski, Canada-U.S. Trade Center, Department of Geography, State University of New York, Buffalo, NY 14261-0023

Abstract

This paper investigates the role of university-based industrial extension services in the business performance of small manufacturing firms in an economically declining region of the United States (Western New York). The outreach initiatives of a specific University at Buffalo (UB) program are described. Particular attention is given to the activities of UB's Centre for Industrial Effectiveness (CIE), an outreach unit with a mandate to improve the product and/or process development efforts of local manufacturing firms. Our data suggest positive returns on investment for firms that have sought technical support under CIE program. A key finding is that CIE's services typically entail the transmission of well-established procedures rather than radically new ways of doing things. A further finding is that firms that have used CIE to develop improved products have experienced stronger investment returns than their counterparts that have focused upon process development (though the returns are positive in both instances). More broadly, our data suggest positive correlations between levels of project investment and a variety of commercial outcomes, including sales growth, job-retention, and unit-cost reduction. The implications of these results for regional economic development policy are discussed. The paper also reviews some of the weaknesses that curtail the effectiveness of university-based centers such as CIE.

Introduction

There is now a considerable body of literature on the role of university-industry interactions in the innovation performance of manufacturing firms (e.g. Etzkowitz and Klofsten 2005, Feller, Ailes and Roessner 2002, Jaffe 1989, Mansfield 1991, Van Looy, Debackere and Andries 2003). These linkages appear to be of particular relevance to small and medium-sized enterprises (SMEs), especially those with limited in-house technical capabilities (Feldman and Florida 1994, Freel 2000, Freeman 1991, Rothwell 1992). Recent spatial-econometric studies suggest that industrial innovation responds positively to university spillovers, notably among firms that are located close to major campuses (Anselin, Varga and Acs 1997, 2000, Varga 1998). Survey-based inquiries at the firm level have reinforced these findings (e.g. Acs, Audretsch and Feldman 1994, Bagchi-Sen, Hall and Petryshyn 2001, Link and Rees 1990, MacPherson 2002), as have several qualitative studies (e.g. Klofsten and Jones-Evans 1996, Lawton-Smith 1993). Although there are formidable barriers to the effective use of university resources by SMEs, especially with regard to contract specification and financing (Charles and Howells 1992, Ziolkowski 2004), there is little doubt that the academic sector has the *potential* to assist the modernization efforts of small companies.

Significantly, the empirical evidence regarding the importance of universities to both radical and incremental innovation spans well beyond the USA. For instance, Britton (2004) draws attention to the contribution of universities to the incremental innovation efforts of Canadian firms; Etzkowitz and Kolfsten (2005) report on the triple helix from a Swedish perspective (radical innovation); Charles and Howells (1992) document the role of EU universities in technology transfer to European firms; while Blind and Grupp (1999) point to a positive role for research universities in the innovation performance of German regions. There is a common thread in this literature. Specifically, universities are becoming increasingly important to the innovation process.

In much of the recent work on this topic, however, attention has mainly focused upon knowledge-transfer functions that generate measurable outputs such as patents, radically new products, or both. Much less attention has been given to university inputs that support incremental innovation, especially on the process side (e.g. assistance with ISO certification, worker training, or the implementation of total quality management [TQM] systems). At the same time, much of the existing work on academic-industry linkages has emphasized large universities in prosperous or high-technology regions (e.g. Silicon Valley, Route 128). Small universities in less dynamic places have attracted comparatively little interest. In this paper, we argue that small universities can deliver useful inputs to local industrial firms via relatively simple modes of technical assistance. Typical benefits include accelerated ISO certification, reduced materials wastage, skills enhancement via worker training, engineering upgrades, or the successful implementation of TQM systems.

We argue that many of these services can meet the industrial modernization needs of economically declining regions that contain large numbers of mature SMEs. More specifically, the goal of our paper is to illustrate the extent to which universities can help local industrial firms via technical outreach initiatives that are modest in scope, relatively low-cost, quick to deliver, and far-removed from the 'breakthrough' technological drivers that are frequently associated with university-based knowledge transfer programs. Our evidence comes from a case study of a single academic institution (University at Buffalo, or UB), a single business outreach unit (the Centre for Industrial Effectiveness, or CIE), and a single region (Western New York).

Three empirical questions are addressed in the analysis that follows. First, to what extent does the CIE deliver commercial benefits to client firms? Second, how much does it cost to obtain these benefits? And, third, how might units like the CIE expand their technical assistance programs to maximize local or regional economic impact? Data for the study come from a sample of CIE clients that were surveyed in the summer of 2004. Supplementary data come from personal interviews with a sub-sample of client firms, as well as from interviews with CIE managers and consultants. While our data are perhaps too context-specific to draw conclusions that might apply to other universities or regions, some of the empirical findings ought to be of interest to economic development practitioners and academic administrators. Specifically, our data reveal a series of statistically significant connections between levels of project investment and a variety of commercial effects. The latter most notably include sales growth, increased operational efficiency, job-creation or retention, and successful product development. Prior to a discussion of the survey results, however, a brief research context is required.

Research Context

Few industrial firms outside the corporate domain are 100 percent internally competent across a full range of professional, scientific, or technical functions (Freel 2000, Freeman 1991, Rothwell 1992). Such functions include specialty fields such as applied research and development (R&D), industrial design, production engineering, product testing, and several other technical areas (e.g. process automation, systems integration). By now, there is no need for firms to develop or maintain in-house expertise across *all* of these fields because of the rapid growth of specialized producer services (Beyers 2003). For cities or regions that contain weak stocks of such services, however, innovative activity may be stifled unless firms can successfully import appropriate inputs from non-local suppliers (Britton 2004). Although this does happen, SMEs appear less likely to tap non-local sources of innovation support than larger firms (MacPherson 1997). Under these conditions, the input needs of SMEs have to be either internally generated or acquired from the public sector (e.g. universities). Public sector sources are often superior to private sector alternatives in fields based on cutting-edge industrial research (e.g. photonics, bioinformatics, lasers). In other cases, public sector sources are desirable when there are no convenient or accessible alternatives in the private domain.

University-based extension services may also be justified from a triple helix perspective. Collaborative networks that link private industrial firms, entrepreneurial universities, government organizations, and other public agencies are increasingly viewed as knowledge-based drivers of regional industrial change (Etzkowitz and Klofsten 2005). Although the triple helix perspective is normally associated with high-technology entrepreneurship (i.e. radically new product markets), the basic concept is equally pertinent to more incremental modes of innovation. The research university occupies centre stage in the triple helix, acting as a powerful agent of regional economic growth by initiating multiple-partnerships for resource acquisition and deployment. The CIE fits with this business model in several respects. Specifically, the CIE evaluates potential clients, helps develop projects, lines up government funding for these projects, and then proceeds with an implementation plan. Central to the triple helix concept is the notion of an 'entrepreneurial university'. Put simply, this is an academic institution with a commitment to ensuring that its knowledge-base is used on a practical basis – especially in the local or home region (Clark 1998, Cooke 2002).

The appeal or utility of the triple helix is that all participants benefit. The university gains credibility, respect, recognition, consulting income, and/or opportunities to expose faculty or graduate students to 'innovation-oriented' projects. Government agencies benefit by demonstrating positive social benefits in terms of new jobs, retained jobs, or an expanded tax base (assuming that projects generate extra taxable income among client firms). Last, private firms benefit as a result of infusions of new expertise.

On this note, many research-based universities have technology transfer offices (TTOs) with mandates to commercialize academic work, generate external income, and shape internal research agendas with a view to tapping outside sources of funding (for an extensive review of the literature on TTOs, see Siegel, Waldman and Link, 2003). These TTOs typically work in areas that reflect the comparative advantage of specific institutions (e.g. bioinformatics at UB, or electronics at MIT). These are high-profile initiatives that capture media headlines, as well as Federal support dollars (e.g., National Institute of Health, National Science Foundation). It is possible that technology transfer via TTOs is an important factor in the positive relationship between industrial innovation and the various types of knowledge spillovers reported in the spatial-econometric literature (e.g. Anselin et al. 2000, Varga 1998). At the same time, however, Shapira (2001) reports that university-based extension services can also support industrial innovation, albeit at modest or incremental levels. Such initiatives would appear especially relevant to SMEs located in regions that contain weak stocks of advanced producer services. [i]

In the USA, university-based technical assistance programs have generally been structured along the lines of the agricultural extension model that first emerged in the 1950s (Shapira, Roessner and Barke 1995). The goal is rarely to bring leading-edge practices to potential clients. Rather, the primary objective is usually to establish good practice among firms that need to modernize their production procedures. According to Shapira (2001), the most common justification for public-private partnerships as an implementation strategy for technology policy pertains to efficiency. Indeed, the very existence of university-based extension services is often taken as evidence of market failure, in that few academic institutions would endorse the provision of business inputs that compete with private sector alternatives (Bozeman 2000). Unlike the EU, where universities are often encouraged to compete with the private sector for revenue generation purposes (Charles and Howells 1992), USA universities that offer industrial extension services typically operate on a non-profit basis (Ziolkowski 2004).

The emergence of a university-based industrial extension program in any given region is usually a good sign that private firms are under-investing in technology, worker training, or skills development. This under-investment often occurs because of high search and transaction costs (Shapira 2001), weak local supplies of advanced technical inputs (Britton, 2004), the inability or unwillingness of SMEs to import specialized technical help from other regions (MacPherson 1997), or the tendency of major producer service companies to cater to the needs of large firms rather than SMEs (Hjalmarsson and Johansson 2003).

In the case of Western New York, all of these conditions appear to prevail. Specifically, the region's industrial base consists mainly of SMEs that operate in mature sectors such as metalworking, food processing, or electro-mechanical equipment (Deitz and Garcia, 2001). Few of these firms appear to search beyond the Buffalo metropolitan area to secure specialized technical inputs (MacPherson 1997). Second, Western New York's location quotient for non-financial business services has been lower than unity for several decades, suggesting supply-side problems in terms of local input availability (Harrington and Lombard 1989, MacPherson 1997).[ii] Third, surveys of Western New York manufacturing firms have repeatedly found that local consulting companies are too specialized, too expensive, or too focused upon the needs of large clients to merit the initiation of business linkages by the area's SMEs (Chandra 1992, MacPherson 1997, Ziolkowski 2004). In short, Western New York is a service-poor environment as far as private technical inputs are concerned. Set against this backdrop, the emergence of a UB-sponsored industrial extension program would seem eminently justified (for a more thorough review of the rationale for public-private extension partnerships, see Shapira 2001).

On a more pragmatic note, university-based extension services are appropriate to Western New York for several reasons. To begin with, this region remains unusually dependent upon manufacturing jobs (13% of total employment, or $3.8 billion in regional income), and most of this employment (65%) is concentrated among SMEs that operate toward the tail end of the product life cycle.[iii] While CIE's ultimate goal is to create new jobs among local firms, a more realistic objective is to decelerate the region's rate of employment decay by maximizing job-retention among clients. Another justification for CIE's existence is that this organization is one of the region's few engineering-based centers that have been continuously listed as a technical asset by the Buffalo-Niagara Enterprise (a local agency that has been trying to market the Western New York area to corporate site-selectors for several years). Significantly, there are few private engineering consultancies on the Buffalo-Niagara Enterprise list, giving further evidence that Western New York does not possess a full range of industrial services in the private sector.

Recent data from the USA Census Bureau (2002 Metro Business Patterns) add empirical weight to the notion that the Buffalo-Niagara metropolitan region is poorly endowed with engineering services relative to other cities in the USA northeast (https://www.census.gov). In 2002, for example, the Buffalo-Niagara region contained a total of 147 engineering establishments under code 54133 of the North American Industrial Classification System (NAICS). These establishments employed 0.5 percent of the region's total workforce, compared to an average of 0.72 percent for the USA as whole. Other cities in the USA northeast exhibit much higher percentages (e.g. Boston = 0.99 percent with 1,626 establishments; Detroit = 1.25 percent with 1,220 establishments; Pittsburgh = 1.24 percent with 550 establishments). For NAICS 54133, the employment-based location quotient for the Buffalo-Niagara region is 0.62. Contrast this with Boston (1.37), Detroit (1.73), or Pittsburgh (1.72). These figures suggest that Western New York lags the nation in terms of engineering services.

To underscore this point at a broader level, table 1 shows that the Buffalo area also trails the USA across other service categories. These categories include management consulting (NAICS 551), as well as professional, scientific, and technical services (NAICS 541). Although NAICS 541 is a broad classification that includes engineering services, this category also contains other specializations such as industrial design, contract R&D, and laboratory testing. At this level of detail, however, employment and establishment counts from the USA County Business Patterns are rather patchy as a result of disclosure restrictions.

Table 1. A comparative snapshot of Buffalo's producer service endowment: 2002.

NAICS	Buffalo		Detroit		Boston		Pittsburgh		USA	
	% total	LQ	% total	LQ	% total	LQ	% total	LQ	% total	LQ
551 (management)	1.43	0.55	5.41	2.08	2.66	1.72	2.86	1.10	2.59	1.00
54133 (engineering)	0.50	0.62	1.25	1.73	0.99	1.37	1.24	1.73	0.72	1.00
541 (professional)	4.83	0.77	7.53	1.20	8.11	1.29	6.59	1.05	6.26	1.00

Notes: % total = sectoral employment as a percentage of total employment; LQ = employment-based location quotient.

Nevertheless, the general picture shown in table 1 would seem fairly clear. Specifically, the Buffalo area is weakly endowed with the types of advanced producer services that are increasingly thought to support industrial innovation and regional economic growth (Feldman and Florida 1994, Freel 2000, Freeman 1991).

A further justification for the existence of CIE is that this centre acts in an information brokerage capacity by connecting local firms with appropriate private consultants (thus reducing search costs among potential clients). Scholars with an interest in public technology policy have been advocating this type of function for several years (e.g. Britton 2004, Malecki 1994, Shapira and Youtie 1998), notably with regard to the correction of flawed information markets. With regard to this particular centre, then, there is no basis for complaint among regional service vendors in the private sector. No such complaints have been documented thus far, nor have any of the region's private vendors been upset to receive inquiries from local SMEs as a result of CIE referrals.[iv] In short, there is very little competition or overlap between CIE and the region's private producer service establishments. While CIE services are partly underwritten by direct or indirect subsidies (e.g. state grants, access to university computing equipment, state-financed graduate assistants), it should be emphasized that CIE services are not 'free'. As shall be shown later, clients typically invest substantial amounts of time and money to implement CIE-related projects. Few of these projects can be described as cutting-edge in terms of organizational or technological sophistication. Nevertheless, most projects are 'innovative' in that they represent knowledge transfers that are new to the recipient -- though not necessarily new to the industry or sector as a whole.

Finally, it should be mentioned that the CIE does not replicate the services of the Buffalo affiliate of the Manufacturing Extension Partnership (MEP) – although there is a moderate degree of overlap on the engineering side. The MEP is a Federally-funded industrial extension program that seeks to enhance the technological or commercial capabilities of USA manufacturing firms, with MEP offices being especially focused in regions that lack private or public sector alternatives. Unlike the CIE, however, the Buffalo MEP affiliate offers a diverse range of management and marketing services at Federally-subsidized prices. MEP affiliates can draw upon national networks of consultants across a wide range of technical and professional fields (Shapira, 2001). The CIE, in contrast, offers mainly shop-floor engineering services that mirror the instructional or research expertise of UB's School of Engineering and Applied Sciences. Although MEP and CIE look similar on paper, the key difference is that CIE is a State-supported centre that offers extension services based on specific strands of industrial know-how.

Structure and Organization of CIE

CIE is a program of UB's School of Engineering and Applied Sciences (https://www.tcie.buffalo.edu). Established in 1987, CIE's objectives are to: 1) assist local businesses in improving productivity; 2) broker appropriate relationships for clients utilizing community and UB resources, other educational institutions, private consultants, and industry practitioners; 3) motivate and help local industry develop human capital, utilize modern technology, improve business practices, and upgrade products, processes and facilities; and 4) mobilize and leverage government, private, public and academic resources to help manufacturers grow and improve.

Assistance can be provided in terms of operational, tactical, strategic and/or training assessments, process improvements, or applied R&D on behalf of the client. Each project is firm-specific, and thus a dedicated team of specialists is identified and assembled for individual ventures. This approach considers each client's particular training, quality, and/or cultural needs. Recommendations may include functionality in the areas of marketing, financing, and technical training, as well as in operations and systems. Project teams consist of faculty members and graduate students, along with CIE professional staff for project management.[v]

Clients are identified by word of mouth, past experience, and proactive outreach. Local economic development agencies direct firms to CIE if they feel it is appropriate. If such agencies feel that Buffalo's MEP affiliate is a more suitable choice, then referrals are diverted to the local MEP office. Many clients have engaged CIE in the past, or know of a company that did, and are utilizing CIE because of the reputation that this unit has accumulated over the years. Proactive business outreach is another way in which clients are identified, and sometimes this is achieved through cold calling. CIE has no real eligibility criteria for extension projects, nor does it target specific sectors or types of firms. Some typical projects include: implementing ISO 17025/QS9000 at an electrical calibration company; assisting a new product developer with marketing, finance, and operational strategy and tactics; and testing the airflow and cooling properties of a turbo intercooler for a local automotive parts supplier. After satisfactorily completing their projects with CIE, many clients return for assistance with new projects (i.e. repeat business is fairly common).

Project financing can be acquired entirely from the client or can be partially underwritten by outside sources. Where outside financial support is appropriate, CIE works on behalf of the client to identify and secure grants and loans to fund specific projects. CIE is one of the largest training grant administrators in the state, working to ensure a positive return on investment for state funds as well as screening vendors for quality.

Some of the sources of financial assistance that CIE works with include the State University of New York's Strategic Partnership for Industrial Resurgence, the New York State Environmental Investment Fund, Empire State Development Workforce Training Grants, Department of Labor Safety Training Grants, local foundations (when their defined mission lines up with a CIE project), the New York State Industrial Effectiveness Program, as well as county and local agencies (for an overview of these various funding programs, see Ziolkowski 2004). [vi] The project development process starts with a framework plan that is built by CIE in consultation with the client. The framework plan is then used to identify a funding structure to tap public grants or other sources of funds (e.g. government loans). CIE manages the grant writing process via internal grant writers.

The most common outcomes associated with CIE projects include process improvements, new product introductions, or both. For example, one of our survey respondents is a metal fabricator that recently used CIE to re-engineer an industrial process to recover scrap material. This process improvement has created cost savings of around $85,000 per year since 2001 on a line of business worth $3 million per annum. The estimated return on investment (ROI) on this project was 35 percent, resulting in the retention of 4 jobs. As a further example, a local manufacturer of medical equipment recently engaged CIE to help design an improved aspirator. In this case, the company did not have the in-house computing power to model the performance characteristics of the proposed product. This project actually created 4 new jobs. In general, however, the common denominator across our survey firms is that CIE projects typically deliver incremental product or process improvements rather than radical change. This, in essence, represents the fundamental distinction between technology transfer (a TTO function) and industrial extension (a CIE function).

Survey Methodology

The authors were first given access to CIE's client files in the summer of 2001. From these files, two databases were created. The first database consisted of general company information, including project descriptions and cost breakdowns by technical field (e.g. ISO certification, worker training, contract R&D). The second database came from a postal survey of CIE clients. These clients were surveyed in 2001, and again in 2004. The need to re-survey in 2004 was driven by the fact that not all projects identified in 2001 had been fully completed at the time of the first survey. The repeat survey was also deemed necessary to verify earlier ROI estimates.

A total of 48 companies were identified from the hardcopy CIE project files as being appropriate for the inquiry. These were companies that had completed CIE projects between 1998 and 2000 (i.e. recent clients). A 2-page survey instrument was mailed to these companies in the summer of 2001. Nineteen valid returns were received after two rounds of follow-up, giving a response rate of 39 percent. The total number of CIE clients for the study period (1998-2000) is unknown because CIE's files were incomplete during the implementation phase of the inquiry. There are, however, 343 projects listed as contracted in the main CIE database (giving an average of 22 projects per year since CIE first started operations in 1987).

The survey instrument asked for basic company information (employment size, sales volume, recent sales growth), as well as CIE-related project information with regard to ROI, job-creation/retention, time spent on the project, and project investment. The survey also requested information on project-related benefits such as new process development, product innovation, inventory effects, downtime reduction, materials wastage improvements, and quality changes. Before looking at the survey results, however, it should be emphasized that our sample may not be representative of the broader population of CIE clients. For example, the average CIE project investment for the 19 companies that responded was

$239,000, compared to only $11,000 among non-respondents. This difference is statistically significant at $p = < 0.05$ (t-test). It appears that we have captured a sub-group that has invested heavily in technical assistance -- at least in relative terms. It should also be noted that non-respondents were generally smaller than respondents, though this contrast was not found to be statistically significant. The mean employment count for non-respondents was 111, compared to 124 for respondents. [vii]

We are hard pressed to offer solid explanations for the dramatic contrast between respondents and non-respondents. It is conceivable that the latter were more willing to participate in the survey because they had invested heavily in their CIE projects (i.e. the survey had greater salience to this particular sub-group). Alternatively, it is possible that respondents (being generally larger than non-respondents) might have employed a broader base of management personnel with the time and/or inclination to participate in the study. Of the two possible explanations, we prefer the former because all 19 respondents wanted to see copies of the aggregate results. This implies survey salience. In sum, we suspect that respondents opted to participate because they were curious about the general 'experience profile' of other CIE users.

Survey Results

A snapshot of the main characteristics of the sample is shown in table 2. The sample consists mainly of SMEs that employ fewer than 150 workers. The sectors represented include automotive products (n = 5), industrial machinery (n = 4), electrical products (n = 3), metal fabricating (n = 3), medical instruments (n = 1), and food products (n = 3). Despite the small size of the sample, this is a representative array in terms of Western New York's current industrial base. CIE-related project expenditures ranged from a high of $400,000 to a low of $10,000. Expressed as a percentage of total sales, these expenditures ranged from a high of 1.9 percent to a low of 0.2 percent (mean = 1.2 percent). On average, projects took around 48 days to implement, though measurable project outcomes in many cases took much longer to emerge (in some cases more than one year).

Several clarifications regarding the project investment data shown in table 2 are warranted.

Table 2. General characteristics of the survey firms.

	mean	median	high	low
a. Employment size	124	100	400	8
b. Project investment	$239,000	$200,000	$450,000	$10,000
c. Project duration (days)	48	44	120	5
d. Investment-intensity	1.2%	0.8%	1.9%	0.2%

a = fulltime employment in 2001 (initial contact year for project evaluation)
b = total investment in the project (internal plus external funds)
c = number of days allocated to the project
d = project investment as a percentage of total sales

First, the investment estimates represent project expenditures by the firms themselves (CIE does not invest directly in projects).[viii] In some cases these investments are 100% internally funded by clients, though in most instances local or state grants are part of the picture. CIE typically earns between $50-75K in service fees per project (charged directly to the client). Over the space of a typical operating year, these fees amount to around $1 million in consulting-based revenues. For clients, a typical project might include spending on equipment, tools, materials, outside consultants, CIE services, and labour. We do not have precise data on the allocation of funds by spending category, nor do we have data on the distribution of investment sources (e.g. internal funds versus local or state grants). A second point worth flagging is that project investment estimates come from the survey firms themselves, and not from CIE. As a result, we have no easy way of verifying the accuracy of the investment estimates.

Keeping these caveats in mind, a Spearman's rank order correlation matrix for key variables is shown in table 3.

Table 3. Spearman correlations between selected variables.

	Size	Investment	Duration	ROI	Growth [1]	Jobs [2]
Size	1.00	0.241	0.218	0.136	0.212	0.132
Investment			0.452*	0.548**	0.939 **	0.378*
Duration				0.501**	0.616 **	0.412*
Growth						0.643**

[1] Average rates of post-project revenue growth (project related)
[2] Number of jobs retained as a result of the project

Rank-order tests were employed instead of Pearson's correlations because some firms supplied ranges for specific variables rather than ratio-level data (this was especially the case for ROI, which is notoriously hard to quantify in the absence of statistical process control). This said, positive and statistically significant relationships emerged between investment outlays and project duration, ROI, post-project sales growth, and project-related job-retention ($p = < 0.05$). Post-project sales growth was defined as additional sales that could be credited to CIE assistance (2000-2004), while ROI was defined as the difference between project costs and post-2000 revenue gains (expressed as a percentage rate of return). Notice that size of firm failed to correlate significantly with any of the variables listed in table 3. This is probably because there was relatively little variance in the distribution of firm sizes for this particular sample (i.e. few very small firms, and few large ones).

Of particular note is the fact that project investment correlates strongly with revenue growth ($r = 0.939$; $p = 0.004$). Revenue growth, in turn, correlates positively with job-retention ($r = 0.643$; $p = 0.007$). Both of these performance metrics correlate positively with project duration ($p = < 0.05$ in both cases). These are intuitively reasonable findings, all of which gel with earlier empirical findings from the USA (e.g. Feller et al. 2002, Shapira and Youtie 1998). The most obvious implication is that sales growth responds positively to investment in external help. Notwithstanding the fact that many respondents were unable to supply precise answers regarding project-related sales growth or ROI, the data are at least suggestive of a general connection between investment in outside technical know-how and positive outcomes.

The number of jobs that were retained by the project and the number of new products introduced as a result of CIE assistance was also found to be positively correlated ($r = 0.479$; $p = 0.038$). Most of the jobs retained were reported to be associated with product innovation. Job retention associated solely with process innovation ($n = 75$) was noticeably weaker than job retention associated with product innovation ($n = 150$). An average of 12 jobs was retained per project, with an average ROI of 6 percent from 2000 to 2004. ROI estimates spanned from a low of 1 percent to a high of 40 percent. Although these ROI estimates are questionable in light of measurement difficulties, it is worth stating that not one respondent indicated a negative or zero ROI effect.

Project Type and Firm Performance

Firms that used their CIE project to create new products experienced faster rates of post-project sales growth than firms that focused upon new process development (table 4).

Table 4. Main differences between product innovators and process innovators

Mean values	Size	Investment	Duration	Growth	Jobs
Product	148	$241,000	55	6.4%	13.8
Process	85	$125,000	24	1.2%	9.5
T-test p value	0.001	0.004	0.024	0.002	0.04

For example, firms that introduced new products (n = 11) as a result of their CIE project averaged sales growth rates of 6.4 percent per annum for the business unit the project encompassed. In contrast, firms that used their CIE project for process improvements (n = 8) grew at an average of 1.2 percent. These differences are statistically significant at $p = < 0.05$ (t-test), and mesh closely with some of the earlier findings reported by Shapira and Youtie (1998).

This said, it cannot be stated with certainty that a focus on product development will *necessarily* deliver better commercial results than a focus upon process development. After all, the two phenomena are likely to be mutually interdependent at a variety of levels. For example, the introduction of new manufacturing procedures could open up new opportunities for innovative product development. New product development, in turn, might spur a need to invest in new processes. Clearly, a longitudinal study is required in order to capture potentially dynamic interrelationships between these two types of innovation.

For now, however, it is clear that we have two distinct groups of firms. The process innovators appear to focus upon engineering or training upgrades to reduce unit costs and/or achieve ISO certification.[ix] In these cases, CIE projects do not translate into rapid sales growth. Instead, these projects deliver benefits such as reduced materials wastage, lower defect rates, faster production speeds, improved accuracy in machining, or better inventory management. Not surprisingly, these benefits by themselves do not directly spur sales (at least not immediately). The product innovators, in contrast, experienced faster rates of sales growth simply because they introduced new items to the marketplace. Thus, the fact that product innovators grew faster than process innovators is not surprising. The data also show that product innovators tend to be larger than process innovators ($p = 0.001$). The latter typically spend less on external assistance ($p = 0.004$), and their projects generally yield both weaker revenue growth ($p = 0.002$) *and* weaker job-retention ($p = 0.006$).

Even so, there is little doubt that firms that used CIE services to support process development have benefited from their projects. In particular, Spearman's correlations revealed a significant relationship between project ROI and the estimated savings with regard to reduced materials wastage ($r = 0.662$; $p = 0.002$). Efficiencies in process development have led to cost savings in other areas too. For example, a positive and statistically significant correlation was found between the number of new production processes introduced by the project and estimates of subsequent inventory savings ($r = 0.480$; $p = 0.037$).

Regional Economic Effects

CIE services help to retain local industrial jobs by supporting incremental innovation at either the product or process level. Given that close to 80 percent of the sales of the survey firms come from outside Western New York, innovation-support services help the region to capture revenue from non-local sources. This is important because there is a strong relationship between export expansion and regional economic growth for the Western New York area (for a discussion of this relationship see Will and MacPherson 2001).[x] Aside from income effects, CIE-related activities include other impact classes that ought to be mentioned. For example, the fact that graduate students are always members of CIE project teams implies that young people are being exposed to practical experience at the project level (i.e. human capital development). By word of mouth, moreover, the benefits associated with CIE projects are often communicated to the business community by former or current CIE clients. Evidence presented elsewhere (Ziolkowski 2004) suggests that the various best-practice solutions that emerge from CIE projects are frequently copied by non-clients as a result of informal spillovers (e.g. clients tell suppliers about new procedures). From an economic perspective, however, perhaps the main benefit that flows from CIE programs is that mature industrial firms can remain competitive on the basis of relatively modest investments in best-practice methods.

From an employment standpoint, only 2 of the 19 survey firms reported that their CIE project had resulted in job-creation (a grand total of 14 new jobs overall). On the face of it, this looks like a dismal record. On the other hand, it should be kept in mind that job-creation within the manufacturing sector has not been a realistic goal among local economic development agencies for many years (Deitz and Garcia, 2001). Instead, the goal has been job preservation and/or output expansion. In order to survive, some firms have been investing in advanced process automation to maintain or increase total output while simultaneously cutting jobs. This is surely better than exiting the market altogether, killing all plant-level jobs, and severing local supply linkages. Market exit is the worst possible scenario for Western New York, as close to 50 percent of the material and service inputs purchased by the survey firms come from inside the local region. In short, the best metric of CIE impact is possibly firm *survival* rather than employment stability or growth.

It is worth noting that CIE projects delivered an average of 12 retained jobs per firm over the study period, and that the average wage of a retained job was around $46 thousand. The product innovators retained a total of 152 jobs (an average of 13.8 jobs per firm), whereas the process innovators retained a total of 76 jobs (an average of 9.5 jobs per firm). Spread over the 19 survey firms as a group, this translates into almost $10.5 million in annual income earned by retained workers. While it is not feasible to accurately estimate the total job-retention record of CIE over its 18 year lifespan, a record of 200-300 jobs per year would not be unrealistic. For an engineering outreach centre that is supported by less than $200 thousand per year via UB funding, benefits to the local community would seem to outweigh the costs. Recall also that CIE earns around $1 million per year in client fees, and that CIE is a non-profit organisation. Client fees are used to defray operating costs and pay university overhead. Some of the overhead paid to UB eventually comes back to specific Departments or research units, giving a basis for financially sustainable outreach activity.

Obstacles to University-Based Industrial Extension Initiatives

Despite some of the positive findings documented above, personal interviews with CIE staff and faculty revealed that there are serious obstacles to the efficient delivery of university-based industrial extension services. Some of these obstacles are generic to most USA universities, whereas others may be specific to UB. On the generic side, it is difficult to motivate younger faculty members when it comes to extension initiatives. These initiatives generate consulting income, but participation in such ventures rarely counts in terms of the tenure or promotion process (grants and journal publications are more important).[xi] This means, in effect, that many of the brightest and most innovative faculty members never get involved in the service delivery process. A potential solution that is currently being explored by UB administrators is to reward younger faculty members for participation in such initiatives. Although the nature of these rewards has yet to be determined, Tornatzky, Waugman and Gray (2002) note that Ohio State University's Office of Academic Affairs has recently accepted new promotion and tenure guidelines that recognize entrepreneurial and economic development activities in the faculty review process. If public universities continue to emphasize 'outreach and engagement' activity at the local level, then it would seem prudent to compensate faculty members that support these types of missions. Other universities have at least partially resolved this problem by engaging professional staff to work 'routine' or 'incremental' improvement projects with SMEs (for specific examples, see Tornatzky et al. 2002). This reduces the burden on faculty members (both young and old), and helps add an element of stability and/or credibility to the outreach effort.

A second generic problem is that university-based centres such as CIE typically operate in uncertain financial environments, leading to high levels of staff turnover between funding cycles (i.e. staff members often leave for more 'permanent' jobs).[xii] CIE has certainly been affected by this problem. Instead of reviewing such centres on an annual basis, as is often the case, guaranteed funding for historically cost-effective units should perhaps be extended over longer time horizons (e.g. 5 years). This is important because cost-effective units can in some cases exit the outreach business as a result of personnel changes within the university administration. Sunset clauses based upon reasonable non-performance criteria might reduce the staff turnover problems associated with outreach centres that actually deliver net benefits on a consistent basis.

Some of the difficulties that are more specific to UB and CIE are worth noting, if only because they might have implications for similar types of units across the USA and elsewhere. First, CIE is a relatively low-visibility consulting unit. Previous firm-level surveys conducted in the Western New York area have shown that rather few industrial firms even know that CIE exists. Clearly, marketing efforts are required to inform potential clients that Western New York actually does have public technical resources that can be used effectively by the private sector. A further problem facing CIE is that there has been no attempt to target clients by location, sector, or size-class. Mature industrial SMEs are heavily represented in the CIE's client files. Relatively few service organisations can be found in these files, even though there is growing evidence that service-based establishments could also benefit from extension initiatives (for recent examples, see Ziolkowski 2004). On a related note, the geography of CIE-linkages is mainly restricted to Western New York. This is strange, as the potential market is much broader. For instance, the service orbit could extend westward to Erie, PA, or eastward toward Syracuse, NY. Additionally, it is unfortunate the CIE does not have a monitoring or tracking system in place to evaluate the effectiveness of its programs over time. A firm-level tracking system by project might help to identify strengths and weaknesses that could be addressed in terms of strategic planning needs and priorities. Tornatzky et al. (2002) note that Pennsylvania State University's industrial extension projects are monitored, tracked, and statistically profiled in terms of outcomes. Perhaps this is something that all university-based extension programs should do.

Summary and Conclusions

While our data suggest a positive role for industrial extension services in incremental innovation at the local or regional level, it would be inappropriate to conclude without saying something about the limitations of our analysis. Aside from the inherent problems that flow from our small sample size and our cross-sectional approach, company managers are seldom in a position to quantify accurately the benefits of any project in terms of commercial outcomes such as sales growth, ROI, or other effects (positive or negative). In the absence of statistical process control systems at the firm level, this simply cannot be done. We fully accept this criticism, and concede that our data are impressionistic rather than precise. As a partial corrective to this deficiency, the authors intend to launch a tracking study of the 19 CIE clients to monitor the dynamics of specific project outcomes over the next 5 years. In the case of a local auto-parts manufacturer, for example, a TQM programs that was implemented 3 years ago is only now starting to deliver tangible benefits. Clearly, a time-series approach is warranted if we are to obtain a sharper understanding of the dynamic effects of university-based industrial outreach initiatives. An additional limitation is that our survey did not include a control group to test for performance differences between CIE-users versus non-users. This is something that might be considered in future work of this type.

Despite these deficiencies, there is a positive and statistically significant relationship between CIE project investment and post-project revenue growth among clients. Among firms with only small project investments, however, post-project benefits have been realized in terms of profitability. Profit improvements have most notably stemmed from reduced materials wastage, lower defect rates, ISO certification, and TQM (which creates new operational efficiencies across multiple segments of the production and marketing effort). Thus, it is not just the product innovators that profit from investments in CIE projects. If firms can reduce defect rates, for example, then profits are like to increase as a result of expanded sales.

For economically challenged regions such as Western New York, the empirical results suggest that university-based extension services can help retain local industrial jobs, promote best practice manufacturing procedures, encourage product improvement, and/or elevate the credibility of local business establishments via ISO certification or TQM implementation. These university-industry linkages need not be technologically cutting-edge in terms of sophistication. They just need to be good. Further, the fact that a relatively small university like UB can deliver such services suggests that other small universities in economically stagnant regions might want to consider similar initiatives. At the lowest impact level conceivable, the region benefits while the university loses nothing.

Unlike university-based technology transfer programs, industrial extension initiatives do not purport to radically transform clients in terms of either products or processes. Instead, the intent is more typically to introduce best-practice to support incremental styles of modernization. In a similar vein, the ultimate economic goal is usually to retain jobs rather than create new ones (though job-creation is always welcome). The fact that CIE still exists after 18 years of operation can partially be attributed to its modest objectives. If the Centre's original mission statement had included terms such as 'technological innovation' or 'radical change', then we suspect that CIE would have been terminated many years ago. While we are not in a position to run any type of cost-benefit analysis regarding CIE, the fact that CIE is still here in an environment of harsh cost-cutting by the State of New York suggests that this particular extension unit must be faring reasonably well.

There is an element of triple helix philosophy behind the CIE's operations, if only because this centre attempts to engage and integrate networks of partners for project development. Specifically, the CIE acts as the primary UB unit for moving engineering expertise from the university to private firms; the CIE is the main university player in terms of securing State or Federal dollars to support engineering-related projects; the CIE brokers information to private and/or public consulting units (when appropriate); and the CIE delivers business advice on a continuous basis to SMEs that need immediate help regarding practical issues (e.g. ISO certification, TQM recognition). This is not the triple helix of radical innovation. Instead, it is the triple helix of incremental improvement.

Finally, it would seem that some of the empirical findings have practical implications for policy design at the university level. For a start, efforts to enhance the visibility of industrial extension units such as CIE ought to be considered. A relatively easy and low-cost solution might be to directly send the CIE's web-based electronic newsletter to all of the region's industrial firms on a quarterly basis. At present, this newsletter can be accessed from CIE's website. Firms that do not visit the website cannot read the newsletter. The CIE newsletter typically contains recent client testimonials, as well as updates regarding new or modified programs. A second and related initiative might be to run periodic informational seminars to educate local firms regarding the availability of particular types of services, funding options, and typical project outcomes. Recall that some types of services are eligible for substantial public funding. We wonder just how many firms in the Western New York area are aware of this. A third and perhaps more important initiative might be to broaden the target range both geographically and sectorally. For example, firms in the service sector should be made aware that TQM programs and related forms of technical training are not solely designed for the benefit of the manufacturing community. Efforts to connect with service-based establishments would seem appropriate. After all, the service sector represents the largest component of the urban economic base for virtually all USA cities -- even Buffalo. A final possibility might be to compensate faculty for project involvement by explicitly recognizing extension work as a criterion for promotion and tenure. Although several USA universities are moving in this direction, including UB, the glacial pace of this movement is astonishing in light of the growing expectation among university administrators that technical outreach activities be sustained or expanded with a view to serving local or regional economic interests.

End Notes

[i] CIE is not a TTO. The TTO for UB is the Office of Science, Technology Transfer and Economic Outreach.

[ii] Aside from financial services (banking and insurance), the Buffalo/Niagara region has a lower 2001 location quotient for business services (0.81) than any other metropolitan region in the USA northeast (mean = 1.16).

[iii] Industrial jobs account for less than 10% of total employment across most USA metropolitan areas. In Western New York, however, 13% of total employment is factory-based. This 13% earns roughly 22% of the region's total income.

[iv] These referrals are typically to non-engineering consultancies in spheres such as marketing, management, information technology, or finance/accounting.

[v] CIE has 7.75 professional and support staff measured on an FTE basis.

[vi] In 2004, CIE won the University Economic Development Association (UEDA) 'Project of the Year' award for excellence in extension services. UEDA is a national organization that annually ranks the effectiveness of

various types of university-based economic development efforts. The award was given on the basis of CIE's worker training programs and TQM initiatives.

[vii] The CIE estimates that clients typically invest between $12-18 thousand in their projects. Our survey has captured firms that spend at the higher end of the investment scale.

[viii] The term 'CIE project investment' refers to the total amount of dollars spent by clients on projects that were supported by CIE consulting services. In all cases, CIE developed the framework plan for project implementation.

[ix] ISO certification is in many cases sought to satisfy customer stipulations rather than to introduce dramatically improved manufacturing procedures. Several firms noted that ISO compliance was good for customer relations, but that process improvements were actually quite minimal.

[x] Export-base models calibrated over the period 1980-2001 (quarterly data) suggest that a 1% increase in regional exports delivers a 0.76% increase in gross regional income. Few other USA metropolitan regions exhibit such a high export elasticity of income (notable exceptions include Seattle [aircraft exports], San Francisco [electronics and media], and New York City [financial, business, and media services]).

[xi] For an exploratory assessment of these issues in the context of TTOs, see Siegel et.al. 2003.

[xii] University-based centers often lose key staff members because central or base-funding is allocated on an annual basis, leading to fears about job-security and/or rewards (e.g. salary growth).

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