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Innovation linkages in new and old economy sectors in Cambridge-Guelph-Kitchener-Waterloo (Ontario)

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Abstract

The region around Canada's Technology Triangle (CTT) – including the cities of Cambridge, Guelph, Kitchener and Waterloo – is often portrayed as a Canadian economic success story due to its transformation from a regional economy dominated by traditional manufacturing to one driven by knowledge-based, information technology (IT) firms. The region is thus sometimes held up as a model for other Canadian city-regions to emulate. Explanations for the regional success focus on the role played by high-technology firms related to the local universities, which provide research and human capital, and help drive spin-off and start-up processes, leading to knowledge spillovers in the region. In this chapter, we examine the degree to which both IT spin-offs/start-ups and traditional manufacturing firms have established regional innovation networks and trans-regional knowledge pipelines. Our analysis also investigates whether innovation networks have formed across the two segments of firms. Our results indicate that the region strongly benefits from a distinct entrepreneurial culture and international linkages in production and innovation, while regional networks or cross-sectoral relationships are weakly developed.

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Innovation Linkages in New and Old Economy Sectors in Cambridge-Guelph-Kitchener-Waterloo (Ontario)

1 Introduction

It is now widely accepted that knowledge and innovation are key resources for regional economic success (Lundvall and Johnson 1994), and that learning is the decisive process that stimulates knowledge creation and innovation (Lundvall 1988; Malecki 1991). Further, regional well-being depends on the capacity to stimulate processes of interactive learning, networking and innovation at the local level (Cooke and Morgan 1998; Gertler 2004). In this context, the region around the mid-sized Ontario cities of Cambridge, Guelph, Kitchener and Waterloo is regarded as one of the model economies for Canada – a claim based primarily on the region's success at innovating and transitioning from a traditional manufacturing economy to one that increasingly includes high-technology firms in the information technology (IT) sector. A myth of regional reconfiguration driven by spillovers from university-related start-ups and spin-offs into the traditional manufacturing sector has developed to explain this reconfiguration. One hypothesis that could be derived in this context is that innovation around technology-based university start-up firms in the region has not only benefited the growth of the IT sector, but also spilled over to the traditional manufacturing sector via material linkages, knowledge flows and innovation networks.

This paper investigates a number of interrelated questions regarding innovation practices and the social foundations of innovation in the region around Cambridge, Guelph, Kitchener and Waterloo, as laid out in the framework of Wolfe (2009). It does this by, first, investigating the contribution of university-related IT spin-offs/start-ups to innovation and technology clustering. Second, the nature of innovation processes in the traditional manufacturing sector is analyzed. Third, this research investigates whether there are cross-sectoral linkages that drive regional innovation processes, particularly between IT-based university start-ups and traditional manufacturing firms. As pointed out in the literature, firms that are connected through regional producer-user relationships can stimulate regional economic growth and competitiveness (Etzkowitz *et al.* 2000; Vohora *et al.* 2004). This has, for instance, been shown in the seminal works of Roberts (1968) and Cooper (1971), who studied technology-related spin-off phenomena along Boston's Route 128 and in Silicon Valley, respectively. While Route 128 and Silicon Valley have established themselves as the prototypes of advanced high-technology/IT regions (Saxenian 1985; de Jong 1987), relatively few other examples exist of regions that might have benefited from equally strong local university spin-off activities and related innovation processes.

The Kitchener and Guelph metropolitan areas, located about 100 km west of Toronto, around which the initiative "Canada's Technology Triangle" (CTT) was founded in the late 1980s, have received a lot of attention by policy makers because of their success in shifting the economic focus from traditional manufacturing to new IT-related businesses and, as a result, maintaining high regional growth. The regional economies have achieved above-average performance levels, according to indicators such as job growth, unemployment rate, or average household income. Between 2001 and 2006, the Kitchener census metropolitan area (CMA) and the Guelph census agglomeration (CA) experienced an increase in population and jobs that was significantly higher than the national and provincial growth rates and similar to those in the Toronto CMA (Bathelt *et al.* 2010; 2011). This supports the view that the region benefited from university spin-offs and related innovation processes. Numerous IT firms, such as Open Text and Research in Motion – the maker of the now famous Blackberry device – have successfully spun off from researchers and students at the University of Waterloo, establishing a growing high-technology sector in the region (Bathelt and Hecht 1990; Bramwell and Wolfe 2008) with high growth potential (BMO Capital Markets 2008; Florida and Martin 2009).

In the media hype around the supposedly "post-industrial" future of the Waterloo region (Perry 2009), it is often forgotten that the region has a strong, established manufacturing tradition (English and McLaughlin 1983; Holmes *et al.* 2005; Rutherford and Holmes 2008; Vinodrai 2011). Both academic and policy analyses on innovation, however, tend to focus on its "elite" forms related to high-technology growth and ignore the often informal innovation that happens in traditional manufacturing firms (Rutherford and Holmes 2007). Upon closer analysis, we can see that 44,100 of 76,700 manufacturing employees (57%) and 1,048 of 2,164 establishments (48%) in the region fall within traditional manufacturing in the plastics and rubber, metal-fabricating and processing, machinery, electrical equipment and automobile supplier industries in 2008 (Table 1). In the Kitchener CMA, the manufacturing sector had a share of 20.3% of the total labour force in 2007, which was nearly twice as high as the Canadian average (Figure 1). As such, this sector's contribution, despite a substantial decline in the past decade, cannot be neglected in the economic success story of the region.

Table 1: *Number of Firms and Employees in the Kitchener Census Metropolitan Area (CMA) and Guelph Census Agglomeration (CA) by Industrial Sector, 2008 (Source: Statistics Canada 2008)*

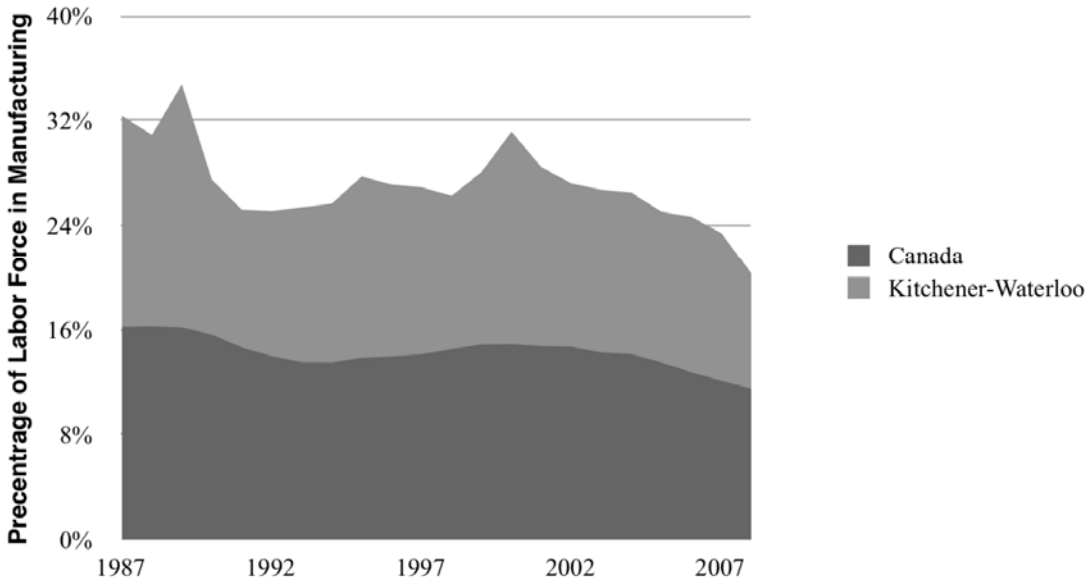
Industrial Sector by NAICS Code	Kitchener CMA		Guelph CA	
	Number of Firms	Number of Employees	Number of Firms	Number of Employees
311 - Food Manufacturing	96	7392	32	1308
312 - Beverage and Tobacco Product Manufacturing	13	131	6	408
313 - Textile Mills	17	278	1	3
314 - Textile Product Mills	31	1004	3	21
315 - Clothing Manufacturing	34	668	8	376
316 - Leather and Allied Product Manufacturing	11	64	3	17
321 - Wood Product Manufacturing	79	1158	19	191
322 - Paper Manufacturing	13	1221	13	795
323 - Printing and Related Support Activities	104	1069	30	267
324 - Petroleum and Coal Product Manufacturing	7	171	2	2.5
325 - Chemical Manufacturing	53	1482	24	731
327 - Non-Metallic Mineral Product Manufacturing	49	2091	11	560
331 - Primary Metal Manufacturing	23	1111	3	69
334 - Computer and Electronic Product Manufacturing	87	4837	11	296
337 - Furniture and Related Product Manufacturing	114	2836	21	136
339 - Miscellaneous Manufacturing	165	1929	32	163
326 - Plastics and Rubber Products Manufacturing	*93*	*5347*	*24*	*709*
332 - Fabricated Metal Product Manufacturing	*329*	*8654*	*96*	*3004*
333 - Machinery Manufacturing	*272*	*7671*	*52*	*2882*
335 - Electrical Equipment, Appliance and Component Manufacturing	*56*	*2255*	*11*	*967*
336 - Transportation Equipment Manufacturing	*75*	*7446*	*40*	*5199*
Total	1721	58816	442	18106
Selected Traditional Manufacturing Industries Total	*825*	*31373*	*223*	*12761*

Notes: Selected traditional manufacturing industries in italics

To explain this development, it is important to understand the social foundations – in the sense of inter-firm linkages – of regional innovation in both new and old economy sectors in the region, as well as to investigate the potential relationships between both. This was done in our study by analyzing, first, the vertical and horizontal networks underlying innovation and, second, the institutional support for such activities. Our research in the region around Cambridge, Guelph, Kitchener and Waterloo was conducted in two phases. In the first phase, we examined the role that university-related spin-offs and start-ups in the ICT sector played in guiding technological change at the regional level, and investigated the resulting innovation linkages. In the

second phase, we similarly analyzed the innovation processes and linkages in the traditional manufacturing sector in the region. Throughout both phases we explored the social foundations of innovation and how networks of relationships, such as supplier-customer networks, university-industry collaboration, cooperation with industry associations and cross-sectoral linkages, influenced further innovation and growth in the region.

Figure 1: *Percentage of the Canadian and Kitchener CMA Labour Force in Manufacturing Sectors, 1987 - 2007 (Source: Statistics Canada 2010)*



The argument developed in this paper is structured as follows: In section 2, we present the regional context of CTT. Then, the conceptual framework (section 3) and methodology of the study (section 4) are briefly discussed. The empirical part analyzes the nature of innovation linkages of both university-related IT spin-offs/start-ups (section 5) and traditional manufacturing firms (section 6), before a summary is provided and policy conclusions are drawn (section 7).

2 Regional Context of CTT

Regional modernization and success in innovation are sometimes connected to the presence of leading universities and research facilities. In the social science literature, the advantages knowledge-based, technology-intensive firms can accrue from being in close proximity to a university have been widely recognized. Explanations often point out that high-technology ventures derive benefits from localized knowledge spillovers emanating from the two common tasks performed by universities, i.e. to conduct basic research and to create human capital (Audretsch *et al.* 2005). While these knowledge inputs are appealing to firms due to their "public-good" character, access to these inputs appears to depend on the spatial proximity to a particular university institute.

It was not until the late 1960s, when new industries such as computer technology, microprocessors and semiconductors emerged, that scholars began scrutinizing the technology transfer mechanisms that led to the direct commercialization of university research, and resulted in firm formation and subsequent regional economic growth (Landström 2005). Above all, it was the institutional and structural changes that began in the

1980s, such as the passage of the Bayh-Dole Act in the United States, and increased labour mobility – in particular of highly-skilled individuals – along with a shift to more flexible modes of production and venture capital financing, which triggered research efforts concerning university entrepreneurship and technology-based growth (Rothaermel *et al.* 2007). Since a shift from a closed to a more open innovation system (Chesbrough 2003) has become visible, university spin-off firms are acknowledged in the literature as one of the key drivers of economic change and growth (Bercovitz and Feldman 2006). Today, most advanced national economies strive to generate economic wealth by exploiting and diffusing public research by means of university spin-offs (Clarysse *et al.* 2005). In many cases, however, such endeavours have had limited success (Callan 2001). Although local universities – especially the University of Waterloo – played an important role in the modernization of CTT, the strong economic performance in the region's traditional manufacturing industries dates back further and was unrelated to university research.

The Kitchener and Guelph metropolitan areas were traditionally – and still are – characterized by a strong diversified manufacturing base. In the first half of the 20th century, the region had well-developed economic strengths in the rubber, textile, leather, furniture and food processing industries. Despite the differentiated industry structure, however, regional supplier linkages never seemed to be very strong. While the rubber industry was, for instance, originally established as a supplier sector to the shoe industry, when Schlee and Kaufmann founded the Berlin Rubber Company in 1899, it later shifted toward other customer groups, especially toward the production of tires (English and McLaughlin 1983). In the post-World War II period, manufacturing growth was driven by industries, such as fabricated metals, machinery and electrical products. Furthermore, the region developed a strong basis in the automobile supplier and transportation equipment sector (Rutherford and Holmes 2008).

Since the 1970s, numerous university spin-offs were started up in the region. This was related to the foundation of the University of Waterloo in 1959 as a university with an engineering focus, allowing members of the university to own patents from university research. Industrial leaders, such as Ira Needles from the rubber producer BF Goodrich, played an important role in the design of the university. They shaped the university's co-operative education program and its openness toward private sector collaboration (Bathelt 1991a; Wahl 2007; Bramwell and Wolfe 2008). Compared to other Canadian universities in the post-World War II period, the University of Waterloo not only had a more pronounced focus on establishing university-industry linkages, but also developed a stronger focus on basic and applied research. According to data presented by Niosi (2000), the University of Waterloo was Canada's largest research university in the late 1960s with 533 researchers, representing about one quarter of all researchers at Canadian universities. At that time, the University of Waterloo became an important driver of a more research-oriented, rather than a resource-led national production and innovation system. The university's initial advantage, however, decreased over time. Already in the 1990s, observers began speculating that the overall key to economic growth and success in the region was primarily due to the co-op program and a constant flow of highly qualified graduates, who found a job in the region's growing technology sectors, rather than a consequence of university research and spin-off processes (Bathelt 1991a).

Aside from start-ups around the University of Waterloo, the region also attracted a number of multinational IT firms, such as Google, Hewlett-Packard, Microsoft and NCR, which established branches or acquired existing technology firms. Although 87% of the firms surveyed in information and communication technologies in a Communitech (2006) report had in-house R&D, most of this seemed focused on incremental development tasks rather than basic or applied research. In addition, local technology firms seemingly had not developed extensive input-output linkages in the regional economy (Bathelt 1991a; Xu 2003; Bramwell *et al.* 2008).

In recent years, the regional economy continued to transform its manufacturing base, while remaining strongly diversified. Traditional manufacturing sectors such as textile mills, clothing and leather manufacturing lost

between 50% and 60% of their employees in the Kitchener CMA between 2001 and 2006; and chemical and electrical equipment manufacturing lost another 20% of their employees. This structural change was over-compensated by a 20% increase of the employment in plastics/rubber product and computer/electronic product manufacturing. Furthermore, most knowledge-based producer-related services experienced substantial job growth. In the areas of professional, scientific, technical and educational services, for instance, total employment increased from about 40,000 to 47,500 from 2001 to 2006. The most spectacular job growth in the Kitchener CMA in this time period occurred in the scientific research and development services branch. Here, the number of employees increased by almost 300% from 400 to about 1,550 (Statistics Canada 2001; 2006a; 2006b).

Upon closer investigation, our understanding of the successes in regional economic development and innovation still appears limited. CTT does not form a true regional industry cluster of closely interrelated firms of a particular value chain (Bathelt 1991b). What we find instead is a highly heterogeneous and segmented regional economy characterized by limited commonalities. The region hosts a variety of larger and smaller establishments, old and young firms, and businesses with diverse manufacturing and service backgrounds. There is no simple explanation for the overall success of these different economic segments, as our study of the nature of innovation practices and the social foundations of innovation clearly shows.

3 Conceptual Framework

In this section, we outline our conceptual framework by focusing on the conditions for regional clustering and innovation. As the region under investigation cannot be described as a fully developed industry cluster, we focus on the nature of linkages and knowledge flows that could support further agglomeration and innovation in the future.

In the knowledge-based economy, creating and sharing knowledge has become key to encouraging economic growth and innovation (Lundvall and Johnson 1994). Much of the literature on regional innovation and clustering has pointed out that firms, which establish linkages to other regional firms in the same or a similar value chain, have enhanced opportunities for interactive learning (Cooke and Morgan 1998; Morgan 2004), thus stimulating regional innovation processes (Lundvall 1988). Based on observations concerning the tendency of firms in complementary industries – defined by value–chain-related linkages – to form agglomerations (Porter 1990; 2000), cluster theory has developed as a network approach that examines material linkages and knowledge flows between these firms (Pinch *et al.* 2003; Visser and Atzema 2008). In such settings, the co-location of firms provides numerous opportunities for inter-firm linkages (Storper and Walker 1989; Gordon and McCann 2000; Preissl and Solimene 2003). It supports frequent face-to-face communication, which enhances opportunities to resolve conflicts and exchange complex information more easily. Close geographic proximity does not, however, automatically ensure that firms engage in such exchanges (Amin and Cohendet 1999); yet, it can operate as a catalyst for channelling different corporate knowledge bases and organizational cultures, thereby increasing the potential to develop common understandings and interpretative schemes (Bathelt *et al.* 2004). Such a configuration may, in fact, be quite supportive to regional innovation.

Clusters can be distinguished on several key dimensions: The vertical dimension typically consists of specialized suppliers and service providers that generate a division of labour, allowing each firm to focus on their core area of expertise (Malmberg and Maskell 2002). This reduces transaction costs, provides incentives for new firms to locate in the cluster and, thereby, stimulates the development of a specialized labour market (Scott 2006). The horizontal dimension consists of the firms that compete with each other in the same or related market segments, possibly establishing a precondition for vertical growth (Porter 1990; Maskell and Lorenzen 2004). These firms may not collaborate in joint research projects but they have opportunities to

closely monitor their rivals who develop similar products under similar conditions. This increases opportunities for mimicry and signals the need to differentiate products, all of which contributing to innovation.

Other organizations are also connected to an industry agglomeration and can provide significant input to the firms, such as universities, government agencies, standards councils and trade agencies (Parker 2001; Wolfe and Gertler 2004). Following Setterfield (1993), they establish the formal basis for institutions, in the sense of correlated behaviour of agents. The institutional dimension frames economic interaction, allowing specialized users and producers to discuss and solve particular problems, and to develop reasonable expectations regarding each other's actions (Hodgson 1988; MacKinnon *et al.* 2009). While we have already emphasized that the CTT economy cannot be conceptualized as a coherent industry cluster, extended practices of vertical and/or horizontal cooperation and knowledge exchange are nonetheless important for innovation and economic growth.

Many studies have argued that broad regional growth and innovation effects are more likely to occur if the regional economy draws from technological complementarities and related overlapping knowledge bases that enable firms to establish vertical networks and engage in knowledge exchange, even across industrial sectors – as the related-variety argument suggests (Frenken and Boschma 2007). A corresponding regional ensemble of firms may take the form of a regional thickening of a particular value chain or of a full-fledged industry cluster with a well-developed supplier and institutional infrastructure (Porter 1990; Malmberg and Maskell 2002). In the case of a cluster, regional networks can develop and dynamic local knowledge flows, or "buzz", can unfold and drive innovation (Storper and Venables 2004; Bathelt *et al.* 2004). If local firms are not closely related to one another in terms of their utilized technology and knowledge base, possibilities for local networking and related growth triggers likely remain limited (Nooteboom 2000). In this case, growth has more likely few collective qualities but is a result of individual firm successes that rely on bonds with partners outside the regional or even national economy. Strong connections to global value chains and access to external markets and technology partners are then likely key in generating growth impulses, and support processes of innovation in the regional context (Oinas and Malecki 1999; Owen-Smith and Powell 2004; Bathelt *et al.* 2004).

In sum, an ideal-type distinction of industrial agglomerations leads to different scenarios of regional and cross-regional networking in innovation. It is in this context that we designed a qualitative empirical study of the innovation networks and practices in CTT to identify the nature of linkages therein.

4 Methodology

In the first phase in 2007/08, we conducted semi-structured interviews with 18 IT start-up/spin-off firms from the University of Waterloo.[1] In the second phase in 2008/09, another 40 firms in traditional manufacturing industries were interviewed.[2] Additionally, we conducted 8 interviews with university technology transfer officers, economic developers of the cities and leading representatives of business organizations. The latter interviews were conducted for the purpose of triangulation and getting an overview of the overall start-up policies and innovation dynamics in the region (Bathelt *et al.* 2011). The interviews took on average about one hour and were recorded on tape. Some of the analysis was done, using the qualitative research software NVivo.

[1]./ The total number of IT start-ups/spin-offs identified in the region was 42 (Bathelt *et al.* 2010). Of these, 32 firms were contacted resulting in 14 rejections (44%) and 18 interviews.

[2]./ Of a total of 642 traditional manufacturers identified in the selected industries (see Table 1), 310 were contacted and asked to participate in our study. Of these, 270 rejected and only 40 agreed to a personal interview. The unusually high rejection rate of 87% is indicative of the difficulties we encountered in engaging firms in this research in the midst of a severe economic-financial crisis.

Through our interviews, we investigated the way in which firms established regional networks in innovation, to which degree they developed and depended upon global linkages, or pipelines, and whether this dynamic produced spillovers to other regional industries, due to practices such as inter-sectoral networking, technology transfer and job hopping. We primarily talked to the founders, executives or chief operational managers. Our questions focused on three main areas of interest: First, we asked with what goals and incentives and under which conditions the firms were started up in the region. The second set of questions was concerned with material linkages and knowledge flows related to innovation, within the region or with partners in other regions and countries. Third, we were interested in finding out whether local institutional support and economic policies provided incentives to develop local linkages, and the importance of cross-industry linkages in innovation.

5 University-related IT Spin-offs/Start-ups in CTT

CTT is frequently portrayed as a dynamic technology region that draws from university start-up/spin-off processes, knowledge transfers and corresponding regional networks. Our research, however, portrays a different picture of the development in this region and offers interesting insights into the underlying social dynamics of innovation processes. In contrast to what we expected, we did not find proof of strong value-chain-based or cross-sectoral networks and knowledge flows. In the first stage of this research, this was systematically explored by means of semi-structured interviews with 18 university-related IT spin-offs/start-ups.

We started off with the assumption that IT firms would be the most likely of the university start-ups/spin-offs that could demonstrate evidence of regional horizontal and vertical relationships in innovation, both within and across value chains thus supporting broad "local buzz". However, the empirical results derived from our interviews were somewhat surprising. They showed that, first, there were fewer such start-ups/spin-offs than expected and, second, most of these firms operated in specific cross-regional networks along market and technology linkages that adhere to their particular technological expertise. Local linkages with customers and suppliers and the existence of regional industry networks, such as those described in conventional cluster approaches, were quite limited in their extent or absent altogether. This is clearly indicated in Tables 2 and 3. Only about one-third of the IT firms had significant local supplier linkages (≥ 10% of overall supplies), and just one firm purchased its supplies primarily locally (Table 2).

Table 2: *Local Supplier Linkages of Firms in Canada's Technology Triangle, 2007 - 2009 (Source: Survey Results)*

Firm Type	Firms with Significant/High Local Supplies			
	Significant (≥ 10%)		High (≥ 50%)	
	Number	Share	Number	Share
IT Start-up/Spin-off Firms	6 of 17	35%	1 of 17	6%
Traditional Manufacturing Firms	14 of 37	38%	11 of 37	30%

In terms of sales linkages, only one firm showed a significant local orientation (≥ 10% of overall sales), while most had predominantly international customer linkages (Table 3). Almost 90% of the IT start-ups/spin-offs sold most of their outputs in the United States or overseas. This pattern was clearly reflective of the nature of knowledge flows in innovation which primarily involved non-local producer-user linkages.

Regional industry organizations were also of limited importance in stimulating innovation, playing a role in deepening social networks and generic skill sets (Xu 2003; Colapinto 2007; Bramwell *et al.* 2008). Firms frequently turned to specialized Internet-based user groups as their initial problem-solving tool and rarely found

opportunities to collaborate with other firms in the region, typically citing that nobody else was working on the same type of products and problems they encountered. It appears unlikely that these firms would spur the development of specialized regional innovation networks.

Table 3: *Table 3: Local and International Sales of Firms in Canada's Technology Triangle, 2007 - 2009 (Source: Survey Results)*

Firm Type	Firms with Significant/High Local Sales				Firms with Significant/High International Sales			
	Significant (≥ 10%)		High (≥ 50%)		Significant (≥ 10%)		High (≥ 50%)	
	Number	Share	Number	Share	Number	Share	Number	Share
IT Start-up/ Spin-off Firms	1 of 15	7%	1 of 15	7%	14 of 15	93%	13 of 15	87%
Traditional Manufacturing Firms	18 of 37	49%	8 of 37	22%	23 of 37	62%	14 of 37	38%

Although the IT sector may be somewhat specific in terms of its ability to create international networks, it does not possess fundamentally different linkage patterns compared to other new technologies. In particular, we expected university start-up/spin-off firms to display a somewhat stronger regional orientation, especially in their early stages. This was, however, not the case. We found three reasons that help explain this: First, it seemed that firms in the area of specialized software solutions were able to establish a broader extra-regional customer base more quickly and easily than firms in other sectors. Second, the regional firms were extremely diversified, limiting the opportunities for local network creation in a mid-sized region. Third, acquisitions of firms by larger entities that took place in the region served to provide access to wider extra-regional corporate networks, and thus boosted market legitimacy for the respective units. Overall, we found that spin-off/start-up firms created an unexpectedly limited amount of specialized "local buzz" in innovation.

In our interviews, we encountered only a few IT start-ups/spin-offs that reported existing linkages in innovation with firms in other sectors, and none of these firms cited a single particular industry outside their value chain as important for innovation. We were particularly interested in seeing if there were cross-industry linkages between the traditional manufacturing and IT sectors in the region, but only found two significant cases where IT firms indicated such linkages. One producer of electronic control boards identified some of the manufacturers interviewed, but did not name any of those firms as an important customer or partner in innovation. In a second case, a firm sold its CNC software to a local manufacturer, but distributed the software through an out-of-region machining hardware supplier. The regional connection was merely accidental, and the interviewee only knew about it through a social relationship. When asked about cross-sectoral relationships, firms often did not know in which way these could be important. The answers received were usually quite generic as firms mentioned that a diversified economic base would provide a diversified labour market. However, nothing specific was mentioned about this, suggesting that such linkages were not very common. The absence of noticeable cross-sectoral linkages clearly indicated that implicit claims about regional spillovers from regional IT spin-offs/start-ups to traditional manufacturing firms may be over-stated.

With respect to the conditions for regional innovation, we found that most firms were stand-alone units in the regional economy with strong international customer linkages, particularly to the United States. They had little ongoing research activities with R&D laboratories and the regional universities, with the exception of those that had a hardware-related component to their product offering. Despite the lack of strong regional relationships, the IT spin-off/start-up firms appeared to be clearly embedded in the community structure. The University of Waterloo provided important skill flows to the regional firms in the form of qualified graduates, but these were generic skill flows that did not directly strengthen innovative capabilities (Brady 2004). As

Bill Gates, Microsoft Corp., emphasized during a visit to the region: "Most years, we hire more students out of Waterloo than any university in the world, typically 50 or even more" (CTV.ca 2005). In contrast to these labour market effects, our study indicated that limited specific knowledge was transferred to the region by entrepreneurial faculty members and graduates. Over time, existing university spin-offs/start-ups seemingly entered a stage of incremental innovation, with few strong R&D relationships to the university (or the region) persisting.

6 Traditional Manufacturing Firms in CTT

In the second phase of our research, we interviewed 40 firms in traditional manufacturing industries in the areas of plastic and rubber products, fabricated metal products, machinery, electrical equipment and transportation equipment. We were particularly interested in looking at the state of innovation activities in this sector and the potential for cross-sectoral exchanges of knowledge that could stimulate further innovation.

The firms interviewed differed widely in their role in the design process of the products that they fabricated or manufactured. Some firms primarily performed generic treatments, such as heat-treating or painting, to the products. Similarly, contract fabrication shops, which did limited runs of machining and/or CNC manufacturing from a design provided by their clients, often had little involvement in the development of the products they produced. They provided feedback to their customers when parts became problematic to manufacture but had little influence on the actual product design. Some of these firms, however, developed internal capacities to take the designs and provide input to their customers from a manufacturing stand-point. Over time, some firms became increasingly involved in early-stage design processes of the end products. Furthermore, we encountered firms in the upper tiers of the manufacturing value chain that both manufactured and designed products. Overall, we were surprised that most of the firms were quite innovative in recent years: One third had developed new products and another third introduced new processes in the two years prior to our interviews.

Firms in traditional manufacturing differed substantially in terms of supplier-customer relationships and the kinds of knowledge-transfer-based innovative activities they engaged in, depending on where they were positioned in the value chain. On the one hand, firms with little knowledge of the end use of the products were rarely engaged in intensive interaction with their customers. On the other hand, firms with a stronger involvement in the actual design of the products, even in the case of short-contract fabricators, had the opportunity to gather more information about the operations of their customers and the kinds of capabilities needed. They used this to develop specific innovation capabilities over time, often trying to extend their competence from manufacturing to research, development and design.

Altogether, we identified two distinct cohorts of firms in our sample that were active in innovation. One cohort primarily engaged in custom manufacturing, converting raw materials into finished components using other firms' designs. They worked from a blue-print and gave feedback primarily on the manufacturability of the parts, rather than their end function. For these firms, most of their innovation came from cost-cutting measures and improving workflow and material management to reduce production delays. Another source of innovations were capital investments in new equipment in order to increase capabilities and enhance automation to save on labour costs. The second cohort generally utilized their own designs to fabricate products, even if their outputs fed into other firms' product value chain. Some of these firms were very innovative with long-term research strategies in the development of new products. This was dependent on close interaction with their customers, which were often not near-by.

With an opportunity to observe the different cohorts of firms, we expected to see that the foundations of the underlying innovation networks would be found in the regional value chains. However, it turned out that the

firms interviewed usually did not identify either regional suppliers or customers as important to their innovation processes. Nonetheless, local/regional linkages through purchases of supplies and sales of products were higher than in the segment of IT start-ups/spin-offs: Almost 40% of the firms purchased at least some raw materials (≥ 10% of overall supplies) from within the wider region (14 of 37; see Table 2), but their decision to do so was primarily based on logistical concerns and price factors, and not on innovation inputs. Compared to the IT firms, a higher share of traditional manufacturers had primarily a regional supply orientation (≥ 50% of overall supplies). In terms of sales linkages, half of the traditional manufacturers had at least some significant local sales and about one fifth were primarily locally oriented (Table 3). Given that we interviewed numerous tier-2 and tier-3 manufacturers, as well as fabricators and metal treaters that would typically try to access the local market and provide customized jobs, this orientation toward local sales, however, appeared low rather than high. In fact, a substantially higher share of firms was mostly reliant on customers in the United States or in Europe: Almost 40% of the firms had primarily international sales, which clearly had an impact on innovation linkages.

Firms overwhelmingly indicated that ideas for new products were developed from within the firm, sometimes through corporate ties connecting facilities in different countries. Most firms did not have important regional suppliers or customers that they collaborated with in innovation; thus, it was not surprising that these firms relied on internal problem-solving. The firms interviewed also did not use consultants or have close relationships with research laboratories. When they ran into problems in their production processes, the way they responded varied depending on the type of firm:

More than half of the traditional manufacturing firms interviewed were metal fabrication shops. When these firms encountered problems, they were typically related to the product designs and challenges in manufacturing. In these cases, firms typically solved the problems in-house, but sometimes turned to their machine suppliers to help them improve manufacturing performance. A second group of firms provided coating and heat-treating services. The firms relied on particular processes and were limited in the number of places they could consult to solve problems and innovate. Typically, they innovated by adding new capacity, either in volume or process rate. Original equipment manufacturers (OEM) were the third group of firms focusing on in-house problem-solving without engaging intensively in inter-firm innovation networks. Some were branch plants of larger, multinational corporations and consulted with other corporate units around the globe to see how to solve problems in innovation.

For the metal fabricators and treaters, the driving force in innovation was the customers' demand to lower costs or boost turn-around times. For the OEMs, the expectation of customers was related to improved product performance or design and feature enhancements. Regardless of the firm type, the customers were seen as the main push behind innovation, and often the key source for design input. Although sales in the traditional manufacturing sector were not as internationally oriented as they were for IT firms, such linkages were critical to the success of these firms.

As in the case of IT start-ups/spin-offs, we did not find strong evidence for cross-sectoral linkages in innovation. Most commonly, the firms indicated that they benefited from a joint labour pool in the region and the ability to draw skilled employees from firms in other industries using similar processes. But the flow of employees between firms was not seen as a significant input for innovation. A couple of firms indicated that they benefited from having a diverse pool of suppliers in the region, but suggested that the benefits came from the ease of having access to them, rather than from direct innovation inputs. Only one firm made explicit reference to business or management benefits, suggesting that – since so many firms in the region exported around the world – discussion with firms in unrelated sectors on how to solve export challenges and share information and strategies on business operations was useful. Most answers appeared vague, however, indicating that cross-sectoral linkages were not common.

Generally, the results of the second phase of our research on traditional manufacturing in CTT paralleled the key observations about regional innovation processes from the first phase. Again, we did not see substantial patterns of local supplier-customer linkages that were important to innovation processes. Firms relied on international linkages, often with partners in the United States, and used regional suppliers primarily for generic business services, labour and raw materials. Regional industry organizations, inter-firm labour flows and the local universities and community colleges were only occasionally mentioned as being significant for innovation. Most firms indicated they had very little employee turn-over, and many participated in the regional high school and community college apprenticeship programs, but had no distinct regional innovation networks otherwise.

7 Conclusions

The transformation that has taken place in the region around Cambridge, Guelph, Kitchener and Waterloo from an economy based on traditional manufacturing to one with a substantial proportion of IT-related businesses is often attributed to knowledge transfers and growth triggers based on university spin-off processes and related networks. This would suggest that firms are regionally linked through cluster-like relations or other forms of inter-firm networks in innovation. In contrast to this expectation, our research shows that local firms are not closely related to one another in their technological and knowledge base. This limits the possibilities for local networking and knowledge flows between firms. In general, firms tend to engage in international linkages to provide the necessary growth impulses, both within corporate networks and through inter-firm linkages. Therefore, restructuring successes in CTT are primarily due to individual-firm competencies, rather than the consequence of collective action.

In addition, we found less than a handful of examples of some sort of relationships between traditional manufacturers in the region and IT firms, and where they existed the firms did not indicate that they were relevant for their innovation processes. Of course, this should not be taken to suggest that there are no cases of cross-industry linkages in the region, nor do we mean to suggest that such relationships have not been significant for some firms outside our sample; but our results show that cross-industry linkages between value chains are rare and that their influence on regional innovation processes appears minimal.

This is a different story of CTT and the University of Waterloo from that portrayed in the media and transpired, in part, through academic publications. Successful regional restructuring and modernization is primarily a result of individual strengths, shared generic knowledge assets and a strong sense of community in marketing the region's attributes, rather than the effect of collective endeavours in innovation or networking. Although the fragmented regional economy may experience strong growth in some future periods based on diversification advantages, it may under-perform due to a lack of economic cohesion and little collective synergies in innovation in other periods. What we find is that the knowledge behind the economic success and the social foundations of regional innovation still appears incomplete. Clearly, CTT cannot be viewed as a true industry cluster of closely interrelated firms that engage in joint innovation networks. Further, considering that the University of Waterloo is often portrayed as one of the key examples of spin-off and start-up processes, we might have to lower our expectations regarding regional technology transfer through university-industry interaction. It might be more precise to conclude that the region's success is primarily based on weak ties and generic knowledge, rather than strong, formalized ties that hold together the fabric of innovation. The role of local universities as a source of spin-off/start-up firms or as a partner in leading-edge innovation appears over-stated and does not, in itself, explain the successful modernization path.

At the same time, our study shows that traditional manufacturing firms are not necessarily less resilient towards economic crises than new, creative or high-technology industries. Firms in the former industries can also be innovative and flexibly adjust to new market situations if they engage in ongoing re-bundling activi-

ties, involving incremental improvements and adjustments, the acquisition of new resources and related diversification and renewal processes. While the traditional manufacturing sector has proven to be more innovative than expected, this is not related to strong regional producer-user interaction, local innovation networks, university-industry collaboration or cross-sectoral triggers. There is little evidence suggesting that collective qualities in innovation are key to the successes of these firms. Other more generic factors are important, such as a highly skilled labour market, successful corporate "role models" and community leaders, or a strategically important location within the Southern Ontario transportation networks and markets; but these factors do not suffice to truly explain strong economic growth and successful modernization in CTT. Rather, it appears that regional successes have primarily relied on individual endeavours of firms, internal corporate networks and firm-specific competencies, as well as intensive linkages with the US and other foreign markets – all of this within a diversified regional economy and labour market beyond a certain minimum-threshold size.

What does this mean from a regional policy perspective? First, it will be important in the future to support firms in maintaining strong trans-local and global pipelines through corporate or inter-firm linkages that are key to innovation and economic success. Second, it is nonetheless important to provide platforms for regional technology transfer and knowledge exchange. This could potentially strengthen the adaptability to and robustness against future economic crises as it helps local agents evaluate alternatives and variations to existing problem solutions. Third, we cannot expect that cross-sectoral networks will automatically form or play a role in innovation. Such linkages would have a greater chance to be useful if carefully orchestrated by regional policy makers or industry organizations in areas where technological complementarities are likely.

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