**NETWORKS AND LINKAGES AMONG FIRMS AND ORGANIZATIONS IN
THE OTTAWA-REGION TECHNOLOGY CLUSTER:
A FOLLOW-UP STUDY**

By

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Abstract

This paper reports on a follow-up study of the networking and linkage practices of technology firms within the Ottawa cluster. This study compares technology and non-technology based supplier firms to assess the quantity and value of their networks and linkages within the cluster and *market web*. Using a similar methodology to the original Madill et al. (2002) study, this work seeks to discover whether things have since changed. Existing literature argues that technology firms need to be relatively more adept at developing external relationships in order to be successful than do non-technology based companies. While the technology firms have increased their use of linkages since the previous study, they still exhibit fewer linkages than the non-technology based companies. Yet, the technology firms demonstrate a stronger international orientation. The research contributes to the literature on Canadian technology clusters and suggests that the Ottawa cluster could benefit from additional promotion of networking and linkages among regional firms.

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Chapter 1: Introduction

1.1 Summary

Three years ago, in the Spring of 2000, researchers Madill, Riding and Haines (2002) did an exploratory survey which examined empirically the usage and value of networks and linkages as well as how firms market and manage their relationships. Furthermore, the study was undertaken within the Ottawa technology cluster to learn specifically about relationships and linkages among organizations in a cluster environment. The research revealed that technology firms had fewer linkages than non-technology firms within the cluster. Previous work in this area (Ryans et al, 2000) argued that technology firms need to develop more external relationships in order to be successful, than non-technology based firms. Interestingly, to the contrary, the study by Madill et al. (2002) found that within the Ottawa cluster, technology firms had formed fewer linkages. At the time the data was collected, the technology “boom” with high profits and high growth was ending. Since then, the technology sector has experienced a significant downward slide in sales and profitability and many technology companies are facing very difficult times. Some of the largest technology companies in the Ottawa Cluster (e.g. Nortel and JDS Uniphase) have downsized and faced falling revenues as well as depressed stock prices.

This thesis is a follow-up to the 2000 Madill, Haines and Riding research. This study goes into the field to see if things are changing using a similar methodology to the original study. Thus, this study compares technology and non-technology based supplier firms to assess the quantity and value of their networks and linkages. It is a study of the

networking and linkage practices of technology and non-technology supplier firms within the Ottawa technology cluster.

1.2 Research Question

Are there significant differences between technology-based firms and non-technology based supplier firms in the usage and valuation of networks and linkages with other organizations in their cluster and their *market web*?

1.3 Investigative Questions

- i. Do technology based firms a) use more linkages and b) value more highly their linkages with organizations in their cluster and *market web*, than do non-technology based firms?
- ii. Have technology-based firms' usage and value of linkages with organizations in the Ottawa cluster changed in the last 3 years?
- iii. Are technology-based firms more likely to have (a) more frequent and (b) more valued linkages with organizations that are similar to the organization's original source of technology?
- iv. Are technology-based firms that have obtained financing from venture capitalists likely to have (a) more frequent and (b) more valued linkages with organizations than are organizations that have not received venture capital financing?
- v. Do technology-based firms within the Ottawa technology cluster have more intra-regional linkages than non-technology based firms?
- vi. Do technology-based firms have fewer internationally based linkages than non-technology firms?

- vii. Are subsidiaries of major organizations less likely to engage in local networking and partnerships because of easy access to external company-based large firms? (Based on Keeble and Wilkinson, 2000, p. 217).
- viii. Is there a difference between small and large businesses in the use and value of networks and linkages?

1.4 Importance of Topic

There is most definitely a need for additional research with regard to the use of networks and linkages in technology driven companies as opposed to those that are non-technology driven. Conflicting views exist on this issue and there is a lack of empirical research. As will be shown in the literature review to follow, few studies have been conducted comparing technology-based with non-technology based firms in terms of networks and linkages.

It should further be acknowledged that although industry clusters have been years in the making (e.g. Ottawa tech cluster began formation some 40 years ago), the topic is still relatively new in research literature. As Cooper and Folta put it, “while the generalities of cluster locations have been established, many research questions need to be addressed to add to the understanding of clusters and their importance” (Cooper and Folta, 2000).

With the downturn in the economy, several high tech firms in the Ottawa cluster have suffered severe cutbacks, particularly in terms of employees. The Canadian operations of JDS Uniphase, the world's largest fibre-optic maker, reported a net loss of almost 1.3 billion U.S. dollars in its third quarter ending March 31, 2001. This market

downturn cost them 5,000 jobs, of which about 2,300 were in Ottawa (Xinhua, 2001). In total, “after losing about 80% of the 10,000 people it employed in Ottawa, JDS has retreated from 20 buildings locally to [just] one” (Austen, 2002). Overall, Nortel Networks has slimmed down its Ottawa workforce from 18,000 to less than 6,000 people (Austen, 2002).

It is hard to know what impact such cutbacks have had for the Ottawa technology cluster. It has not been overwhelmed by bankruptcies. Many of the workers who were laid off, receiving severance packages or perhaps stock-option payouts, have launched small start-ups in the Ottawa area (Austen, 2002).

As previously stated (Madill et al. 2002 - survey letter to respondents), “by focusing on Ottawa's technology cluster we believe the research will make a valuable contribution to understanding enterprise development, commercialization of innovation, and how the development of trust and co-operation in the context of an interlocking and integrated web of supportive organizations enhance collective learning capabilities”. This study will help further contribute to these aforementioned topics.

It is expected that the findings of this study will be useful to academics, policy-makers, and especially the organizations which are involved in the Ottawa cluster, as well as those involved in other clusters around the world. The findings could also pique the interest of economic development practitioners since this research proposes to study changes in networking that occurred while economic conditions have changed. Some suggested benefits, as listed by Madill et al. (2002) include: “incremental knowledge about the interactions of the factors leading to the development of clusters of growth

oriented technology-based businesses; a yet better understanding of the role of public policy in the commercialization process; and an improved knowledge about the attributes of regional infrastructures that are conducive to fostering growth of new technology-based businesses”.

1.5 Key Assumptions

One of the key assumptions is that technology based firms and non-technology based firms’ use and value of linkages with organizations in their cluster and *market web* can be measured accurately. The current literature on the topic (Keeble and Wilkinson, 2000) is not very extensive and is somewhat conflicting. It is assumed that the respondents’ reports provided on networks and linkages of the organizations studied will be accurate. It is further assumed that company linkages may be measured using a quantitative method – as outlined below in *Research Methodology and Data Analysis*.

Chapter 2: Literature Review

2.1 Introduction

In this section, the literature pertaining to the theory of networks and linkages within a cluster and among technology based and non-technology based firms alike will be visited along with related topics. The next section “Theory on Relationships in Business” will provide the necessary background to understand the ‘market web’ that surrounds any given organization.

This will provide a nice lead into the next topic areas of networks as relationships, networking and linkages related to business size, and performance as related to networking. From there, the literature review will get more focused and will look at research surrounding technology-intensive firms and *their* use of networks and linkages.

Literature on clusters, particularly technology clusters such as the one in Ottawa, will then be reviewed with particular emphasis on the definition of a cluster and on the interior functioning of a cluster. Issues surrounding business networks within clusters, collective learning, market web networks, and the nature and type of funding will be visited in an effort to increase the understanding of high technology clusters. The literature review section will conclude with a look at the economy’s impact on the use of networks and linkages; and finally with a section entitled “Overall Conclusions from the Literature”, which will provide an overview of any key issues that could influence the direction of this research.

2.2 Theory of Relationships in Business

Grönroos (1996) looks at three strategic issues in relationship marketing. The first is *“Defining the firm as a service business”*. This means going beyond just selling the product. It really demands a more “holistic service offering” which includes information about how best to use the product as well as delivery, installation, updating, repairing, maintaining, and correcting solutions for the product. The product itself is often not the reason for dissatisfaction among customers, thus the core product is essentially not necessarily enough to produce successful results for an organization. It really becomes a competition on who can better manage the additional elements of the “total offering”. A study was performed by Cann in 1995 on the satisfaction of mainframe computer customers that included six focus group interviews in three major cities. The study revealed that a number of the factors that these customers considered most important to their overall satisfaction with the mainframe computer were service-related intangibles (Cann, 1995). The second strategic issue, *“managing the firm from a process management perspective”*, is the coordination and collaboration among functions and departments, which are responsible for different elements of the offering. The third issue is *“developing partnerships and networks”*. The premise is that relationship marketing is based on cooperation rather than adversarial situations and the parties involved will be best off as partners with a win-win situation. Both will benefit from additional knowledge and resources. Corporate experience in managing interorganizational relationships is typically focused on vertical relationships, such as suppliers, producers and marketing intermediaries. These partnerships and networks of firms can be formed horizontally and

vertically, thus the management perspective must also include the possibility of a horizontal collaboration. Further, the network partner could be a competitor, which can create some challenges, that is anti-trust implications, about sharing information and trust between the partnering units (Cravens and Piercy, 1994). As Hunt and Morgan (1994) put it, “the paradox of relationship marketing is that being an effective competitor in the era of network competition also means being an effective co-operator”.

According to Grönroos (1996), relationship marketing is a *new* paradigm, not just a new model that is emerging. He also states that relationship marketing is the “biggest paradigmatic shift marketing theory and practice has seen during the last 50 years.”

Galbreath (2002a) talks about this paradigm shift in terms of economic ages. He identifies three economic ages, the last of which he calls the *Relationship Age*. First was the *Industrial Age* (1880-1985) which was the age of mass production, assembly lines, and a time when manufacturers produced uniform products for a homogeneous set of customers. It was characterized by centralized management, uniform marketing, fixed pricing, and distrust of competitors. Then there was the *Information Age* (1955-2000), which came with the arrival of information and technology. Organizations were better able to capture large volumes of data and were able to make that data available to others. The Information Age had a basis of better *information* for value creation. It was the age of decentralized management and specialized production. Marketing was heavily based on segmentation with flexible pricing and the nature of competition was characterized with cooperation yet loose affiliation. Now, with better knowledge as the basis of value creation, the *Relationship Age* (begun in 1995), is characterized by perpetual strategic

plans, virtual management structures, and relationship assets as strategic resources. The nature of production for this era is customization and personalization with an economic output described as *experiences*. The marketing strategy is one-to-one with dynamic pricing and the nature of competition is distinguished by collaboration and trust.

In the Relationship Age, the generation of maximum market value has gone from tangible assets to intangible assets or “hidden” assets. The primary form of these intangible market value-generating assets are what Galbreath (2002a) calls *relationship assets*, which must be accounted for the same way a business accounts for all of its other forms of assets. Relationship assets are the difference between a company’s market value and the sum of its tangible assets (Galbreath, 2002a). To depict the distinction between tangible assets and relationship assets, one can think of tangible assets as those which form the basis of a company’s free cash flows. Relationship assets, on the other hand, are the key determination of net future opportunities (Galbreath, 2002a). In essence, “relationship assets are the principal driver of these cash flows, as the vast majority of business’ intangible assets are embedded within its key relationships – relationships with customers, employees, partners and suppliers” (Galbreath, 2002a, p. 17).

Accordingly, the Relationship Age is really about the value of the associations a company sustains and manages. The ultimate goal of a firm in this age is to “maximize its value through the productive utilization of its relationships network, compromising the firm’s relationships with its customers, employees, suppliers and partners.” Interestingly, all of these relationships are dynamically linked, which means that any change in the nature of one relationship will invariably affect the others. Relationship marketing is

really not just about a firm's relationship with its customers. It is the isolation of this relationship that leads organizations to an incomplete picture.

To depict the types of relationships that drive firm value, Galbreath (2002a) introduced the *Relationship Network*. This network demonstrates the key relationships for a business. As illustrated in Figure 1, these relationships go beyond typical relationships with customers. All of these relationships constitute a complex relationship network where, as aforementioned, a change in any one relationship can affect all the other relationships. Galbreath contends that, “maximum value in the market is generated only when these relationships are effectively understood, organized, and leveraged throughout the business” (Galbreath, 2002a, p.10).

Figure 1

The Fundamental Driver of Firm Value, the Relationship Network

Gummeson (1995) defines relationship marketing as a marketing approach that “is based on relationships, interactions and networks”. Cravens and Piercy (1994) recognize the importance of building relationships with other companies as a necessity to

compete effectively in the turbulent and rapidly changing business world. These authors refer to relationships with customers, suppliers and competitors as those resulting from “a variety of new organizational forms called networks”. The authors actually predict that, “the *network paradigm* may become the dominant organization form in the twenty-first century” (p.39).

Instead of a relationship network, Ryans et al. (2000) describes a firm’s relationships as developing and existing within a “market web”. At the center of the web is the *market chain*, which consists of the company itself, and a number of relationships upstream and downstream from it. Surrounding this *market chain* is a number of “off-chain” relationships which add to the market chain and turn it into a web. The form of these relationships can range from loose to distant, such as transactional relationships, to tight and close, as in strategic alliances. The nature of the strands in the web can become somewhat complex. Many of the relationships can contain a number of dimensions (Ryans et al., 2000).

A generic market web consists of three “strand” levels. First, there are the *market chain strands*. The market chain strands are made up of buyer-seller relationships and supplier relationships. Then there are the *off-market chain strands* and these are made up of complementors, co-marketing alliances, horizontal selling alliances, and collaborative product developments. Finally, there are *knowledge and influence strands*, which are learning alliances and influence relationships (Ryans et al. 2000).

A ‘business network’ as defined by Yeung (1994, p. 476) is “an integrated and coordinated set of ongoing economic and non-economic relations embedded within,

among and outside business firms”. This aforementioned definition is broad enough to include geographical groupings of SMEs, transnational corporations as well as the linkages between them.

2.3 Networks as Relationships

In order to fully understand the state of their relationships, a business requires a consistent framework for defining the *goal* of the relationship, the *key value outcome* of the relationship and the *key ingredient* of success for the relationship. Galbreath (2002a) demonstrates this in his depiction of this framework in Table 1.

Table 1

Framework for Successful Relationship

Relationship	Goal	Key Value Outcome	Key Ingredient for Success
Customer	Loyalty	Lifetime revenue and profit	Knowledge of the customer
Employee	Maximum personal growth and development	Improved value contribution and higher productivity	Organizational leadership and design
Partner and supplier	Increased business velocity and innovation	Increased customer share and improved revenue growth	Collaboration and communications via electronic integration
Investor and analyst	Full economic valuation	Share price and availability of investment capital	Continuous measurement, education and communication of relationship assets

Source: Galbreath, 2002a

A business' network relationships (market web) can range from linkages with suppliers, customers, and other firms; to linkages with academic institutions, government/support agencies, and investors and analysts.

2.3.1 Suppliers, Subcontractors, and Partners

In the UK, out-sourced items account for over 50% of total costs for the average manufacturing firm (Freel, 2000). A study by Rothwell and Dodgson (1991) found that in the case where there was significant innovation, only 10% of innovations involved collaboration with customer only, as compared to 55% that involved both customers and suppliers. In contrast, those where there was only 'incremental' innovation, 40% involved customers only and 20% involved collaboration from customers and suppliers. These findings suggest that suppliers are of particular importance to firms who wish to be innovative. It is suggested that small firms who supplement internal resources with the use of subcontractors and suppliers can better innovate product technologies. That is, they can do this without having to invest a large sum of money into equipment and other related expenses (Freel, 2000).

Other recent research (Harbison et al., 2000) reveals some interesting implications of creating and successfully managing partnerships. These studies demonstrate just how important and valuable partner and supplier relationships can be to a business. Strategic partnerships have consistently produced a return on investment of nearly 17% among the top 2,000 companies in the world for nearly a decade. This is 50 percent greater than the average return on investment the companies produced overall. "Successful partnerships see 20 per cent profitability, as compared to only 11 per cent for the less successful companies. Revenue generation from high success alliances equates to 21 per cent of a firm's overall sales, as compared to 14 per cent of low-success partnerships" (Harbison et al., 2000). Those numbers are predicted to rise to 35 per cent and 24 per cent,

respectively, by 2004 (Harbison et al., 2000). 'Efficiently run' supply chains have proven to produce inventory levels that are reduced by as much as 50 percent, stock outs lowered ninefold, on-time deliveries increased by as much as 40 percent, supply chain costs decreased by as much as 20 percent, and finally revenue increased by as much as 17 percent (Teagarden, 2000).

Not all companies, however, are able to successfully incorporate partnerships with other organizations. Research from KPMG suggests that as many as 70% of all partnerships fail to achieve stated goals (Murphy and Kok, 2000).

2.3.2 Customers

Rothwell and Gardiner (1985) have argued that there is the possibility for considerable gain through involving the user in the product design and development processes. There are four primary gains to links with customers. First, firms can supplement internal design and development by accessing the technical and managerial skills of their customers. Second, user involvement is likely to be the ideal way to establish the optimum price/performance combination; Third, involving the user in product design and development will likely accelerate the innovation acceptance process of these customers and others; and last but not least, the strong relationship evolved from user involvement will result in user feedback and thus product improvements which will ultimately lengthen the product life span (Rothwell and Gardiner, 1985).

It is much less costly to keep a customer than to attract a new customer. Bhote (1996), provides a summary of research on the true economic value of customer relationships to a firm. Finding new customers costs five to seven more times than

retaining current customers. Moreover, reducing customer defection by 5% can increase profit between 30 and 85% and increasing customer retention by 2% equals cutting operating expenses by 10%. Other interesting facts are; 15 to 40% of customers who say they are “satisfied” defect from a company each year; of dissatisfied customers 98%, never complain; they just switch to other competitors. As well, “totally satisfied” customers are six times more likely than “satisfied” customers to repurchase a company’s products over a span of one to two years (Bhote, 1996). Galbreath contends that customer relationship value is represented by the future positive cash flows to be derived from a business’ relationships with its customers (Galbreath, 2002a). This implies that a business can only measure customer relationship value after the cash flows have occurred.

2.3.3 Competitors and Other Firms

Horizontal linkages with competitors and other firms may be said to be just as important, if not more important, than vertical linkages (Freel, 2000). Freel’s (2000) article suggests that some of the principal benefits gained through horizontal collaboration involve complementing and supplementing internal product development efforts, cost and risk sharing, assessing new markets and the transfer of both technology and knowledge. Dodgson (1994) has even suggested that inter-firm collaboration can lead to what he calls a “positive sum gain”. That is, he argues that firms can obtain mutual benefits together that could not be attained independently (see Freel, 2000, p. 248).

2.3.4 Universities/Colleges

There have been some arguments that the success of Silicon Valley and other technology clusters is due to their proximity to certain university/colleges (Acs, 1993). It

is posited that links with universities and colleges are especially likely to improve small firms' ability to innovate. University research may drive industry research and small firms are also able to improve internal resource deficiencies by accessing university resource networks (Westhead and Storey, 1995). There has been, however, little empirical evidence to substantiate any of these presumptions that nearby universities help with the degree of innovation. There is support however by Wilkinson et al. (1996) who found that 90% of the most innovative firms in their study had formal links with a university.

2.3.5 Government/support agencies

Freel's (2000) UK research suggests that innovative small firms are more likely to have contact with public sector support agencies, government departments and/or trade associations. Certain countries offer certain different support agencies and support services, thus generalizing the findings from research conducted in the UK to the rest of the world may not be appropriate.

2.3.6 Employees

Employee relationships are a particular part of an organizational network that was not mentioned in Freel's (2000) work. Galbreath contends that employees have a clear impact on the values of other relationships within the relationship network. A company with poorly managed employee relationships would likely also have lower quality customer relationships. The Relationship Age places value on people along with their knowledge and talent. The key is really that growth must be meaningful to both employee and the business (Galbreath, 2002a). The most valuable employees to any business are

those that have been with the business the longest because they know the business, the customers, and how things are done. With this concept, Galbreath applies the “80/20” rule, such that 20 percent of a company’s workforce represents 80 percent of the “learned knowledge”, or the “intellectual capital” in that particular company. The real message communicated here is that employee personal growth is key to long-term and sustained organizational growth. In another article, Galbreath (2002b) says that employees are a large determinant of a business’s value. He contends that high employee retention leads to higher customer retention rates, which in turn lead to higher revenues and net income and thus leads to higher net future opportunities (Galbreath, 2002b).

2.3.7 Investor and Analyst Relationships

Galbreath’s major point concerning investor and analyst relationships is that it is important not to lose sight of investors and analyst relationships. Those relationships could prove to be important in harnessing all your other relationship assets. It is, basically, investors and analysts who acknowledge and reward the value outcomes of the relationship assets from all of the business’s key relationships (Galbreath, 2002b).

Galbreath (2002b) contends that businesses must focus their efforts on Enterprise Relationship Management (ERM). ERM is a business strategy for value creation that focuses on a firm’s relationship network. It is a “body of individuals artfully and judiciously using a means – relationship assets – to accomplish an end: maximizing market value” (Galbreath, 2002b). It does not focus on cost containment but on “leveraging the network- enabled processes and activities from any of the above programs to transform the relationships between the organization and all its internal and

external constituencies in order to maximize current and future opportunities” (Galbreath, 2002b). Essentially, networking comprises “social processes over and above the normal economic trading relationship” (Chell and Baines, 2000).

It is difficult for one organization to possess the skills and resources needed to gain and sustain a competitive advantage. It is through the successful implementation of network strategies that these companies can maintain a competitive advantage (Cravens and Piercy, 1994).

The network organization lets different independent organizations take care of some business functions. The relationships among firms in a network include; joint ventures, strategic alliances, supplier-producer collaborations, franchises, research consortia and channel-of-distribution linkages (Cravens and Piercy, 1994). Relationship marketing involves the creation and distribution of value through mutual co-operation and interdependence (Sheth, 1994). Co-operation and interdependence are central features of many network organizations. Relationship marketing offers an essential framework for understanding, explaining and managing network relationships (Sheth 1994).

With no empirical data as support, the conditions that favour adopting a network structure are claimed to be fast technological change, short product life cycles, market structures where preferences are segmented, and markets that extend beyond national boundaries (Achrol, 1991). Specifically, organizations that compete in a rapidly changing environment, according to Achrol, are often specialists using a marketing core that coordinates an extensive network of suppliers and buyers (Achrol, 1991). The

aforementioned conditions presented by Achrol are quite typical of the innovation sector. It is, thus, natural to discern that technology firms definitely fit that category and are more apt to make use of networks and linkages than are non-technology based companies.

2.4 Time and Network Relationships

A particular longitudinal study by Johannisson (1996) draws many comparisons to this study on the Ottawa cluster. The panel-study¹ in question was performed over a period of six years (1987-1993). On a similar topic, the study surrounding 361 prospective and existing young Swedish entrepreneurs, focused on the role of networking in the venturing process.

The original study, in 1987, found conclusively that social proximity remains important to all entrepreneurs during the researched early stages of their careers. Physical proximity was also found to be important as 4 out of 5 of the entrepreneur's primary network partners were found to be within an hour's drive.

The 1993 research by Johannisson into emergent Swedish entrepreneurship and their personal networking confirms that networks offer both stability and change in the venturing process (Johannisson, 1996, p.267). It is noted that while changes in individual dyadic relationships may be initiated to ensure that the tie is maintained, creation of new ties and ending of existing relationships could be only taken as a way to preserve basic characteristics of the overall network. With reference to the evolving role of the network (Johannisson, 1996) notes that, "envisaging the venturing process as embedded in the

¹ Panel-study: collection of data from the same individuals at different points in time.

egocentric exchange network makes it natural to consider contemporary venturing activities as only a partial mobilization of a slowly changing overall network” (p. 257). It can therefore be expected that the results for the follow-up study on the Ottawa cluster will be somewhat different than those from the study performed by Madill et al. in 2002; exhibiting signs of perhaps a changing environment but also signs of changes in the venturing process among the firms within the cluster.

2.5 Networking and Linkages Related to Business Size

The data presented in Chell and Baines’ paper (2000) appears to support the Aldrich-Birley position (Aldrich et al., 1986; Birley et al., 1991) that there is in fact a close association between network activity and business performance. Active *weak-tie* networking was in fact associated with business growth. Moreover, the authors were able to show that the type of business is also likely to have an effect. They differentiated between “knowledge” (such as design consultants) and “non-knowledge” (photographers, printers, recruitment agencies, etc.) and found that there was a higher incidence of networking activity amongst the knowledge workers.

It is believed that the benefits that are presumed to accrue from contact with external agencies are of particular importance to small firms, such that their internal resource limitations can be alleviated by accessing external expertise (Barber et al., 1989; Advisory Council on Science and Technology [ACOST], 1990).

Chell and Baines are concerned with microbusiness owners’ links and networks with other business owners and with the many organizations extending support and services to them. Microbusiness research, along with that of Chell and Baines’ (2000),

has embraced Granovetter's (1985) account of the role of concrete personal relations that include strong ties and weak ties. People linked by *strong ties* trust each other and are likely to share contacts and information. Thus, reliance on strong ties influences against the generation of new information and fresh perspectives to create and exploit business opportunities for growth and development. Weak ties are short in duration and have a low frequency (Chell and Baines, 2000). It is argued that weak ties enable individuals to reach actively and purposively outside their immediate circle and to draw on information, advice and other sorts of assistance from a larger, more diverse pool of resources (Chell and Baines, 2000). It is thus not surprising that many advocates of entrepreneurship maintain that weak tie networking is a fundamental part of entrepreneurial behaviour (Chell and Baines, 2000). However, if strong ties are developed, there is a basis for trust, which can lead to providing mutual assistance. Geographic proximity may facilitate the development of these social networks (Cooper and Folta, 2000).

Owners of small businesses typically lack time for networking. Moreover, they tend to value their independence which leads to "an extreme reluctance to engage in any behaviour which might lead to a dependence on others or even be seen as showing a need for others" (Curran and Blackburn 1994, p.172). Gray also argues that owner-managers of small businesses typically adhere to a "self-employed or microfirm culture of individualism and anti-participation" (Gray 1995).

On the other hand Birley et al. (1991) suggest that networking activity is actually adequate for small businesses because the practice of it “reinforces owner-managers’ taste for a personalized as opposed to an administrative approach.”

Chell and Baines (2000) asked owner-managers whom they used as information sources. Customers were found to be the most important sources (71% overall) and second was other business owner-managers (57% overall). This suggests “a degree of co-operation and trust discordant with the idea of cut and thrust competitive behaviour” (Chell and Baines 2000).

It was concluded that a minority, although a substantial one, of business owners readily recognized a need to draw upon the expertise, practical support and friendship of people outside their business and their family. The networks most valued by owner-managers are, almost invariably, those at which they have worked hard and built up themselves, often over long periods (Chell and Baines, 2000).

2.6 Networking and Performance

Research has demonstrated a link between networking and performance! Results indicate a trend suggesting that the higher the performance the greater the networking activity (Chell and Baines, 2000). Yau et al. performed a study in Hong Kong with over 500 companies to verify empirically the impact of relationship marketing (or as they call it *relationship marketing orientation* – RMO), and to compare it with market orientation in terms of impacts on firms’ business performance across three industry sectors, namely manufacturing, retailing and wholesaling, and other industries (Yau et al. 2000). These researchers define relationship marketing orientation based on four behavioural

components of *bonding*, *empathy*, *reciprocity*, and *trust* such that, “the RMO centers on the creation and maintenance of relationship between two parties of exchange, the supplier as an individual and the consumer as an individual through the possession of the desire to be mutually empathic, reciprocal, trusting and to form bonds.” Yau et al. found that relationship marketing orientations helps link the parties involved to higher levels of cooperation and interdependence, and therefore leads to higher levels of satisfaction and performance (Yau et al. 2000).

There are a number of reasons why a firm would seek to develop relationships. Relationships can exploit the complementarities of an individual partner. Relationships can help a firm more effectively acquire resources and complete a sale of a product. Partnering firms can possibly both reduce costs and increase sales by knowing each other better and appreciating what each can offer each other: “Relationships also provide continuity and stability with an increased ability to plan, reduce costs and increase effectiveness” (Axelsson 1992, p.9). From entering into relationships, a firm should also be able to exploit network access; “[a] relationship implies a measure of control over another organization and, through that organization, the environment” (Axelsson, 1992, p. 9). What’s more, a firm in a relationship can have access to third parties. These third party firms might have resources that can be either valuable or crucial for survival.

In situations where market chains are long and complex, the success of a firm can easily be impacted on whether relationships between the players in the market chain can be formed. Thus, “successful competitors in technology-intensive industries often are

companies that are very effective at developing both internal and external relationships required for success” (Ryans et al., 2000).

2.7 Drawbacks of Relationships

Although much has been said about the advantages and benefits of implementing relationship marketing and its concepts such as networks and linkages, there can be some drawbacks. One of the major outcomes of the relationship building process, as outlined in the body of this report, is the commitment from both parties involved to cooperate and continue the relationship for the long-term; “a major disadvantage to a dyadic relationship achieving this level in a relationship is very high termination costs” (Morgan and Hunt, 1994). What’s more, “the two parties are so committed and involved that they cannot afford to separate” (Cann, 1998). Thus, high termination and switching costs can severely impede on a company’s willingness to form long-term relationships (Cann, 1998). Such relationships demand a great deal of trust and commitment from all parties.

Another price a firm might have to pay for the benefits that a relationship can provide is “dependence” on another organization for firm success (Axelsson, 1992). This really all depends on where the power and control resides within the relationship.

2.8 Technology-Intensive Businesses

Technology-intensive businesses are not like any other ordinary business: “technology-intensive businesses are characterized by rapid advances in technology that allows the company and its competitors to offer new functionality or applications to help customers solve existing or latent problems” (Ryans et al. 2000).

As explained by Keeble and Wilkinson in their 2000 book, “high-technology”, “technology-intensive”, and “technology-based” can be, and have been used broadly to refer to firms and industries whose “products or services embody new, innovative and advanced technologies developed by the application of scientific and technological expertise” (Keeble and Wilkinson, 2000). Furthermore, such businesses regard their expertise and ensuing technological leadership as their leading competitive advantage and they are most often identified with high research and development (R&D) expenditures. The following types of products and services, and the businesses built around them, are prime examples of technology-intensive businesses: computer hardware and software, telecommunications, advanced materials, pharmaceuticals, semiconductors, electronic equipment, specialty chemicals, instruments and controls (Ryans et al., 2000).

2.9 Relationships and Technology-based Firms

There has been a long-standing debate in research concerning technology firms and their use of links with external organizations. Little empirical research has occurred to compare innovators and non-innovators in their use of external linkages. Overall, the general findings in the diffusion of innovation literature (Rogers, 1995) point to innovators making greater use of external linkages, of certain types and in particular directions. Other research suggests, however, that non-technology based firms have more and higher valued linkages with outside organizations (Madill et al. 2002).

Freel (2000) did a study based in the West Midlands region of England with manufacturing firms. His findings and data confirm the proposition that the most innovative firms are “significantly more likely to have been involved in some form of

collaborative arrangement with their suppliers – 51.5% of innovators versus 37.2% of non-innovators” (Freel 2000). The most innovative firms were significantly more likely to have had some interaction with a university than were their less innovative counterparts and more contact with the government, support services and trade bodies. They were also more likely to have undertaken design, development and product improvement activities in partnership with customers. The surprising findings are however that the *least* innovative firms were significantly more likely to have co-operated with competitors in projects that required a joint commitment of resources (Freel 2002).

It is often stated in literature that relationships are critical to technology-based firms, for example: “frequently, relationships with market chain members and with organizations and individuals beyond the market chain are important to strategy in technology-intensive businesses” (Ryans et al., 2000). The need for networking may differ depending upon the line of business of the firm, as per Johannisson longitudinal study (1996): “in sectors of industry where technology development is rapid, networking activity may be assumed to be generally high and the networks accordingly volatile” (p. 255).

A few key reasons as to why relationships are important to technology-based firms are as follows (Ryans et al. 2000):

- 1) In technology-based businesses, market chains are long, complex, and evolving:
 “building strong relationships with market chain members, both on the supply

side and on the customer side, can determine whether you win in an attractive market opportunity” (Ryans et al., 2000).

- 2) With the blurring of competitive advantage around the technology itself, with pricing strategies responsive to competitive moves, with distribution channels providing access to most end users, gaining competitive advantage through these dimensions of a marketing program is becoming more and more difficult.
- 3) Many companies are attempting a competitive advantage through the nature and strength of the relationships they build. This potentially gives them a *collaborative advantage*, which is described as, “the linking of capabilities between organizations to create value for the end user, and strategic leverage for market chain members” (Ryans et al., 2000).
- 4) “Going down the market chain, collaborating with market chain members closer to the end user allows you to tap into knowledge, trends, and emerging needs understood by those closer to the end user; a combination that can guide innovation” (Ryans et al., 2000).

There are a number of characteristics of technology-intensive markets, which present some interesting challenges to the firms in that environment. Following are a select few, which tend to drive technology firms toward forming networks and linkages (Ryans et al., 2000).

First, technology-intensive firms are characterized by *Complex and Dynamic Market Chains*: “in many technology-intensive businesses, there is less vertical integration than in more mature, less technology-intensive businesses”. This has the end-

result of producing long market chains where several different organizations are playing key roles in the task of converting raw materials into the solutions that the end users require (Ryans et al., 2000). It is said that, “companies in technology-intensive industries find it very difficult to develop and maintain the necessary competencies in all the roles in the market chain that contribute to success in a market” (Ryans et al., 2000). It is because of this that many high-technology companies need to rely on a complex network of partners.

Second, in a technology-intensive environment, the speed of change is high and technology intensive firms are faced with rapid and continuous change, which places some major stress on them.

Third and lastly, technology-based firms are faced with *Markets and Competition that are Global* (reason for global networks and linkages). The globalization of technology-intensive industries is driven by a number of factors which include converging customer needs, lower trade barriers, deregulation of markets (or lack of regulation), and the fundamental economics of many technology-intensive businesses. Because, by their very nature, technology-intensive industries are heavily based on research and development (R&D), they must find ways to sell volumes of their product/service in an attempt to recoup that large initial investment. For some, this requires rapid worldwide distribution and market share. This strong global presence is also crucial for technology-intensive businesses where the product has a very short life cycle (e.g. life cycle measured in months).

There are several reasons that could explain why technology firms might not be strong users of linkages with members of their market web. For one thing, building relationships with managers and executives from different cultures and business environments, according to Ryan et al. (2000), can be a “challenging and time consuming activity” (Ryans et al., 2000) and, as mentioned above, technology based firms work in a high speed environment where changes are made quite often. It has also been argued that the emphasis is on technology rather than relationships with people in high technology firms (Madill et al., 2002).

It has been established that collaborating in product development can provide a number of benefits for technology-based businesses (Ryans et al., 2000). These collaborative alliances, however, can cause problems. A prime example of such difficulty for technology-based companies is the control over technology such that sharing technology with others can be dangerous: “successful collaboration demands a high level of trust and commitment rather than powerful agreements” (Ryans et al., 2000).

2.10 Clusters

An industry cluster, by its very definition, implies strong and abundant relationships along with collaboration for mutual gain:

“The cluster process assists industry leaders to identify and grow the competitive advantages of a region based on collaboration and a unique industry identity. It builds a true partnership between industry, government, education and other stakeholders and offers an integrating mechanism for other initiatives” (<http://www.unitedfocus.com.au/clusters.html>, 2002).

According to Porter (1990, p. 149), a “cluster consists of industries linked through vertical (buyer/supplier) or horizontal (common customers, technology, channels, etc.) relationships”.

In a similar way, Wever and Stam (1999) define a regional cluster of high technology firms as “a geographical concentration of firms which exhibit a significant degree of intra-regional linkages”. Similarly, clusters have been defined as “geographic concentrations of interconnected companies and institutions in a particular field” (Porter, 1998, p.78). A further definition describes business clusters as, “organic, complex and interrelated systems composed of large anchor firms, multiple small and medium-sized enterprises (SMEs), and micro-enterprises, soft/institutional infrastructure, and hard/physical infrastructure” (Roy, 2002).

Certain factors attract firms to a cluster: a joint labour pool, a broad supplier and customer base, knowledge spillovers, and low transaction costs (De Langen, 2000). Some of the outlined benefits of forming an industry cluster truly surround the whole concept of business networks and linkages. An Australian website lists, among others, the following benefits which could be expected to flow from an industry cluster approach

(<http://www.unitedfocus.com.au/clusters.html>, 2002):

- Establish a collaborative approach by industry, education and government to the growth of the industry in the region
- New commercial opportunities through teaming and joint marketing
- New commercial networks
- Collaborative forms to address industry issues

A cluster will typically exist in a larger urban area where “suitable smaller supplier firms, technical services firms, professional resources, critical resources, and

essential infrastructure are available; actual requirements may vary with particular economic sectors” (Roy 2001, p.22).

Overall, clustering appears to be associated with outstanding rates of both technological innovation (Baptista and Swann, 1998) and new firm spin-off (Oakey, 1995, p.13).

Bergman (1998) refers to a *regional cluster* as an aggregation of connected sectors concentrated within a particular region and competitive on world markets. Their connection can be based on anything from financial externalities to knowledge sharing and spillovers leading to a high rate of firm start-ups (Coe and Townsend, 1998).

A specific type of cluster is an “innovative milieu” which refers to local concentrations of high-technology industries. In leading high-tech regions it is argued that an elusive synergy of factors produces an innovative milieu, which is typically marked by high rates of knowledge diffusion and learning (Castells and Hall, 1994, Keeble and Wilkinson, 2000). Camagni (1991, p. 130) defines an innovative milieu “as a set of territorial relationships encompassing in a coherent way a production system, different economic and social actors, a specific culture and representation system, and generating a dynamic collective learning process” whereby innovation is sustained and uncertainty minimized (Keeble and Wilkinson, 2000).

There are a number of different technology cluster regions, which are mentioned in several different pieces of literature. Some of the most widely known cluster regions are as follows: Route 128 (Cooper and Folta, 2000); Boston (Saxenian, 1994); Silicon Valley, California (Saxenian, 1994); Oxfordshire, UK (Lawton Smith, 1997), Cambridge

Region, UK (Lawson, 1997), and Ottawa “Silicon Valley North” (Roy, 2001; Mason et al. 2001).

Summarizing all the research and definitions of a cluster, a more operational definition for a cluster could be summed up as a formation of firms *within a specific region*, with a similar industry classification, linked through vertical and horizontal relationships which are based on collaboration for mutual gain.

2.11 Ottawa Technology Cluster

Ottawa is Canada’s capital city and is the fourth largest city in the country as well as one of the fastest growing metropolitan regions with a population of about 1.2 million. Ottawa’s emergence as a high tech cluster goes back some 40 years. The high tech industry expanded in Ottawa in the 1970s and 1980s despite the absence of local sources of venture capital and any other inflow from non-local investors. Based around IT, telecoms and software, Ottawa is estimated to have around 1300 advanced technology companies which collectively provide some 72,000 high tech jobs (ottawaregion.com, 2002). With an evolved technology cluster, Ottawa is home to many leading private sector technology companies. Many of the firms who now exist and prosper in Ottawa were first started in the region. A sample of these technology firms include: Newbridge Networks, Calian Communications, Corel Corporation, Mitel Corporation, Mosaid Technologies, Bridgewater Systems, Gallium Software, Cognos, Philstar, Tundra Semiconductor, JDS-Uniphase, and WorldHeart Corp. Ottawa’s Cluster has been informally referred to as the ‘Silicon Valley North’. Silicon Valley North was successful in attracting \$1.3B in venture capital in 2000 (Mason et al., 2001).

Major cutbacks by leading employers such as Nortel, Mitel, Nokia and some prominent failures amongst recent start-ups resulted in estimated total job losses as of 2001 at about 9,000 (Mason et al., 2001).

See *Impact of Economy on Relationships (section 2.17)* for further discussion on recent changes to Ottawa technology cluster.

2.12 SMEs and Technology Clusters

While large firms are likely involved in the growth of regional high-technology clusters, all clusters of the sort are characterized by “substantial numbers of small, new and innovative enterprises engaged in technologically-advanced manufacturing and service activities” (Keeble and Wilkinson, 2000). It has been shown that high technology clusters with locally headquartered firms (large technology-based firms) appear to benefit from their activities mainly through their role in “orchestrating local networks of SMEs as subcontractors and suppliers” (Keeble and Wilkinson, 2000, p.217).

Since the 1970s, there has been an increase in the share of small firms in economic activity (Keeble and Wilkinson, 2000, p. 22). It is furthermore noted that, “SMEs are critically important to business clusters, and account for 90-95% of all firms in business clusters” (Roy 2001). SMEs are, however, risky businesses. Canada loses approximately 65% of all new firms with 1-4 employees within five years from start-up, and 48% of all new firms with 5-99 employees within five years of start-up (Roy 2001, p25). It was identified that the main cause of this substantial failure rate is the lack of adequate business management skills (Roy 2001, p25).

It is further shown empirically that technology SMEs do differ significantly from the more traditional non-technology based SMEs. High-technology SMEs are significantly more innovative (Tether, 1995, ch.2), they grow more rapidly in both employment and sales, they are less vulnerable to closure and more likely to survive over any given period (Reid and Garnsey, 1996, 1997), they more frequently serve wider national and global markets (Keeble et al., 1998), they are much more likely to engage in collaborative and co-operative arrangements with other firms and organizations, and they employ much higher proportions of highly-skilled and highly paid employees (Keeble and Wilkinson, 2000). This has been shown to boost regional incomes and to stimulate regional entrepreneurship via researchers spinning-off new firms from existing high-technology SMEs (Keeble and Wilkinson, 2000, p.6).

Technology based new firms are typically young, less than 25 years old, and are largely based on exploiting a potential invention or competence of some sort. Because of the potential for sustained relations with former employers (and essentially their market web) spin-offs can lead to continuing links, which sustain a cluster in the longer-term (Hendry et al., 2000).

A cluster environment has been shown to be crucial for the survival of small firms, especially start-ups. Start-ups are less likely to have needed resources in-house and therefore must often rely on other organizations. Start-ups also suffer from lack of credibility which means they often have to depend on relationship with others in the industry to increase the likelihood of attracting employees, orders, credit and assistance

(Cooper and Folta, 2000). It is clear, thus, that clusters have particular implications for start-ups and spin-offs.

2.13 Networks and Linkages in Clusters

Even though the formation of a cluster has yet to be fully understood, five elements have nonetheless been established as essential ingredients to its success (Mallett, 2002): access to technology and technical know-how; availability of highly qualified people, visionary entrepreneurship; access to venture capital; and finally *networks and linkages*. Mallett describes innovation as an “active social process” which requires networks and linkages within a cluster. These include linkages developed among public research institutes, the education sector and local businesses. Interestingly, universities and colleges in Ottawa were important R&D players throughout the development of the Ottawa technology cluster. The Doyletech genealogy of high-technology companies² actually credits Carleton University with influencing the start-up of some 50 firms through the research and training functions of its engineering and science faculties (Doyletech, 2002).

Several researchers have found that proximity is important for networking and interaction in various ways, especially for small and medium sized enterprises (Saxenian, 1994; Storper, 1993; Sternberg, 1996; Keeble, 1997).

Flexible business networks occur within business clusters: “these highly innovative networks allow groups of three to twenty-five or more micro-enterprises and

² Map tracing the origins and growth of Ottawa-Gatineau’s high technology industry - includes a family tree tracking the genealogy of companies since 1950, graphs of employment and number of companies from 1950 to 2002.

SMEs to form soft and hard networks to collaborate to compete, to build scale, scope and speed in order to innovate together and gain access to larger markets more quickly” (Roy, 2002).

Accordingly, there are six main types of business networks which exist within business clusters: horizontal networks, vertical networks, cross-sectoral networks, emerging and converging science and technology networks, public and private sector networks, and virtual networks. Keeble and Wilkinson (2000) claim that local networking represents an important mechanism whereby regional clusters can over time “develop a collective learning capacity for creating, diffusing and elaborating new technological and organizational knowledge within and between the cluster’s constituent firms” (Keeble and Wilkinson, 2000, p.9). In fact, the development of a localized collective learning capability is noted as a fundamental common characteristic of all successful regional clusters as studied by a European research network led by Keeble and Wilkinson (2000). This is made possible by the interaction and collaboration common to clusters such that, “business clusters typically have strong forward and backward linkages among firms, products and services” (Roy 2001). What’s more, “business clusters quite naturally foster high levels of competition, unique forms of inter-firm collaboration, and unique forms of firm and infrastructure collaboration. There is a very strong sense of interdependence among multiple players” (Roy 2001).

Bramanti and Ratti (1997, p.5) have come up with what they call the *innovation milieu concept*, which argues that innovation is fundamentally a collective process, that it is a complex and interactive process, and that it stems from a creative combination of

generic know-how and specific competencies. Camagni (1991, p. 130) maintains that an innovative milieu “emphasizes the importance for firm innovative activity of inter-firm relationships, territorial socio-economic embeddedness, and dynamic local collective learning processes” (Keeble and Wilkinson, 2000, p.10).

Many of the researchers in the UK use the term “innovative milieu” as they refer to an accumulation of high-technology firms within a region. From the research performed on high-technology milieux, SMEs will perform a double role of acting both as “a channel for the accumulation and exchange of knowledge – through collective learning mechanisms – and as means of reducing uncertainty” (Keeble and Wilkinson, 2000, p. 122). A vital element for the existence, functioning and survival of the milieu are inter-SME linkages (Keeble and Wilkinson, 2000).

A study on the Cambridge region, U.K., reported that firms in the cluster had close links with other firms in the area, links with suppliers and with providers of services were rated the most important; whereas links with research collaborators, local firms in the same line of business, and customers were found to be relatively unimportant (Lawson, 1997b). Some key statistics from this study: 76% of high-technology SMEs report ‘close links’ with other local firms, most frequent links being with suppliers and subcontractors (68% have ‘important’ local links), service firms (53%), customers (32%) and research collaborators (29%). Fifty percent of SMEs report research links with Cambridge University since their formation, 56% of which regard these links as ‘important’ for the firm’s development (Lawson, 1997b).

In Oxfordshire, U.K., the majority (87%) of the high technology firms within the cluster regarded their links with other local firms as important or very important. Furthermore, links with local suppliers were seen to be important or very important by more than 57% of the firms (Lawton Smith, 1997). Further statistics are: 46% of high-technology SMEs report 'close links' with other local firms, and 87% of these rate such links as important or very important to them. Fifty-four percent report links with Oxford University or local public research institutes (66% rated these as 'important' for firm's development). A large indigenous technology-based firm, Oxford Instruments, appears to have played a valuable role in fostering local high-technology SME subcontracting links (Lawton Smith 1997).

Lawton Smith (1998) found that, in Oxfordshire, 66% of all R&D-based firms had links with local university and local public sector laboratories. It was found, however, that for firms in the computer and business services sector that the percentage was lower at 29% suggesting that firms which are more R&D based have a higher occurrence of links with regional knowledge centers.

In his study of three German regions, Sternberg (1999) offers an explanation as to why innovative firms, especially small ones, should co-operate with external partners more intensely than non-innovative firms. It is suggested that linkages with firms can help in: reducing uncertainty, costs and competitive pressure, sharing personnel, and entering into new technological fields. It is further noted that innovative SMEs are in need of external co-operation to help realize their innovative efforts (Sternberg, 1999, p. 532). Interestingly, Sternberg was able to establish that within the German regions,

customer linkages are more prevalent than supplier linkages or competitor linkages and that 60% of the SMEs surveyed co-operated with research institutions within their region (Sternberg, 1999). His overall conclusion was that, “among manufacturing firms maintaining linkages with external co-operation partners, innovative firms are overrepresented compared to non-innovative firms” (Sternberg, 1999).

The European network’s research reveals that a characteristic feature of a ‘high learning’ technology-based SME regional cluster is “a high level of local networking, collaboration, and linkage“ (Keeble and Wilkinson, 2000). The research also plainly reveals that Europe’s successful technology intensive clusters are consistently characterized by active and strong local networking.

Moreover, the results of the European studies confirm a previous empirical finding by the ESRC Centre for Business Research, is that high technology SMEs exhibit significantly higher levels of inter-firm networking and collaboration than less technologically-focused SMEs (Keeble et al., 1997). Similarly, research by Hughes (1998) demonstrated that high-technology SMEs are in general clearly differentiated from ‘conventional’ SMEs in exhibiting exceptionally high levels of inter-firm and organization networking and collaborative activity.

Although many of the studies performed to date have found positive links between innovation and networking, some have suggested a clear pattern in the opposite direction. In a very small-scale study conducted in the UK, a pattern was discovered indicating that the firms surveyed found no significant innovation benefit associated with intensive networking with, and/or proximity to customers (Romijn and Albu, 2002).

There was no shown evidence of benefits from frequent or geographically close interaction with like-minded companies, financial institutions, industry associations and government bodies. Hence there was no evidence that intensive networking with, and/or proximity to, firms in similar or the same lines of business and customers would add anything special to the firms innovative processes and performance (Romijn and Albu, 2002).

A working paper by Madill, Haines and Riding (2002) reported on the networking and linkage practices of technology firms in the Ottawa cluster. They actually compared these firms to non-technology based companies and found, contrary to previous work in this area, that non-technology based firms exhibit more linkages than do technology-based firms in the Ottawa cluster. They found that technology based firms were significantly less linked than non-technology based firms in the Ottawa cluster. The non-technology based firms reported that they use and greatly value linkages with other organizations or individuals in their “market web”. It was, thus found that technology firms need to be more proficient at developing external relationships in order to succeed than non-technology based firms. These findings are not consistent with previous research in this area cited above. A possible explanation for this is offered in what Keeble and Wilkinson (2000, p.216) describe as time dependency:

“Networking and associated new knowledge development appear to be especially important for small, new and innovative firms. However, this review also suggests an important qualification to this general conclusion. There is considerable evidence that development of successful local networks and linkages, and of a consequent collective learning capacity, is time- and ‘critical mass’ – dependent. Younger and newer innovative milieux, such as the Oxford

region compared with the more developed Cambridge case, exhibit fewer local linkages (although their importance to the fewer firms involved is greater)..." (Keeble and Wilkinson, 2000, p.216).

This would suggest if correct, that a follow-up study would show an increase in usage of networking reported by technology based firms in the Ottawa cluster.

2.14 Collective Learning

Many studies, primarily based in Europe, have looked at regional collective learning processes and how these processes contribute to growth and success of firms and the region itself within various regional high technology clusters. Recent work includes papers on Cambridge (Keeble et al., 1999; Lawson, 2000), Sophia-Antipolis (Longhi, 1999), Grenoble (de Bernardy, 1999), Pisa, Piacenze and NE Milan (Capello, 1999), and Munich (Sternberg and Tamasy, 1999).

Regional collective learning processes do play an important role in pulling together knowledge which can ultimately generate high rates of technological and product innovation (Lawson and Lorenz, 1999). According to Lundvall, "... interactive learning and collective entrepreneurship are fundamental to the process of innovation" (Lundvall, 1995, p. 9). According to Keeble and Wilkinson (1999), "the key elements of these processes are: linkages and networking among firms and other organizations; flows of highly skilled workers within scientific and professional labor markets; and, spin-offs of new firms from existing organizations" (cited in Madill et al. 2002). Empirical evidence shows that high technology clustering is associated with both collective learning and innovativeness: "high learning regions are also and invariably highly innovative regions" (Keeble and Wilkinson, 2000, p. 220).

Localized clusters of high technology SMEs may exhibit a considerable degree of intra-regional networking in which collective learning is a club good from which outsiders are excluded: “regional collective learning processes are cumulative and interactive, whatever the nature of the interactions, formal or informal, traded or untraded” (Capello, 1998). Regional collective learning involves “the creation and further development of a base of common or shared knowledge among individuals making up a productive system which allows them to co-ordinate their actions in the resolution of the technological and organizational problems they confront” (Lorenz, 1996).

More specific to this research, the process of creating and developing a localized and interactive knowledge base can involve a conscious mechanism such as deliberate research collaboration between local SMEs or between an SME and a local university or association: “Knowledge development through conscious interaction and collaboration between firms and other local organizations (firms, universities, research institutes), as theorized by workers such as Camagni and Lorenz, represents the most intuitively-obvious regionally-based process of collective learning in a high-technology cluster” (Keeble and Wilkinson, 2000, p.11).

Collective learning processes tend to involve regional mechanisms which reduce the uncertainty faced by firms in a rapidly-changing technological environment such as that present in a technology intensive cluster (Lawson, 1997a). They tend to focus on links and networking between firms via the regional labour market (Camagni, 1991) and often play a central role in the development of a successful innovative milieu.

Regional collective learning processes appear to play a central role in creating a capability for combining and reassembling knowledge to generate high rates of technological and product innovation (Lawson and Lorenz, 1999). The rate of innovation has shown to be higher in high-technology SMEs within technology clusters than SMEs outside such regional clusters (Keeble and Wilkinson, 2000, p. 219).

For Camagni, collective learning is central to the development and definition of a successful milieu; “the local milieu may be defined as a set of territorial relationships encompassing in a coherent way a production system, different economic and social actors, a specific culture and a representation system, and generating a dynamic collective learning process” (Camagni, 1991, p.130). Camagni’s conceptualization of regional collective learning focuses on links and networking between firms and via the regional labour market. He strongly suggests that collective learning plays a central role in the development of a successful innovative milieu.

2.15 Wider Networks

It seems intuitive to suggest that subsidiaries are less likely to engage in local networking and partnerships because of easy access to external company-based large firms (Keeble and Wilkinson, 2000, p. 217). Research, however, has been found linking subsidiaries of large corporations to higher levels of inter-firm linkages within the region than independent SMEs (Lawson, 1997b, p. 44). It has been shown that local subsidiaries of *large* firms, in the European studies, were more embedded in regional networks and thus more involved in “local knowledge development and collective learning than other firms, again supporting the thesis that large firms are more likely to enhance than

diminish the growth of regional clusters of technology-based SMEs” (Keeble and Wilkinson, 2000, p. 217).

Empirical analyses performed in different European high tech clusters looked at inter-firm networking within the cluster region. The conglomeration of analyses revealed: “a relatively high proportion of firms reporting close links with other firms within the region, especially those in vertical customer/supplier chains” (Keeble and Wilkinson, 2000). For example, within the Italian districts, it was shown that firms like to develop links with local customer and suppliers, such that only 16% of suppliers and 19% of customers were outside the area (Campoccia, 1997). In Munich, Germany, innovative firms were found to have more intra-regional links than non-innovative firms (Sternberg, 1999).

Internal networks are often not the only consideration for firms within high technology districts. The markets for their products are often worldwide (Keeble et al., 1998). For example, in Ottawa, a substantial amount (90%) of its high-tech revenue comes from sales abroad, mostly in the United States (Economist, 03/03/2001). It is also important to realize that locally concentrated firms can have linkages outside their immediate region: “it is possible, however, that the importance of industrial districts as regional concentrations of trading activity is overstated by failing to take account of other forms of networking in which firms engage, extending beyond their immediate locality” (Castells, 1987). These include national and international supply chain relationships, collaborative agreements and strategic alliances (Hendry et al., 2000). For this reason, the research will also specifically examine linkages outside of the Ottawa cluster.

Extra-regional orientations can be in part due to ownership patterns, such that smaller firms being owned by larger parents elsewhere are provided with access to central research laboratories and global distribution channels; in part due to the international location of leading customers, and in part because of the need for the purest materials from suppliers wherever these can be found (Hendry et al. 2000). If a given cluster is found to have more links outside the region than within, it raises questions about what technology firms derive from proximity which will also invariably contribute to the debate about high technology industrial districts (Hendry et al., 2000).

New technology-based firms in Cambridge have more relationships outside their area than within it (Keeble, 1994, p.205). Again, from a study in Cambridge, it was reported that: “many Cambridge managers see themselves as networking more closely with firms abroad in supplier and customer relationships than with firms in the Cambridge area or with large British companies” (Garnsey and Cannon-Brookes, 1993, p. 27). It was however also suggested that technology-based SMEs, which are more international in orientation, and thus likely have better growth prospects, also have stronger local links than those firms who have a narrower national orientation (Keeble *et al.*, 1996).

Research conducted into the Cambridge and Oxford technology-based clusters revealed that the most “globalized” of the high-technology SMEs surveyed also tended to be the most locally-embedded and networked (Keeble et al., 1998). This finding further suggests that successful globalization by high-technology SMEs may actually be enabled by local networking and research and technology collaboration (Keeble et al., 1998).

Moreover, "...technology intensive SMEs which successfully develop global markets and research partnerships actually tend to exhibit greater local networking intensities than their less internationally-oriented counterparts" (Keeble and Wilkinson, 2000, p. 218). Regional and global networking appear to be complementary and simultaneous rather than alternative processes which actually allows high-technology SMEs to sustain their innovative activity and competitive advantage (Keeble and Wilkinson, 2000, p. 14). This suggests that high-learning regions should actually focus on being embedded not in just in local, but also in global and national learning networks if they want to sustain healthy competitiveness over time (Keeble and Wilkinson, 2000, p. 218).

Successful European high-technology SMEs are more oriented to national and international markets than conventional SMEs (Keeble, 1994, pp. 211-12) and tend to interact more with external innovation partners than with regional partners (Keeble and Wilkinson, 2000, p. 218). In the Munich region specifically, Sternberg and Tamásy (1999) found that 58% of innovative partner firms and organizations are external to the cluster (20% foreign). In Cambridge, "national and global innovation networks are ... appreciably more frequently rated as important than are local networks" (Keeble et al. 1999, p. 327). Similar results were also found in other British SME surveys (Curran and Blackburn, 1994; Cooke, Boekholt and Toedtling, 1998, Ch. 4).

Wever and Stam (1999) found that in the Utrecht region of the Netherlands, most customers and suppliers that were considered relevant for the innovative development of the participant SMEs were located outside the regional cluster. Horizontal partners, such

as other SMEs, were more often found in the regional cluster itself. What is interesting is that the role of these regional partners for the innovative development of the firms involved in the study was considered much less important than the role of vertical partners, customer and suppliers.

Angel (2002) contends that most technology development partnerships are with non-local firms: “initiatives that focus on promoting partnerships only among local firms and/or regional networks may be too blunt a policy instrument”.

There has been mention that there is increasing importance of inter-regional, that is mainly international, linkages between innovative firms integrated into globalized networks, likely a result of general globalization processes dominating regional economies (Curran and Blackburn, 1994). On the other hand, some researchers such as Dicken et al. (1994) and Saxenian (1994) argue that globalization is also accompanied by regionalization. This means that both the regional and local levels will gain importance because of the opportunity for reducing transaction costs and because of linkages between innovative firms.

More than 75% of Cambridge high technology firms reported possessing close links and networks with other local firms (Keeble et al., 1999; see also Lawson, 1997b; and Lawson *et al.*, 1998). Most of these firms rated their local links as important (3, 4 or 5) for their development, with links with suppliers, subcontractors and service firms being particularly frequent (see Tables 2 and 3).

Table 2

Local Inter-firm Networking

‘Do you have any *close* links with other firms in the Cambridge region?’

	Yes		No. in survey
	No.	%	
High technology manufacturing	17	81	21
High technology services	21	72	29
Total sample	38	76	50

Note: Percentage is of total respondents in each row.

Source: CBR Survey.

Table 3

The Importance of Local Inter-firm Links

‘How important are *local* links with:’

	No. ¹	% of firms with local links
Suppliers or subcontractors	26	68
Firms providing services	20	53
Customers	12	32
Research collaborators	11	29
Firms in your line of business	10	26

Taken together, the findings provide empirical evidence of the existence of “a relatively high intensity of inter-firm and other organizational links within the Cambridge region, which significant numbers of firms regard as important for their development ” (Keeble et al. 1999).

2.16 Impact of Financing on Relationships

Florida and Kenney (1988, p. 43) have referred to venture capital as being "an integral part of the well developed technology infrastructures, or 'social structures of innovation'". Venture capitalists may in fact help create a broader range of inter-firm linkages (Saxenian, 1994) and may render firms more open to communications (Barney et al., 1994).

Venture Capital is consistently identified as being a key factor in explaining the emergence and growth of high technology clusters. Bygrave and Timmons (1992, p. 244), for example, comment that, "there is no doubt that a vigorous local venture-capital community was a necessary element in the building of Route 128 and Silicon Valley".

Accordingly, venture capital makes two key contributions to the development of technology clusters (Mason et al. 2001):

- 1) It is a source of specialist finance for new and growing technology ventures.
There is no guarantee that new high tech firms will be able to recoup their substantial R&D and product development costs in the form of profitable sales. Thus, bank finance is rarely appropriate or available for that matter to high technology firms.
- 2) Venture Capital firms, by their very nature, are involved in supporting their investee companies and assisting business formations. They can do this because they are at the center of extended personalized networks, which link other financiers, entrepreneurs, corporate executives, head-hunters and consultants. These sorts of networks are typically characterized by rapid and continual

circulation of information. It is from this network that venture capitalists draw upon to gather up the resources required for business start-up and growth (Florida and Kenney, 1988b).

Saxenian (1994) notes that venture capitalists in Silicon Valley have provided such things as technical skills, operating experience, networks of contacts, and money, to their 'investee' companies. According to Florida and Kenney (1988), what encourages the need for venture capital firms to locate in close geographical proximity to technology clusters is this reliance amongst venture capital firms on personalized networks of information for identifying investment opportunities, deal-making and mobilization of resources, plus the active participation of such investors in their investee companies.

The Ottawa cluster, however, was not built around a strong presence of venture capital. Most of the venture capital in Ottawa was only made available in the region relatively recently (that is early 90s) (Mason et al. 2001). There has been significant growth in the pool of business angel capital since the mid-1990s with an investment capability of around \$20 million - \$50 million. Now the population of business angels is estimated to be in the order of 500, reflecting the growth in the number of cashed out entrepreneurs and the many company executives who have made significant amounts of money from stock options in successful companies such as Nortel and JDS. There has been a recent (post 1995) influx of venture capital coming from outside of Ottawa such as from other parts of Canada and from the US (Mason et al. 2001).

In 2000, \$1.2 billion of venture capital was invested in Ottawa, 25% of the Canadian total. Venture capital has fallen back in 2001 by some 25% which is not

unexpected in view of the general decline in venture capital investment activity in response to a weakening economy, the collapse in value of high tech stocks and the difficulties of the telecom sector (OBJ, 24 May 2001).

2.17 Impact of Economy on Relationships

As noted in earlier sections, since the previous study (Madill et al. 2002) conducted on the Ottawa technology cluster, advanced technology industries have faced market difficulties. Some of the largest technology based firms have experienced major cut backs, which have led to more than 4,000 layoffs in Canada's high-tech industry.

It is hard to estimate what kind of impact these events have had on the Ottawa technology cluster's inter-firm linkages or on each individual firm's market web. Market webs are known to vary as time passes on: "market webs are not static" (Ryans et al., 2000). They have been shown to change along with changes in competitive conditions, market web members' objectives and loyalties, as well as with new products and services' journey through the product life cycle. From that, one could speculate that market webs and the linkages among organizations might change according to economic conditions. This might even call for a longitudinal analysis (Angel, 2002) such as that planned in the current research.

2.18 Firm Survival

Canadian statistics indicate that a large number of small organizations fail every year. For example there were 9,472 commercial bankruptcies in Canada in 2002 (Statistics Canada, 2003). Although not included in the statistics, failure, or organizational death can also be defined as "critical loss" (Sheppard, 1994b) meaning the

loss in the ability to determine whether one's existence will continue. When two organizations combine, such as in mergers or acquisitions, at least one ceases to exist and this should also be considered a death (Sheppard, 1994b).

Linkages between one firm and another can be critical to the survival of the organization (Sheppard, 1994a; Havnes and Senneseth, 2001, Mazzola and Bruni, 2000; Meyer and Rowan, 1977; Pfeffer and Salancik, 1978). In fact, Galaskiewicz (1985) suggests that the overriding reason that firms establish interorganizational linkages is to ensure their own survival.

To control the effects of the environment, theorists suggest that linkages will increase an organization's ability to survive: "linkages will increase efficiency and serve as a mechanism to secure and increase resources, and to provide access to critical information in the marketplace. As the environment changes, the importance of these linkages becomes more significant" (Bernstein and Beliveau, 1994).

Maintaining a successful performance and surviving in hostile environments is often difficult for more established firms (Hall, 1980). Low performance may be a result of the negative effects of "structural inertia in older, established organizations" (Hannan and Freeman, 1984). Organizational mortality, however, has been shown to decline with age (Freeman, Carroll and Hannan, 1983). An analysis, by Thornhill and Amit (2002) of 339 Canadian corporate bankruptcies suggests that failure among younger firms may be attributable to deficiencies in managerial knowledge, and financial management abilities. On the other hand, failure among older firms may be attributable to an inability to adapt to environmental change.

Sheppard looked (1994a) at the effect on firm survival (defined here as non-failure³) of one particular type of organizational linkage with the board of directors. One particular theory, as related to use of linkages and firm survival, conclusions based on Sheppard's work (1994b), are such that since the perceived functions of outside directors is to insure the long run survival of the organization (West, 1985), one would expect failed companies to have significantly fewer outsiders on their boards (Sheppard, 1994b). Similar to other researchers and theorists, Sheppard (1994a) contends that linkages have a significant effect on the survival likelihood of a corporation and that relationships are attempts by organizations to influence the behaviours of others in their environment (Sheppard, 1994b). In theory, through the manipulation of the firm's relationships with other firms, the organization can better ensure its continued existence. Longitudinal research has suggested further that failing firms gain linkages as they decline; in terms of linkages, "failing firms began to look more like their surviving counterparts as they approached bankruptcy" (Sheppard, 1994b).

Research by Haynes and Senneseth (2001) confirms that there is an interaction between the networking index and growth in market extension. In fact, their data indicated that firms "transcending from a lower to the highest category of networking [networking score] precedes increased growth in market extension" (Haynes and Senneseth, 2001). Confirming these results, a study by Baum and Oliver (1991), demonstrated a significantly positive relationship between an organization's institutional linkages and its ability to survive in increasingly competitive environments.

³ Failure defined as bankruptcy

2.19 Overall Conclusions from Literature

It has been established that each firm is surrounded with a market web which consists of the firm itself and a number of relationships upstream and downstream from it (Ryans et al. 2000) and that relationships and linkages are important to the survival of any business, especially firms which are technology oriented. A *market web* can extend beyond regional borders, and more importantly beyond a cluster region.

Inherent in the definition of a cluster is the concept of linkages and relationships (Porter, 1990,1998; Wever and Stam, 1999; De Langen, 2000). A cluster, as opposed to a *market web*, consists of relationships with firms within the cluster region only. A cluster environment has been shown to be crucial for the survival of small firms, especially start-ups (Cooper and Folta, 2000). Moreover, the benefits of networks and linkages have been found to be of particular importance to SMEs primarily because of lack of internal resources. Technology clusters are largely comprised of SMEs: 90-95% of the firms in clusters (Roy, 2001). It is further shown empirically that technology SMEs do differ significantly from the more traditional non-technology based SMEs. High-technology SMEs are significantly more innovative and have demonstrated a high level of local networking, collaboration, and linkage (Keeble and Wilkinson, 2000).

The majority of the research has found that technology based firms have a higher frequency and place more importance on their networks and linkages than do firms in non-technology based industries although clear patterns of the opposite have been found in some recent studies. Madill et al. (2002) (the study upon which this particular research

proposal is based) found that technology based firms were significantly less linked than non-technology based firms in the Ottawa cluster.

The literature has also demonstrated that regional collective learning processes contribute to growth and success of firms and the region itself within various regional high technology clusters and that inherent in these processes are inter-firm linkages.

Due to globalization, many of the linkages in a cluster environment do also include outside linkages to other firms/associations outside the cluster such as national and international linkages. Regional and global networking appear to be complementary and simultaneous rather than alternative processes which actually allow high-technology SMEs to sustain their innovative activity and competitive advantage (Keeble and Wilkinson, 2000, p. 14).

In terms of funding, venture capitalists may in fact help create a broader range of inter-firm linkages (Saxenian, 1994) and may render firms more open to communications (Barney et al., 1994).

Chapter 3: Research Premise

3.1 Introduction

In 2000, Madill, Haines and Riding conducted a study that was intended to explore networks and linkages among organizations in the Ottawa technology cluster. The main objective of the study was to achieve a better understanding of the forces that create and shape regional technology clusters and the nature of the networks that appear to be central to regional cluster formation. It was their intention to examine in more detail the nature of linkages and networks among firms in a technology-rich cluster. They chose to investigate the differences between technology intensive firms and non-technology based supplier firms in the Ottawa cluster. Data was collected from a sample of technology and non-technology based firms within the tech cluster of Ottawa, Ontario, Canada, in the Spring of 2000.

3.2 Background

Data for the previous study was collected under the direction of Madill, Haines, and Riding. The questionnaire administered had sections measuring: formation of firms, owner characteristics of firms, founders of firms, and the nature, frequency, and value of the networks and linkages of the firms in the cluster.

To obtain this quantitative data, Madill et al. surveyed CEOs of both technology firms and non-technology firms in the Ottawa region. Questionnaires were sent to the CEOs of 423 technology-based businesses within the Ottawa region and to the CEOs of 343 non-technology supplier firms within the Ottawa region. The questionnaires were

distributed using a fax-back method, as part of a personalized mail merge package. Within the package was a fax cover sheet, a personal letter from the research team to the CEO seeking their participation, a one-page description of the research project, a return fax cover sheet and the five-page questionnaire. To encourage participation, follow up faxes were sent to non-respondents after two weeks, which were later followed up by reminder telephone calls.

The research group was able to gather 111 responses from technology-based firms, a 26% response rate, and 75 responses from non-technology based firms, that is a response rate of 22%.

3.3 Research Objectives

The objective of this study is to enhance the current understanding of the forces and influences that come together to create and shape regional technology clusters and to further study the nature of the networks that appear to be central to regional cluster formation. The main goal of this research is to examine in more detail the nature of networks and linkages among firms in the technology cluster of Ottawa.

This research tracks changes in the nature and use of networks and linkages among technology firms within the Ottawa cluster from the study performed in 2000 to this 2003 follow-up study.

3.4 Focus of the Research

The goal is to focus on the same variables as were examined by Madill et al. in order to provide for a strong basis of comparison. New dimensions, which may have

been touched upon in the previous research, are however added (i.e. use of *market web* linkages). This adds a new depth to the research.

3.5 Propositions

The purpose of the present study is to continue on the basis of the work performed by Madill, Haines and Riding in a longitudinal framework. The literature reviewed above was used to guide this research proposal; and as such, the following propositions were developed from the existing literature.

Proposition 1: Technology-based firms use more linkages with organizations in their cluster than do firms in non-technology based sectors.

Proposition 2: Technology-based firms use more linkages with organizations in their market web than do firms in non-technology based sectors.

Proposition 3: Technology-based firms value their linkages with organizations in their cluster more than do firms in non-technology based sectors.

Proposition 4: Technology-based firms value their linkages with organizations in their market web more than do firms in non-technology sectors.

Note: The previous research by Madill et al. (2002) was solid yet the results are quite contradictory to previous findings in this area, hence the reason for propositions 1 through 4. The weight of empirical evidence suggests that, as presented in Freel (2000), most innovative firms are more likely to have a higher frequency of linkages and to value their linkages more than non-technology based firms. In fact, the results of several European studies confirm that high technology SMEs exhibit significantly higher levels of inter-firm networking and collaboration than less technologically-focused SMEs

(Keeble et al., 1997). The substantial evidence provided by the literature thus lead to the development of the above-mentioned propositions, despite Madill et al.'s contradictory results.

Proposition 5: The technology-based firms in the 2003 sample are likely to use more linkages with organizations in their cluster web than was reported by the technology firms in the 2000 research sample.

Proposition 6: The technology-based firms in the 2003 sample are likely value more their linkages with organizations in their cluster web than was reported by the technology firms in the 2000 research sample.

Note: Propositions 5 and 6 were based on the fact that the previous study was conducted during a period of prosperity for high technology firms in the cluster, and this follow-up study will be performed during a time of recession. The thought is that this economic variable will have an impact on the usage and importance of linkages among firms in the cluster. Since no empirical evidence was found to support these propositions, they are merely based on reason. It is expected that because technology firms are suffering financially, that perhaps they will look to outside sources to help them endure this hard economic period. Three years ago, the technology cluster in Ottawa was extremely prosperous and flourishing. Many firms were able to find success with minimal assistance by means of networks. Now that many firms are suffering, it is thought that their usage patterns and view on the importance of linkages will have changed.

Proposition 7: Technology-based firms are likely to have more frequent linkages with organizations that are similar to the organization's original source of technology.

Proposition 8: Technology-based firms are likely to have more valued linkages with organizations that are similar to the organization's original source of technology.

Proposition 9: Technology-based firms that have obtained financing from venture capitalists are likely to have more frequent linkages with organizations than are organizations that have not received venture capital financing.

Proposition 10: Technology-based firms that have obtained financing from venture capitalists are likely to have more valued linkages with organizations than are organizations that have not received venture capital financing.

Proposition 11a: Technology-based firms are likely to have more intra-regional linkages, than firms in non-technology based industries.

Propositions 11b: Technology-based firms are likely to have less inter-regional (national) linkages, than firms in non-technology based industries.

Proposition 12: Technology-based firms are likely to have more internationally based linkages than non-technology based firms.

Proposition 13: Subsidiaries of major technology organizations are more likely to engage in local networking.

Proposition 14: SMEs are likely to have more frequent linkages with organizations in their cluster and *market web* than large organizations.

Proposition 15: SMEs are likely to have more valued linkages with organizations in their cluster their *market web* than large organizations.

Chapter 4: Research Methodology and Data Analysis

4.1 Introduction

New data was collected with the goal of measuring the frequency and value of technology firms' linkages with both their cluster and *market web*. The study will compare this data to the existing data from the survey conducted in 2000. The methodology of this research resembles greatly the format of the previous study, which enhances the consistency of the longitudinal analysis.

In this section, the design of the research will be outlined, along with the measurement questions and the overall methodology of the research, including the data collection process.

4.2 Research Design

In order to conduct the follow-up research, a simple one-part methodology was employed using a delivery and return technique. To test the propositions outlined in section 3.5, the study has remained regional in scope (Ottawa region) and has had a time frame of April 2003 to September 2003. The fieldwork constituted of a series of faxed surveys along with follow-up letters.

4.3 Measurement Questions

This section (presented in detail in Appendix E) links the investigative questions with the appropriate propositions and then indicates the measurement questions that were applied. Appendix E also includes the data analysis techniques that will be used in making sense of the final data.

4.4 Research Methodology

4.4.1 Population Definition

The population for the study comprises of technology intensive firms and non-technology based firms that supply the technology intensive firms in the Ottawa cluster.

4.4.2 Sampling Frame

The sampling frame was pre-determined by the original study performed three years ago (Madill et al., 2002). It was derived from a commercial database purchased from the *Ottawa Business Journal*, which provides an industry classification for each firm. The use of this database as the sampling frame is appropriate in this situation because there is no other up-to-date listing readily available that distinguishes the technology industry classification. In keeping with the methodology of the previous study, for consistency reasons, it is also important that the same conceptual sampling frame be used. This way, comparisons to the previous study conducted in the Ottawa cluster can be accurately made.

4.4.3 Unit of Analysis

SMEs are defined as firms with annual revenues of \$50,000,000 or less and 500 employees or less. Storey (1994, p.13) provides support for this in his definition of SMEs as he divides the sector into three as follows:

- Micro-enterprises are those with between 0 and 9 employees;
- Small enterprises are those with 10 to 99 employees; and
- Medium enterprises are those with 100-499 employees.

4.4.4 Type of Sampling

Given that the population of technology firms in the Ottawa cluster was a manageable number (769 technology-based firms and 698 non-technology supplier firms), the entire population of firms provided by the commercial database were sent a faxed survey, as was done in the previous study.

4.5 Data Collection

The previous study used the fax/fax-back technique. This method seems not to have presented any undue difficulties and yielded relatively decent response rates (26% and 22% respectively for high technology and non-technology based supplier firms). Following suit, the questionnaires were thus sent out as a fax-back form and were addressed to the attention of the CEO. A similar package to the previous study was also sent, consisting of a fax cover sheet, a personal letter from the committee, a one-page description of the research project, a return-fax cover sheet, and the questionnaire. The entire package faxed consists of 11 pages.

Follow-up letters were also faxed out two weeks after the initial distribution to encourage participation (see Appendix C). An additional option of filling out the survey online was offered to the recipients, which helped bring up the response rate. This fieldwork was carried out during the months of May to July of 2003.

It is noted that ongoing research has been conducted by the members of the committee in this area, pulling firms from the Ottawa cluster to conduct interviews on this very topic of networks and linkages. The chances were high that a fax would be sent to a firm who had been already contacted, maybe even on more than one occasion. Of

the high-technology firms in the 2003 technology database, 68 (8.9%) were contacted and 9 (1.2%) actually participated in the interview process. Of the non-technology based supplier firms, 36 (5.2%) were contacted and only 5 (0.7%) agreed so far to participate in the interview process. See *Appendix D* for an overview of the overlap between the database used for this study and the companies used as case studies.

4.5.1 Fax Back Surveys

The research questionnaire for this study was heavily based on the one used by Madill, Haines and Riding. A similar questionnaire was used along with some additional questions (see Appendix A - for whole package of cover letters and survey). In view of the recent research efforts described above, the firms who participated in the case study interviews were pulled from the database.

4.5.2 Cover Letters

Each survey questionnaire was accompanied by a fax cover sheet, a personalized introductory letter and a generic description of the current and previous research titled “Knowledge Transfer in Regional Technology Clusters: The Case of Ottawa” (see Appendix A for whole package of cover letters and survey).

In order to decrease the resistance on the part of previous participants, as mentioned above in section 4.5 *Data Collection*, a separate letter has also formulated targeting these particular companies, which acknowledged their latest contributions to the research (see bold wording in *see Appendix B*).

4.5.3 Pre-Test

Pre-testing was performed in the last week of April. The survey included an additional question as recommended by Aaker and Day (1983) which goes as follows, “We would appreciate any suggestions you may have for making this questionnaire clearer or easier to answer. For instance, were any of the questions confusing? Why?”. The pre-test survey was delivered to some graduate students at Carleton University who have full-time employment in firms in the Ottawa region. Further, the survey was also distributed to a few random contacts from both the technology and non-technology databases. The pre-test phase was quite useful in making sure that the intended audience would understand what was asked of them. In fact, a couple of graduate students at Carleton suggested that the questions be re-arranged into a more strategic and rational order.

4.6 Data Analysis

Due to the nature of this follow-up study and the configuration of the survey, the data analysis for this research draws on only quantitative techniques. The previous study utilized a series of t-tests to measure differences between technology intensive firms with the non-technology based supplier firms in the Ottawa cluster. This study will thus include primarily t-tests in order to perform a similar basis of analysis. The data analysis techniques are summarized in Appendix D.

4.7 Conclusion

The intent of this research is to answer the research question: “Are there significant differences between technology-based firms and non-technology based

supplier firms in the usage and valuation of networks and linkages with other organizations in their cluster and their *market web*?”. The importance of the topic was established and an extensive literature review was performed outlining several different theories surrounding market web relationships, networks and linkages within clusters, technology-based firms and their use of linkages, and several other areas surrounding cluster research. The research premise was outlined along with propositions. The research design was laid out providing details on the research methodology, the data collection, and the data analysis. The study remained regional in scope (Ottawa region) and had a time frame of April 2003 to September 2003.

Chapter 5: Analysis and Results

This chapter will report on the results of the research survey. The first few sections will go in depth with the profile of the technology firms and non-technology firms including company demographics, information on the company founders, and information on the formation characteristics of the firms in the sample. A short comparison will then be performed to identify some of the key similarities and differences with the 2000 Madill et al. sample firms. The next sections will examine and test in detail the research propositions. Each proposition will be empirically tested and the research results will be reported. The chapter will conclude with some additional research on the effect of the economy on the way the companies in the research sample use and value their linkages. This is intended to provide some additional insight into the research results.

5.1 Breakdown of Respondents

The following is a short account on the overall research sample. This section provides a breakdown of the firms that made up the sampling frame and the firms that make up the research sample.

The technology database purchased from the *Ottawa Business Journal* (sampling frame) contained 759 companies classified as technology firms and 691 classified as suppliers to the technology firms (non-technology). According to the 2003 technology database, the top three sub-sectors of technology firms are Software (24 percent), Telecommunications (16 percent) and e-Commerce (13 percent) (see Figure 12 in Appendix F). A similar breakdown was done with the 86 non-technology firms (firms

that supply the technology firms) in the research sample, such that 21 percent of them provide an array of consulting services, and 10 percent provide specifically management consulting services (see Figure 14 in Appendix F for rest of breakdown).

For this study, 587 (77.3 percent) technology firms and 493 (71.3 percent) non-technology firms actually received the survey. The remaining firms were unreachable in that they either had no fax number or the faxes bounced back. Although, time and effort were spent trying to locate appropriate coordinates for these firms, they were unreachable.

The total sample size attained for this research study was 182 firms. That is, 182 firms responded with completed surveys. Of these firms, 96 were classified as technology firms and 86 were classified as non-technology firms (supplier firms). That calculates as a 16.4% and 17.4% response rates respectively.

Some of the firms in the sample had also participated in the original study conducted in 2000. Of the 94 technology firms and 47 non-technology firms in the 2003 sampling frame, who had been previous respondents in the 2000 study, 17 technology (18% response rate for repeated respondent) and 4 non-technology firms (9% response rate for repeated respondent) responded again in 2003. See the breakdown of the entire research sample in the Figure 2.

Figure 2
Breakdown of 2003 Respondents

5.2 Profile of Technology Firms: “Formation and Owner Characteristics”

The formation and owner characteristics of technology firms in the sample will be broken down into a few small sections reporting on the age, the formation characteristics, and the use of risk capital by the technology firms.

5.2.1 Age of Technology Firms in Sample

The median year in which the technology firms were established is 1996 (7 years of age) and the mode is 2001. Just over a third of the firms were established within the last four years (see Table 4 below).

Table 4

Year Technology Firms were Founded

	Number	Percentage
Prior to 1989	26	27.7%
From 1990 to 1998	35	37.2%
1999	4	4.3%
2000	12	12.8%
2001	15	16.0%
Within last 4 years	33	35.1%

The age distribution of the respondents' firms is as follows, as in Figure 3.

Figure 3

Age Distribution for Technology Firms

5.2.2 Formation Characteristics of Technology Firms in the Sample

The majority of the technology firms (92.6 percent) were formed in the Ottawa Cluster region. Of 7 firms not formed in the Ottawa Cluster region, 4 were formed in the United States and 3 were formed somewhere else in Canada. The large majority of the technology firms (93.6 percent, 88 firms) were formed as an independent firm, of which

76 firms (85.4 percent) remain independent. Half of the firms who are no longer independent became attached in some way within the last four years (1999 and on).

5.2.3 Raising Risk Capital for Technology Firms

For technology firms, 46 (49 percent) indicated having raised some risk capital. Please refer to the table below for a breakdown of the sources of this risk capital. Please note that firms were asked to list all sources used while raising risk capital, thus some firms may have indicated more than one answer. See Table 5 and Figure 4 for more detail.

Table 5

Technology Firms' Source of Risk Capital

	Frequency	Percentage
Business Angels	29	30.9%
Ottawa-Based Venture Capital Firms	16	17.0%
Other Canadian Business Venture Capital Firms	21	22.3%
US Venture Capital Firms	15	16.0%
Other Foreign Venture Capital Firms	4	4.3%
Non-Financial Corporations	4	4.3%
Other Source of Venture Capital	5	5.3%
Total	94	100.0%

The source of venture capital most often used by the technology firms is business angels (30.2%) and other Canadian business venture capital firms (22.3%). Ottawa-based venture capital firms came in third place with 17%. See Figure 4.

Figure 4**Sources of Venture Capital for Technology Firms** **5.3 Profile of Supplier Firms: “Formation and Owner Characteristics”**

The formation and owner characteristics of non-technology firms (supplier firms) in the sample will also be broken down into a few small sections reporting on the age, the formation characteristics, and the use of risk capital by the technology firms.

5.3.1 Age of Non-Technology Firms in Sample

The median year in which the non-technology firms were established is 1995 (8 years of age). The mode was 1998 and 2001. A large number of firms (46.5%) were established in the 1990s (see Table 6).

Table 6

Year Non-Technology Firms were Founded

	Number	Percentage
Prior to 1989	22	25.6%
From 1990 to 1998	40	46.5%
1999	5	5.8%
2000	7	8.1%
2001	9	10.5%
Within last 4 years	24	27.9%

The distribution of age of the respondents' firms is as follows, as in Figure 5.

Figure 5

Age Distribution for Non-Technology Firms

5.3.2 Formation Characteristics of Technology Firms in the Sample

The majority of non-technology firms (84.9 percent) were formed in the Ottawa Cluster region. Of the 13 firms not formed in the Ottawa Cluster, 3 were founded in the United States and 10 firms were founded somewhere else in Canada. Again, the majority (96.5 percent) of the supplier firms were formed as independent firms, of which 78

remain independent (90.7 percent). Only 9 supplier firms indicated being a subsidiary of a larger organization. The remainder confirmed that they are not a subsidiary of a larger firm (89.4 percent).

5.3.3 Raising Risk Capital for Non-Technology Firms

Of the total non-technology firms, 14 (17 percent) indicated having raised some risk capital. Please refer to the table below for a breakdown of the sources of this risk capital. Please note that firms were asked to list all sources used while raising risk capital, thus some firms may have indicated more than one answer. See Table 7 for sources of financing.

Table 7

Non-Technology Firms' Source of Risk Capital

	Frequency	Percentage
Business Angels	11	36.7%
Ottawa-Based Venture Capital Firms	4	13.3%
Other Canadian Business Venture Capital Firms	3	10.0%
US Venture Capital Firms	5	16.7%
Other Foreign Venture Capital Firms	1	3.3%
Non-Financial Corporations	2	6.7%
Other Source of Venture Capital	4	13.3%
Total	30	100.0%

The non-technology firms' responses to this question are similar to that of the technology firms. The source of venture capital most often used by the non-technology firms is business angels (36.7 percent) as shown in Figure 6.

Figure 6**Source of Venture Capital for Non-technology Firms** **5.4 Company Demographics: Comparing Technology and Non-Technology Firms**

Now that each category of firm, technology and non-technology, has been examined individually in terms of formation characteristics, this section brings both groups and compares them in terms of company size (number of employees).

5.4.1 Size of Firms

Of the respondents, 94 technology firms and 84 non-technology firms provided valid answers when asked how many employees worked for their firm. The mean, median and mode of full-time employees for technology and non-technology firms is provided in Table 8 to compare between firm category.

Table 8

Comparison of Overall Full-Time Employees

	Full-Time Employees		
	Mean	Median	Mode
Technology	2140.89	16.5	15
Non-Technology	111.45	8.5	1*

*Multiple modes exist, smallest value is shown

The breakdown, by average number of employees per geographic region, for the technology and non-technology firms is in Table 9.

Table 9

Comparison of Mean Number of Employees per Geographic Area

		Technology	Non-Technology
Ottawa	Full-Time	48.81	14.40
	Part-Time	1.67	0.60
	Contract	2.49	5.98
Rest of Canada	Full-Time	52.23	45.01
	Part-Time	0.90	4.85
	Contract	1.20	11.76
Rest of World	Full-Time	2051.31	30.64
	Part-Time	0.00	1.13
	Contract	0.78	167.50

From these numbers it is clear that technology firms employ many more full-time employees in the Ottawa region and the rest of the world than the non-technology firms. In contrast, non-technology firms employ more contract workers in Ottawa, Canada and the rest of the World.

From another perspective, it appears that the really large firms (above 3000 employees) in the technology group could have impacted the mean scores. The median

scores for overall employees provides a more accurate perspective (Table 8). The breakdown of technology and non-technology firms in terms of micro enterprises (firms with 0 to 9 employees), small enterprises (firms with 10 to 99 employees), medium enterprises (firms with 100 to 499 employees) and large enterprises (firms with more than 500 employees), according to Storey (1994, p.13), is in Table 10. The technology firms are slightly larger in size than the non-technology firms.

Table 10

Breakdown of Firm Size: Comparison of Technology and Non-technology Firms

	Technology		Non-Technology	
	Frequency	Percent	Frequency	Percent
Micro (0 to 9)	24	25.3%	44	52.4%
Small (10 to 99)	56	58.9%	36	42.9%
Medium (100 to 499)	7	7.4%	1	1.2%
Large (500 to 999)	8	8.4%	3	3.6%

5.5 “The Founders”: Comparing Technology and Non-Technology Firms

The comparative analysis between technology and non-technology firms continues in this section in order to examine the similarities and differences in terms of the company founders. This section will compare the technology and non-technology firms on the size of the original founding team, the number of founders that had previously worked together, the number of founders that remain with their firms today, the types of organizations the founders worked for previous to the founding company, the distance from which their previous organizations were from the founding company, the

types of functional responsibility the founders had before founding the companies, and finally, the knowledge on which the founded company is based upon.

5.5.1 Founding Team

The majority of businesses (75.3 percent for technology and 68.2 percent for non-technology) were founded by a team consisting of at least two individuals. For technology firms, 60 percent of firms reported either two or three founders (only 48.2 percent for supplier firms). Just under a quarter of the technology firms (24.7 percent) were founded by only one individual. The same number of non-technology firms were founded by one individual as those founded by two people (31.8 percent each).

5.5.2 Original Founders

The mean number of original founders for the technology firms was 2.53, while the mean number of original founders for the non-technology firms was 2.69. See Table 11 for a breakdown of the number of original founders for the technology and non-technology firms.

Table 11

Technology vs. Non-Technology Firms in Number of Original Founders

# of Founders	Technology		Non-Technology	
	No.	Percentage	No.	Percentage
1	23	24.7	27	31.8
2	34	36.6	27	31.8
3	18	19.4	14	16.5
4	6	6.5	7	8.2
5	6	6.5	3	3.5
6	6	6.5	4	4.7
7	-	-	2	2.4
25	-	-	1	1.2

In the vast majority of technology firms, the founders had worked together prior to founding of the companies. In 55 percent of the firms, all of the founders had worked together and in 27.5 percent, some of the founders had worked together. In half of the supplier firms, the founders had all worked together prior to founding of the companies (50 percent). In a smaller percentage of the firms (22.1 percent), some of the founders had previously worked together and interestingly a larger percentage (26.5 percent) of the firms were founded by people who had never previously worked together.

5.5.3 Founders Still with the Firm

There was a difference between the technology and non-technology firms in the sample, such that, in technology firms, the founders are more likely to remain with their firms (see Table 12 below for summary and Tables 60 to 63 in Appendix G for breakdown). This is similar to the results from the 2000 study.

Table 12

Proportion of Founders Still with the Firms: Comparing Technology and Non-Technology Firms

	Technology Firms	Non-Technology Firms
Established before 1988	49.0%	41.1%
Established after 1988 and before 1999	75.6%	80.4%
Established after 1999	89.9%	92.3%
Total	75.2%	73.9%

5.5.4 Type of Organization Founders Worked For Previous to Founding Company

The type of organization (s) the founder/founders worked for immediately before their companies were founded show some differences between the technology and non-technology firms. For both, technology and non-technology firms, the largest percentage of founders came from small firms (35.9 percent technology and 39.8 percent non-technology). There are noticeable differences between the two groups. Technology firms have a higher proportion of founders coming from universities than do the non-technology firms. There is an even bigger differential in the number of founders coming from medium firms. Many more founders from technology firms (33 percent) worked for medium firms, compared to the founders for the non-technology firms (15 percent). See Table 13 for comparison between two firm categories.

Table 13

Type of Organizations Founders Worked For Before Founding Company

	Technology	Non-Technology
Federal Gov't/ Crown Corp.	19 (10.5%)	17 (9.4%)
Provincial Gov't	1 (0.6%)	2 (1.1%)
University	16 (8.8%)	7 (3.9%)
Small Firm	65 (35.9%)	72 (39.8%)
Medium Firm	60 (33.1%)	27 (14.9%)
Large Firm	52 (28.7%)	45 (24.9%)
Other	16 (8.8%)	11 (6.1%)

5.5.5 Distance of Previous Organization From Founding Firm

When asked, “how far was the organization [for which the founder worked for] away from the start-up location of this company?”, a very large majority of technology firms and non-technology firms indicated less than 30 miles for their respective

companies (88.7 percent technology and 81.3 percent non-technology). See Table 14 for comparison.

Table 14

Distance of Previous Company Founders Worked for Previous to Founding Company

	Technology	Non-Technology
Close (More than 30 miles)	181 (88.7%)	135 (81.3%)
Near (30 to 199 miles)	4 (2.0%)	15 (9.0%)
Far (200+ miles)	19 (9.3%)	16 (9.6%)

5.5.6 Functional Responsibility of Each Founder in Previous Organization

The respondents were asked to indicate what the main functional responsibility of each founder was in the organization that they worked for immediately before starting the company. See the charts below for the breakdown of responsibilities for the technology firms and the non-technology firms. See Table 15 and Figure 7 for comparison.

Table 15

Prior Functional Responsibility of Founders

	Technology	Non-Technology
Research	59 (19.0%)	25 (10.5%)
Technical	91 (29.3%)	56 (23.5%)
Production/ Operations	36 (11.6%)	22 (9.2%)
Sales/ Marketing	47 (15.1%)	58 (24.4%)
Finance	30 (9.6%)	22 (9.2%)
General Man.	37 (11.9%)	43 (18.1%)
Other	11 (3.5%)	12 (5.0%)

Figure 7

Illustration of Functional Responsibility of Founders

The technology firms' founders, as seen in the chart above, appear to have come from mostly technical and research oriented job positions. Founders from the non-technology firms also had a good portion of founders coming from a technical functional responsibility but a larger proportion had a Sales/Marketing oriented position.

5.5.7 Knowledge on Which Founded Company is Based

The respondents to the questionnaire were asked to identify "where ... the knowledge on which this company is based was developed". Respondents could identify multiple sources. The breakdown of the indicated sources is shown in Table 16 and Figure 8.

Table 16

Sources of Knowledge for Technology and Non-Technology Firms

	Technology	Non-Technology
University	20 (14.6%)	28 (20.4%)
Government	12 (8.8%)	18 (13.1%)
Previous Private Sector Employer	41 (29.9%)	42 (30.7%)
Previous Public Sector Employer	8 (5.8%)	14 (10.2%)
Personal R&D Activity	43 (31.4%)	27 (19.7%)
Another Company	11 (8.0%)	19 (13.9%)
Other	2 (1.5%)	3 (2.2%)

Figure 8

Sources of Knowledge for Technology and Non-Technology Firms

The knowledge on which the technology companies are based was developed primarily based on personal R&D activity (31.4 percent) and previous private sector employers (29.9 percent). The largest proportion of non-technology firms were also

based on knowledge stemming from a previous private sector employer (30.7 percent). Non-technology firms were also based highly on knowledge from universities (20.4 percent).

5.6 Comparison with Sample of Madill et al. Research (2000)

This section will highlight some of the key similarities and differences between the technology firms in this 2003 sample and the technology firms in the sample used in the 2000 Madill et al. research.

5.6.1 Breakdown of Respondents: Comparing 2000 and 2003

In the 2000 study, 111 responses were obtained from technology-based firms (26% response rate) and 75 responses from supplier (that is, non-technology) businesses (22% response rate).

In this 2003 study, 96 responses were obtained from technology-based firms (16.4% response rate) and 86 responses were obtained from supplier (non-technology) firms (17.4% response rate). Clearly, the response rate is lower than that established three years ago.

Information technology (IT) firms were the single largest subsector in 2000, representing about one-third of technology-based businesses – see Appendix F, Figure 13 (Madill, Haines and Riding, 2003). In 2003, the *Software* firms are the largest subsector, representing a quarter of the 2003 technology-based firms in the Ottawa cluster and the *Telecommunication* firms subsector come in second representing 16 percent – see Appendix F, Figure 12. The IT firms subsector only represents 14 percent of technology-based businesses in 2003. This is 20 percent less than three years ago.

5.6.2 Age of Respondent Firms: Comparing 2000 and 2003

As reported by Madill et al. (2002), the median age for technology firms in 2000 was 11 years old. In the sample of technology firms, 55 firms were established prior to 1988 and only 18 firms were founded within the last four years (1996 and subsequently) of the study. The median age for the non-technology firms in 2000 was 8 years old. Of the non-technology firms in the sample that year, 32 firms were established prior to 1988 and only 10 firms were founded within the last four years (1996 and subsequently) of the study date.

In this study, the median year in which the technology firms were established is 1996 (7 years of age). Just over a third of the firms (33 firms) were established within the last four years. The technology firms in the 2003 study are thus much younger than the respondents in the 2000 study.

The median year in which the non-technology firms in the 2003 sample were established is 1995 (8 years of age). A large number of firms (45 firms) were established in the 1990s and 24 firms were established in the last four years. The non-technology firms, however, are of comparable age to those in the 2000 sample.

5.6.3 Founding Team: Comparing 2000 and 2003

The technology firms in the 2000 sample were mainly founded in the Ottawa area (88 percent). The large majority of firms (96 percent) were founded as independent companies, of which most remain independent (79 percent). The non-technology firms in the 2000 sample were also mainly founded in the Ottawa region (84 percent) and almost

all firms (93 percent) were founded as independent firms, most of which (76 percent) remain independent

The technology firms in the 2003 sample were mainly formed in the Ottawa area (93 percent) and most were founded as independent companies (94 percent), of which most remain independent (85 percent). The non-technology firms in the 2003 sample were mainly founded in the Ottawa region (85 percent). Nearly all firms (97 percent) were founded as independent firms, most of which (90.7 percent) remain independent.

Most of the technology and non-technology firms (76 percent of technology firms and 77 percent of non-technology firms) were founded by a team consisting of at least two individuals.

For firms in the 2003 sample, 75 percent of technology firms and 68 percent of non-technology firms reported being founded by a team consisting of either two or three founders.

In the 2000 study, it was discovered that the founders for technology firms were more likely to remain with their firms, similar to the 2003 results.

The breakdown of functional responsibility for founders in the 2000 sample is similar to the 2003 sample (see Table 17). The founders for the technology firms in 2000 however were more likely to come from a General Management position than the 2003 technology firms. Founders in the 2003 technology firms' sample were more likely to come from Production/Operations and Sales/ Marketing backgrounds than the 2000 sample of technology firms.

In 2003, the technology firms have a higher proportion of founders coming from Production/Operations background than the non-technology firms in the same year. This is opposite of what was found in 2000.

Table 17

Prior Functional Responsibility of Founders: Comparing 2000 and 2003 Samples

	2003		2000	
	Technology	Non-Technology	Technology	Non-Technology
Research	19.0%	10.5%	21.9%	15.1%
Technical	29.3%	23.5%	27.9%	22.0%
Production/ Operations	11.6%	9.2%	7.4%	12.7%
Sales/ Marketing	15.1%	24.4%	12.3%	19.5%
Finance	9.6%	9.2%	11.4%	11.2%
General Man.	11.9%	18.1%	19.1%	19.5%

The breakdown of the knowledge on which the companies were based was as also comparable overall. There were higher proportions of tech and supplier firms in the 2000 sample that stated a source of knowledge from a university and from another company than the 2003 sample, but overall all other areas were similar in numbers.

The 2000 and 2003 samples bare some slight differences but are overall similar in terms of company profiles and founder characteristics.

5.7 Conclusion of Preliminary Profile Comparison

The non-technology firms in this sample are slightly older than the technology firms. The large majority of firms in both groups were formed in the Ottawa cluster region and formed as an independent firm, of which a high percentage still remain independent.

The two categories of groups are different with respect to the use of venture capital. Nearly half of the technology firms raised risk capital while less than one quarter of the non-technology firms raised such funds. Both groups do however show a use of financing from business angels. The two categories of firms also appear to differ with respect to the proportion of founders still with their respective firms. Founders for the non-technology firms appear to remain with the firms longer than those with technology firms.

The type of organizations the founder/founders worked for immediately before their companies were founded varied on different levels but most of the founders for the technology and non-tech firms came from small firms.

Similar to each other, the large majority of founders for the technology and non-technology firms worked within 30 miles of the founded company, before founding it. This indicates homegrown talent and entrepreneurship.

The technology and non-technology firms differed slightly in terms of the functional responsibility of the founders in their previous organizations. The technology firm founders were mainly set in technical roles while the non-technology founders were mainly in Sales/Marketing roles. Again, the two categories of firms appear to also differ with respect to the distribution and frequencies of sources of knowledge.

It is however, overall safe to assume that the two categories of firms are well matched and provide a reasonable basis for comparison.

5.8 Research Results: Examining and Testing the Propositions

This section will go into detail and empirically test the research propositions. For ease of reading, all propositions will be repeated and will be followed by the research results. For a summary of the t-test results, for all of the propositions in the study, please refer to *Appendix I*. This takes an overall perspective on the research findings.

5.8.1 Networks and Linkages Within Cluster

This section will test empirically the difference in use and value for linkages within the cluster region between technology and non-technology firms. The propositions being tested are listed below followed by the research findings.

Proposition 1: Technology-based firms use more linkages with organizations in their cluster than do firms in non-technology based sectors.

Proposition 3: Technology-based firms value their linkages with organizations in their cluster more than do firms in non-technology based sectors.

To measure the usage and value of linkages the respondents were asked to rate the frequency of use of linkages with 11 types of individuals and organizations in the Ottawa area. They rated usage on 5-point scales ranging from “not used at all” to “used frequently”. The value of these linkages was also measured by asking each respondent to rate the value of each linkage on a 5-point scale ranging from “not at all valuable” to “extremely valuable”. This approach replicates the one used by Madill et al. in 2000. Tables 18 and 19 present the 11 categories of possible linkages along with the means for each scale for technology and non-technology firms in terms of use of and value for linkages.

Table 18Technology and Non-Technology Firms – Usage of Linkages Within Cluster

		Technology		Non-Technology	
		Mean	Stan. Dev.	Mean	Stan. Dev.
1	Suppliers	3.21*	1.17	3.59	1.25
2	Service Firms	3.31	1.09	3.43	1.22
3	Customers	3.45*	1.50	4.12	1.31
4	Research/Universities	2.00	1.19	1.99	1.22
5	Research/Government	2.13	1.31	1.87	1.14
6	Research/Industry	1.92	1.13	1.92	1.17
7	Firms in Industry	2.34*	1.21	2.93	1.24
8	Subcontractors	3.01	1.36	3.3	1.39
9	Professional Organizations	2.39	1.20	2.64	1.28
10	Board of Trade	1.51**	0.76	1.75	1.05
11	Economic Development Office	1.63	0.93	1.64	0.98
	Mean of Total Summated Scores	26.85	7.17	28.78	6.90

* Significant at the 95% confidence interval,

** Significant at the 90% confidence interval

Table 19Technology and Non-Technology Firms – Value of Linkages Within Cluster

		Technology		Non-Technology	
		Mean	Stan. Dev.	Mean	Stan. Dev.
1	Suppliers	3.29	1.21	3.39	1.30
2	Service Firms	3.18	1.10	3.24	1.15
3	Customers	3.11*	1.49	3.90	1.35
4	Research/Universities	1.70	1.02	1.50	0.78
5	Research/Government	2.01**	1.20	1.69	1.08
6	Research/Industry	1.79	0.97	1.75	0.99
7	Firms in Industry	2.36*	1.19	2.77	1.19
8	Subcontractors	2.83*	1.33	3.24	1.39
9	Professional Organizations	2.54	1.23	2.52	1.29
10	Board of Trade	1.43**	0.60	1.64	0.98
11	Economic Development Office	1.57	0.84	1.49	0.84
	Mean of Total Summated Scores	25.87	6.50	27.14	6.28

* Significant at the 95% confidence interval ,

** Significant at the 90% confidence interval

In the 2000 study, to test their propositions on usage of linkages among firms, the researchers constructed a scale measuring overall firm linkage and networking by adding the scores on the frequency of usage of links with the 11 categories of potential linkages. A t-test comparing mean usage (as measured by this summated scale) between technology and non-technology firms showed that technology firms were significantly less linked than the non-technology firms in the Ottawa cluster ($t = 3.44$, $p < .001$). A similar method is performed in this research to test Proposition 1 and 3.

To test the difference in use of linkages, 88 technology firms provided valid responses along with 80 non-technology firms. The technology firms reported a mean usage value of 26.85 (s.d. of 7.17) and the non-technology firms reported a mean of 28.78 (s.d. of 6.90).

The t-test results comparing mean usage (as measured by the summated scale) between technology and non-technology firms showed that at the .10 level of significance, technology firms are significantly less linked than the non-technology firms in the Ottawa cluster ($t = -1.77$, $p = 0.08$). See Table 20 for Independent Samples Test.

Table 20

Use of Linkages Between Technology and Non-technology Firms

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	T	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Use	0.03	0.86	-1.77	166	0.079	-1.92	1.09	-4.07	0.23

To compare the value of the linkages between the technology and non-technology firms, only valid responses were scored (89 technology firms and 76 non-technology firms). The overall mean generated from the summated scale for technology firms was 25.87 (standard deviation of 6.50) and 27.14 (standard deviation of 6.28) for non-technology firms. See Table 21 for Independent Samples Test. Note that the average for non-technology firms is higher.

Table 21

Value of Linkages Between Technology and Non-technology Firms

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Value	.07	.80	-1.28	163	.20	-1.28	1.00	-3.25	.69

The t-test results comparing mean value (as measured by this summated scale) between technology and non-technology firms showed that technology firms do not significantly value more their linkages than the non-technology firms in the Ottawa cluster ($t = -1.28$, $p = 0.20$). The test was run at the .05 level of significance.

To analyze a bit deeper and to find out if there are any significant differences between the two types of firms and where they might exist, t-tests were conducted to compare technology and non-technology firms on each of the 11 specific linkage categories measured in this study (see Table 22 for t-test on use of linkages and Table 23 for t-test on value for linkages – please refer to Appendix H, Tables 64 and 65 for N values).

The results reported in Table 22 show that technology based firms have significantly fewer linkages than non-technology firms with: suppliers, customers, and other firms in the industry. The significant differences are identified by the “*” in Table 18 at the .05 level of significance. Technology firms are also found to be significantly less linked than non-technology firms with boards of trade, at the 0.10 level of significance (identified as “**” in the Table 18).

The results reported in Table 23 suggest that technology based firms value significantly less their linkages than non-technology firms with: customers and other firms in the industry (.05 level of significance). The significant differences are identified by the “*” in Table 19.

Testing at the .10 level of significance shows that technology firms value their linkages significantly less than non-technology firms with subcontractors and boards of trade. Surprisingly, technology firms also show to value significantly more their linkages with government research agencies than do the non-technology firms ($t=1.85$, $p=0.07$). The significant differences are identified by the “**” in the Table 19.

Overall, the mean values reported in the Table 18 suggest that technology firms do not use linkages with a broad range of possible members of the *cluster web* including: Research Collaborators (universities, government agencies and the industry), firms in the industry, Professional Organizations, the Board of Trade, and the Economic Development Office. The means of usage and value are all significantly below the mid-points (3.0) of these respective scales.

Table 22

T-Test Results: Comparing Mean Use of Linkages in Cluster Web for Technology and Non-Technology Firms

t-test for Equality of Means										
Levene's Test Equality of Variances for										
F	Sig.	T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference			
							Lower	Upper		
Suppliers	Equal variances assumed	0.74	0.39	-2.10	178.00	0.04*	-0.378	0.180	-0.733	-0.023
	Equal variances not assumed			-2.09	172.50	0.04	-0.378	0.181	-0.734	-0.021
Service Firms	Equal variances assumed	1.72	0.19	-0.68	177.00	0.49	-0.118	0.173	-0.460	0.223
	Equal variances not assumed			-0.68	170.86	0.50	-0.118	0.174	-0.462	0.225
Customers	Equal variances assumed	8.36	0.00	-3.15	177.00	0.00*	-0.665	0.211	-1.081	-0.248
	Equal variances not assumed			-3.17	176.36	0.00*	-0.665	0.210	-1.079	-0.251
Universities (Res)	Equal variances assumed	0.05	0.83	0.06	179.00	0.95	0.012	0.180	-0.343	0.366
	Equal variances not assumed			0.06	176.31	0.95	0.012	0.180	-0.343	0.367
Gov't (Research)	Equal variances assumed	2.21	0.14	1.39	178.00	0.17	0.256	0.185	-0.109	0.620
	Equal variances not assumed			1.40	177.85	0.16	0.256	0.183	-0.106	0.617
Industry (Res)	Equal variances assumed	0.25	0.62	0.05	175.00	0.96	0.008	0.174	-0.335	0.351
	Equal variances not assumed			0.05	171.81	0.96	0.008	0.174	-0.335	0.351
Firms in Industry	Equal variances assumed	1.13	0.29	-3.22	178.00	0.00*	-0.590	0.183	-0.952	-0.228
	Equal variances not assumed			-3.21	175.72	0.00	-0.590	0.184	-0.952	-0.228
Subcontractors	Equal variances assumed	0.16	0.69	-1.42	178.00	0.16	-0.292	0.205	-0.696	0.112
	Equal variances not assumed			-1.42	175.72	0.16	-0.292	0.205	-0.696	0.113
Prof. Orgs	Equal variances assumed	1.02	0.31	-1.36	179.00	0.18	-0.250	0.184	-0.614	0.114
	Equal variances not assumed			-1.35	174.02	0.18	-0.250	0.185	-0.615	0.115
Board of Trade	Equal variances assumed	5.76	0.02	-1.77	175.00	0.08	-0.242	0.137	-0.512	0.028
	Equal variances not assumed			-1.75	152.86	0.08**	-0.242	0.139	-0.516	0.032
Eco. Dev. Office	Equal variances assumed	0.00	0.96	-0.08	171.00	0.94	-0.012	0.146	-0.299	0.276
	Equal variances not assumed			-0.08	165.96	0.94	-0.012	0.146	-0.300	0.277

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 23

T-Test Results: Comparing Mean Value for Linkages in Cluster Web for Technology and Non-Technology Firms

		t-test for Equality of Means									
		Levene's Test Equality of Variances for									
		F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
									Lower	Upper	
Suppliers	Equal variances assumed	0.85	0.36	-0.50	178.00	0.62	-0.09	0.187	-0.463	0.276	
	Equal variances not assumed			-0.50	172.20	0.62	-0.09	0.188	-0.465	0.278	
Service Firms	Equal variances assumed	0.37	0.54	-0.35	179.00	0.73	-0.06	0.168	-0.389	0.273	
	Equal variances not assumed			-0.35	174.36	0.73	-0.06	0.168	-0.390	0.274	
Customers	Equal variances assumed	3.27	0.07	-3.71	178.00	0.00*	-0.79	0.213	-1.208	-0.370	
	Equal variances not assumed			-3.73	177.97	0.00	-0.79	0.212	-1.206	-0.372	
Universities (Res)	Equal variances assumed	6.70	0.01	1.46	180.00	0.15	0.20	0.135	-0.069	0.465	
	Equal variances not assumed			1.48	175.84	0.14	0.20	0.133	-0.066	0.461	
Gov't (Research)	Equal variances assumed	0.77	0.38	1.85	178.00	0.07**	0.32	0.171	-0.021	0.654	
	Equal variances not assumed			1.86	177.99	0.06	0.32	0.170	-0.019	0.652	
Industry (Res)	Equal variances assumed	0.00	0.95	0.27	179.00	0.79	0.04	0.146	-0.249	0.327	
	Equal variances not assumed			0.27	175.69	0.79	0.04	0.146	-0.249	0.327	
Firms in Industry	Equal variances assumed	0.14	0.71	-2.31	178.00	0.02*	-0.41	0.177	-0.759	-0.059	
	Equal variances not assumed			-2.31	174.96	0.02	-0.41	0.177	-0.759	-0.059	
Subcontractors	Equal variances assumed	0.60	0.44	-1.99	178.00	0.048*	-0.40	0.203	-0.804	-0.003	
	Equal variances not assumed			-1.98	173.46	0.05	-0.40	0.203	-0.805	-0.002	
Prof. Orgs	Equal variances assumed	0.22	0.64	0.09	178.00	0.92	0.02	0.188	-0.354	0.389	
	Equal variances not assumed			0.09	172.15	0.92	0.02	0.189	-0.355	0.391	
Board of Trade	Equal variances assumed	16.95	0.00	-1.77	175.00	0.08	-0.21	0.121	-0.451	0.025	
	Equal variances not assumed			-1.72	131.61	0.09**	-0.21	0.124	-0.459	0.032	
Eco. Dev. Office	Equal variances assumed	0.18	0.67	0.69	174.00	0.49	0.09	0.126	-0.163	0.336	
	Equal variances not assumed			0.69	170.82	0.49	0.09	0.126	-0.163	0.336	

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 19 also suggests that technology firms do not value highly linkages with most of the possible members of the *cluster web* with the exception of suppliers, services firms and customers. These three reported scores slightly above the mid-point of the scale (3).

In summary, technology based firms did not in any instance report significantly more linkages with other organizations or individuals in their *cluster web*. In no instance (at the .05 level of significance) did technology firms value their linkages more than did the non-technology firms in the Ottawa area. These results are thus not consistent with Propositions 1 and 3.

5.8.2 Networks and Linkages in *Market Web*

This section will test empirically the difference in use and value for linkages outside the cluster region (*market web*) between technology and non-technology firms. The propositions being tested are listed below followed by a description of the research findings.

Proposition 2: Technology-based firms use more linkages with organizations in their *market web* than do firms in non-technology based sectors.

Proposition 4: Technology-based firms value their linkages with organizations in their *market web* more than do firms in non-technology based sectors.

To measure the usage and value of linkages outside the cluster region, the respondents were asked to rate the frequency of use of linkages with 11 types of individuals and organizations *outside* the Ottawa area. Table 24 and Table 25 present the

11 categories of possible linkages outside Ottawa, along with the means for each scale for technology and non-technology firms.

Table 24

Use of Linkages Outside Cluster: Comparing Technology and Non-technology Firms

		Technology		Non-Technology	
		Mean	St. Dev.	Mean	St. Dev.
1	Suppliers	3.36	1.31	3.49	1.38
2	Service Firms	2.65	1.18	2.61	1.33
3	Customers	4.20	1.25	4.20	1.16
4	Research/Universities	1.80	1.16	1.81	1.12
5	Research/Government	1.66	1.03	1.63	1.05
6	Research/Industry	2.00	1.22	1.99	1.28
7	Firms in Industry	2.90	1.30	2.73	1.30
8	Subcontractors	2.77	1.31	2.82	1.42
9	Professional Organizations	2.08	1.30	1.91	1.09
10	Board of Trade	1.35	0.72	1.40	0.71
11	Economic Development Office	1.39	0.76	1.30	0.66
	Mean Summated Scores	26.16	7.03	25.89	7.08

* Significant at the 95% confidence interval

Table 25

Value of Linkages Outside Cluster: Comparing Technology and Non-technology Firms

		Technology		Non-Technology	
		Mean	St. Dev.	Mean	St. Dev.
1	Suppliers	3.34	1.30	3.02	1.34
2	Service Firms	2.29	1.17	2.30	1.16
3	Customers	3.89	1.30	3.59	1.36
4	Research/Universities	1.75*	1.12	1.41	0.79
5	Research/Government	1.56	0.86	1.37	0.90
6	Research/Industry	2.00**	1.16	1.67	1.07
7	Firms in Industry	2.67	1.34	2.70	1.19
8	Subcontractors	2.35	1.30	2.49	1.34
9	Professional Organizations	1.89	1.11	1.72	1.01
10	Board of Trade	1.33	0.48	1.26	0.37
11	Economic Development Office	1.46	0.59	1.56	0.58
	Mean Summated Scores	24.53	7.82	23.21	7.22

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Once again, to test propositions 2 and 4 on usage of linkages among firms, a scale measuring overall firm linkage and networking was constructed by adding the scores on the frequency of usage of links with the 11 categories of potential linkages. A t-test was then performed comparing mean usage between technology and non-technology firms in terms of linkages outside Ottawa.

To test whether there were a significant differences in the usage of linkages between the two groups of firms, valid responses by 86 technology firms and 81 non-technology firms were used to run a t-test.

Similar results are produced in this test, showing that technology firms do not have significantly more linkages in their *market web* than the non-technology firms (see Table 26).

Table 26

T-Test to Compare Overall Use of Linkages Outside Cluster Region

N1=86, N2=81

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Technology (Out) Use	0.077	0.781	0.370	165.000	0.712	0.404	1.093	-1.753	2.562

A total of 96 technology firms and 85 non-technology firms provided valid responses to the summated value scale.

The t-test showed that technology firms do not value significantly more their linkages in their *market web* than do the non-technology firms (see Table 27).

Table 27**T-Test to Compare Overall Value for Linkages Outside Cluster Region**

N1=96, N2=85

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Technology (Out) Value	0.476	0.491	1.174	179.000	0.242	1.319	1.124	-0.898	3.537

As done for the “within cluster” linkages, further t-tests were performed to dig deeper to find out if there are any differences between the two types of firms. To do this, t-tests were conducted to compare technology and non-technology firms on each of the 11 specific linkage categories measured in this study (see Table 28 for T statistics and Table 66 in Appendix H for N values).

The results reported in Table 28 show that technology based firms do not have significantly more linkages than non-technology firms across the board of possible individuals or organizations.

The results reported in the value for linkages t-tests (Table 29 – see Table 67 in Appendix H for N values) show that technology based firms value significantly more their linkages with universities as research collaborators (outside the Ottawa region) than do non-technology firms. The significant differences are identified by the “*” in Table 24. Technology firms also value more their linkages with industry research collaborators located outside Ottawa, at the .10 level of significance (identified by “**” in Table 25),

Overall, the mean scores reported for usage and value of *market web* linkages (Table 24 and 25) suggest that technology firms do not use nor value linkages with a broad range of possible members of the *market web*. The means of usage and value are all below the mid-points (3.0) of these respective scales, except suppliers and customers.

In summary, technology based firms reported a significantly higher value for their linkages outside the Ottawa cluster with universities and the industry as research collaborators. Although, overall value for their linkages was not consistent, partial support for Proposition 4 was established.

Technology firms did not in any instance report significantly more linkages with other organizations or individuals in their *market web*. Thus, the results are not consistent with Proposition 2 and it is not directly supported.

5.8.3 Networks and Linkages: Comparison Between 2003 and 2000

This section will test empirically the difference in use and value for linkages between technology firms in the 2003 sample and the technology firms that made up the 2000 research sample. The propositions being tested are listed below followed by a description of the research findings.

Proposition 5: The technology-based firms in the 2003 sample are likely to use more linkages with organizations in their cluster web than was reported by the technology firms in the 2000 research sample.

Proposition 6: The technology-based firms in the 2003 sample are likely value more their linkages with organizations in their cluster web than was reported by the technology firms in the 2000 research sample.

Table 28T-Test Results: Comparing Mean Use of Linkages in *Market web* for Technology and Non-Technology Firms

t-test for Equality of Means										
		Levene's Test Equality of Variances for		T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	F	Sig.							Lower	Upper
Suppliers	Equal variances assumed	0.63	0.43	-0.65	177.00	0.518	-0.130	0.201	-0.527	0.266
	Equal variances not assumed			-0.65	171.99	0.519	-0.130	0.202	-0.528	0.268
Service Firms	Equal variances assumed	2.62	0.11	0.18	176.00	0.859	0.033	0.188	-0.337	0.404
	Equal variances not assumed			0.18	168.52	0.860	0.033	0.189	-0.339	0.406
Customers	Equal variances assumed	0.15	0.70	0.04	177.00	0.971	0.007	0.180	-0.349	0.362
	Equal variances not assumed			0.04	177.00	0.971	0.007	0.180	-0.348	0.361
Universities (Res)	Equal variances assumed	0.03	0.85	-0.03	174.00	0.976	-0.005	0.173	-0.346	0.335
	Equal variances not assumed			-0.03	173.37	0.976	-0.005	0.172	-0.345	0.335
Gov't (Research)	Equal variances assumed	0.00	0.96	0.20	174.00	0.838	0.032	0.157	-0.278	0.342
	Equal variances not assumed			0.20	171.88	0.838	0.032	0.157	-0.278	0.342
Industry (Res)	Equal variances assumed	0.07	0.80	0.06	175.00	0.950	0.012	0.188	-0.359	0.383
	Equal variances not assumed			0.06	171.51	0.950	0.012	0.188	-0.360	0.384
Firms in Industry	Equal variances assumed	0.47	0.49	0.89	176.00	0.375	0.174	0.196	-0.212	0.560
	Equal variances not assumed			0.89	174.55	0.375	0.174	0.196	-0.212	0.560
Subcontractors	Equal variances assumed	0.56	0.45	-0.24	176.00	0.810	-0.049	0.204	-0.453	0.354
	Equal variances not assumed			-0.24	171.26	0.810	-0.049	0.205	-0.454	0.356
Prof. Orgs	Equal variances assumed	5.35	0.02	0.94	176.00	0.350	0.169	0.181	-0.188	0.526
	Equal variances not assumed			0.94	174.56	0.346	0.169	0.179	-0.185	0.523
Board of Trade	Equal variances assumed	0.21	0.65	-0.45	174.00	0.655	-0.048	0.108	-0.261	0.165
	Equal variances not assumed			-0.45	173.49	0.655	-0.048	0.108	-0.261	0.165
Eco. Dev. Office	Equal variances assumed	1.64	0.20	0.81	171.00	0.420	0.088	0.108	-0.126	0.302
	Equal variances not assumed			0.81	170.33	0.417	0.088	0.108	-0.125	0.301

* Significant at the 95% confidence interval
 ** Significant at the 90% confidence interval

Table 29T-Test Results: Comparing Mean Value for Linkages in *Market web* for Technology and Non-Technology Firms

t-test for Equality of Means										
		Levene's Test Equality of Variances for		T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	F	Sig.							Lower	Upper
Suppliers	Equal variances assumed	0.05	0.83	1.64	180.00	0.103	0.320	0.195	-0.065	0.706
	Equal variances not assumed			1.64	176.47	0.103	0.320	0.196	-0.066	0.707
Service Firms	Equal variances assumed	0.25	0.62	-0.06	180.00	0.951	-0.011	0.173	-0.352	0.330
	Equal variances not assumed			-0.06	178.15	0.951	-0.011	0.173	-0.352	0.330
Customers	Equal variances assumed	0.25	0.61	1.43	180.00	0.155	0.292	0.205	-0.112	0.697
	Equal variances not assumed			1.43	178.81	0.154	0.292	0.204	-0.111	0.696
Universities (Res)	Equal variances assumed	10.88	0.00	2.07	180.00	0.040	0.343	0.166	0.016	0.670
	Equal variances not assumed			2.12	156.07	0.035*	0.343	0.161	0.024	0.662
Gov't (Research)	Equal variances assumed	2.40	0.12	1.24	180.00	0.218	0.190	0.154	-0.114	0.494
	Equal variances not assumed			1.25	176.65	0.212	0.190	0.152	-0.109	0.490
Industry (Res)	Equal variances assumed	1.56	0.21	1.78	180.00	0.077**	0.326	0.183	-0.035	0.686
	Equal variances not assumed			1.80	176.99	0.073	0.326	0.180	-0.030	0.682
Firms in Industry	Equal variances assumed	0.64	0.43	-0.15	180.00	0.878	-0.051	0.201	-0.429	0.367
	Equal variances not assumed			-0.15	176.90	0.878	-0.051	0.202	-0.429	0.367
Subcontractors	Equal variances assumed	1.03	0.31	-0.65	180.00	0.520	-0.134	0.208	-0.545	0.276
	Equal variances not assumed			-0.64	168.70	0.523	-0.134	0.210	-0.548	0.280
Prof. Orgs	Equal variances assumed	0.23	0.64	1.04	180.00	0.301	0.164	0.158	-0.148	0.477
	Equal variances not assumed			1.04	179.95	0.298	0.164	0.158	-0.147	0.476
Board of Trade	Equal variances assumed	1.06	0.31	0.48	180.00	0.632	0.078	0.162	-0.242	0.397
	Equal variances not assumed			0.49	175.23	0.627	0.078	0.159	-0.237	0.392
Eco. Dev. Office	Equal variances assumed	0.66	0.42	-0.44	179.00	0.659	-0.106	0.240	-0.581	0.368
	Equal variances not assumed			-0.44	165.10	0.662	-0.106	0.243	-0.586	0.373

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

To empirically test the results of 2003 and 2000 against each other, a t-test was run with the summated mean of scores between technology firms in 2000 and 2003 (see Table 30 and 31).

In the three years since the original 2000 research, the overall summated mean usage score in 2003 for technology firms increased by 1.93 and mean value score decreased by 1.79.

For 2003 technology firms in this study, the summated average scores for use of linkages is 26.85 (standard deviation of 7.17). In the 2000 study, the researchers found that with the technology firms, the summated mean scores equaled 24.92 (standard deviation of 6.36) for total use (see Table 30).

Table 30

Mean Use Scores per Linkage: Comparing 2003 and 2000

	2003		2000	
	Mean	Sta. Dev.	Mean	Value
Suppliers	3.21*	1.17	3.55	1.34
Service Firms	3.31	1.09	3.20	1.19
Customers	3.45*	1.50	2.83	1.56
Research/Universities	2.00	1.19	1.76	1.06
Research/Government	2.13	1.31	1.94	1.16
Research/Industry	1.92	1.13	1.72	0.94
Firms in Industry	2.34	1.21	2.18	1.21
Subcontractors	3.01	1.36	2.77	1.33
Professional Organizations	2.39	1.20	2.23	1.11
Board of Trade	1.51	0.76	1.50	0.86
Economic Dev. Office	1.63	0.93	1.53	0.83
Summated Mean	26.85	7.17	24.92	6.36
Mean Difference (2003-2000)	1.93			

* Significant at the 95% confidence interval

In the 2000 study, the researchers found that with the technology firms, the summated mean scores equaled 27.66 (standard deviation of 8.20) for total value. The summated average scores for value of linkages for the 2003 technology firms was 25.87 (standard deviation of 6.50) (see Table 31).

Table 31

Mean Value Scores per Linkage: Comparing 2003 and 2000

	2003		2000	
	Mean	Sta. Dev.	Mean	Sta. Dev.
Suppliers	3.29	1.21	3.53	1.30
Service Firms	3.18	1.10	3.40	1.16
Customers	3.11*	1.49	3.52	1.55
Research/Universities	1.70*	1.02	2.08	1.25
Research/Government	2.01	1.20	2.28	1.41
Research/Industry	1.79*	0.97	2.08	1.23
Firms in Industry	2.36	1.19	2.45	1.31
Subcontractors	2.83	1.33	3.12	1.42
Professional Organizations	2.54*	1.23	2.19	1.18
Board of Trade	1.43	0.60	1.57	0.86
Economic Development Office	1.57	0.84	1.66	
Summated Mean	25.87	6.50	27.66	8.20
Mean Difference (2003-2000)	-1.79			

The t-test comparing summated mean scores for use of linkages between the 2003 sample of technology firms and the 2000 sample indicates that the technology firms in the 2003 sample use significantly more linkages with organizations than did the technology firms in the 2000 study ($t=1.97$, $p=0.05$) (see Table 32). The results support Proposition 5.

Table 32

T-Test: Comparing 2003 and 2000 Firms in Use of Linkages

N1=88, N2=104

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	T	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Use	0.75	0.39	1.97	190.00	0.05	1.93	0.98	0.00	3.86

The technology firms in the 2003 sample value significantly less their linkages with organizations than did the technology firms in the 2000 sample ($t=-1.72$, $p=0.09$) (see Table 33). The results directly contradict Proposition 6.

Table 33

T-Test: Comparing 2003 and 2000 Firms in Value for Linkages

N1=88, N2=103

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Value	6.38	0.01	-1.72	188.08	0.09	-1.83	1.07	-3.93	0.27

Individual t-tests were run to identify where lie the differences between the technology firms in the 2003 and 2000 sample.

The t-test results indicate that the technology firms in the 2003 sample use significantly less linkages with suppliers than did the technology firms in the 2000 sample ($t=-1.97$, $p=0.05$) and use significantly more linkages with customers ($t=2.89$, $p=0.00$) than did the technology firms in the 2000 sample. See Table 34 for t-test results and Table 68 in Appendix H for N values.

At the .05 level of significance, the technology firms in the 2003 sample value significantly less their linkages with universities as research collaborators ($-2.43, p=0.02$) than did the tech firms in the 2000 sample. At the .10 level of significance, the 2003 technology firms also value significantly less their linkages with industry research collaborators ($t=-1.89, p=0.06$) and customers ($t=-1.92, p=0.06$). The tech firms in 2003 do however value significantly more their linkages with professional organizations than did the technology firms in the 2000 sample ($=2.09, p=0.04$). Refer to Table 35 for t-test results and Table 68 in Appendix H for N values.

In summary, technology firms in the 2003 sample use significantly more linkages and value significantly less their linkages than did the technology firms in the sample of the 2000 study. Therefore, Proposition 5 is supported while Proposition 6 is directly contradicted.

5.8.4 Examination of Individual Linkages: Comparing 2000 and 2003

In the 2000 study, non-technology firms were found to use significantly more linkages with customers, firms in the industry, subcontractors, research firms and professional organizations leading the researchers to conclude that non-technology firms used more their linkages with other firms. They were also able to conclude that the non-technology firms value more their linkages than technology firms based on significant tests indicating that non-technology firms highly value more their linkages with customers and firms in the industry.

Therefore, the 2000 study found that non-technology firms used more and valued more linkages with other organizations than did technology firms.

Table 34

Independent Samples T-Test for Use of Linkages: Comparing 2003 and 2000 Technology Firms

t-test for Equality of Means										
		Levene's Test Equality of Variances for		T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	F	Sig.							Lower	Upper
Suppliers	Equal variances assumed	4.92	0.03	-1.95	203.00	0.05	-0.34	0.18	-0.69	0.00
	Equal variances not assumed			-1.97	202.98	0.05*	-0.34	0.17	-0.69	0.00
Service Firms	Equal variances assumed	1.74	0.19	0.69	201.00	0.49	0.11	0.16	-0.21	0.43
	Equal variances not assumed			0.70	199.72	0.49	0.11	0.16	-0.21	0.43
Customers	Equal variances assumed	0.24	0.63	2.89	202.00	0.00*	0.62	0.22	0.20	1.05
	Equal variances not assumed			2.90	198.18	0.00	0.62	0.21	0.20	1.05
Universities (Res)	Equal variances assumed	2.93	0.09	1.50	203.00	0.13	0.24	0.16	-0.07	0.55
	Equal variances not assumed			1.49	189.49	0.14	0.24	0.16	-0.08	0.55
Gov't (Research)	Equal variances assumed	1.94	0.17	1.10	202.00	0.27	0.19	0.17	-0.15	0.53
	Equal variances not assumed			1.09	188.83	0.28	0.19	0.17	-0.15	0.53
Industry (Res)	Equal variances assumed	3.03	0.08	1.42	201.00	0.16	0.21	0.15	-0.08	0.49
	Equal variances not assumed			1.40	178.86	0.16	0.21	0.15	-0.09	0.50
Firms in Industry	Equal variances assumed	1.70	0.19	0.94	203.00	0.35	0.16	0.17	-0.17	0.49
	Equal variances not assumed			0.94	197.12	0.35	0.16	0.17	-0.17	0.50
Subcontractors	Equal variances assumed	0.10	0.75	1.25	203.00	0.21	0.24	0.19	-0.14	0.61
	Equal variances not assumed			1.25	196.32	0.21	0.24	0.19	-0.14	0.61
Prof. Orgs	Equal variances assumed	0.80	0.37	1.01	203.00	0.31	0.16	0.16	-0.16	0.48
	Equal variances not assumed			1.00	193.18	0.32	0.16	0.16	-0.16	0.48
Board of Trade	Equal variances assumed	0.23	0.64	0.05	199.00	0.96	0.01	0.12	-0.22	0.23
	Equal variances not assumed			0.05	198.40	0.96	0.01	0.11	-0.22	0.23
Eco. Dev. Office	Equal variances assumed	2.56	0.11	0.81	196.00	0.42	0.10	0.13	-0.15	0.35
	Equal variances not assumed			0.81	183.72	0.42	0.10	0.13	-0.15	0.35

* Significant at the 95% confidence interval

Table 35

Independent Samples T-Test for Value of Linkages: Comparing 2003 and 2000 Technology Firms

t-test for Equality of Means										
		Levene's Test Equality of Variances for		T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	F	Sig.							Lower	Upper
Suppliers	Equal variances assumed	1.10	0.30	-1.29	200.00	0.20	-0.23	0.18	-0.58	0.12
	Equal variances not assumed			-1.30	198.94	0.20	-0.23	0.18	-0.58	0.12
Service Firms	Equal variances assumed	1.18	0.28	-1.37	201.00	0.17	-0.22	0.16	-0.53	0.10
	Equal variances not assumed			-1.37	199.53	0.17	-0.22	0.16	-0.53	0.10
Customers	Equal variances assumed	0.55	0.46	-1.92	200.00	0.06**	-0.41	0.21	-0.84	0.01
	Equal variances not assumed			-1.92	197.96	0.06	-0.41	0.21	-0.83	0.01
Universities (Res)	Equal variances assumed	5.98	0.02	-2.40	202.00	0.02	-0.39	0.16	-0.70	-0.07
	Equal variances not assumed			-2.43	200.57	0.02*	-0.39	0.16	-0.70	-0.07
Gov't (Research)	Equal variances assumed	7.62	0.01	-1.44	201.00	0.15	-0.27	0.19	-0.63	0.10
	Equal variances not assumed			-1.46	200.74	0.15	-0.27	0.18	-0.63	0.09
Industry (Res)	Equal variances assumed	8.75	0.00	-1.87	201.00	0.06	-0.29	0.16	-0.60	0.02
	Equal variances not assumed			-1.89	197.96	0.06**	-0.29	0.15	-0.60	0.01
Firms in Industry	Equal variances assumed	1.73	0.19	-0.48	201.00	0.63	-0.08	0.18	-0.43	0.26
	Equal variances not assumed			-0.48	200.98	0.63	-0.08	0.18	-0.43	0.26
Subcontractors	Equal variances assumed	0.66	0.42	-1.49	202.00	0.14	-0.29	0.19	-0.67	0.09
	Equal variances not assumed			-1.50	201.00	0.14	-0.29	0.19	-0.67	0.09
Prof. Orgs	Equal variances assumed	1.14	0.29	2.09	201.00	0.04*	0.35	0.17	0.02	0.69
	Equal variances not assumed			2.09	196.66	0.04	0.35	0.17	0.02	0.69
Board of Trade	Equal variances assumed	12.28	0.00	-1.37	199.00	0.17	-0.14	0.11	-0.35	0.06
	Equal variances not assumed			-1.40	189.17	0.16	-0.14	0.10	-0.35	0.06
Eco. Dev. Office	Equal variances assumed	2.61	0.11	-0.70	199.00	0.48	-0.09	0.13	-0.34	0.16
	Equal variances not assumed			-0.71	199.00	0.48	-0.09	0.13	-0.34	0.16

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Interestingly, the 2003 results provide some level of consistency with the 2000 results. Technology firms are still using fewer linkages than the non-technology firms, and interestingly, one key linkage category, firms in the industry, has not shifted. Another key linkage, that of customers, did however increase for technology firms since the 2000 study. There are a few differences in 2000 that don't appear in 2003 and there are some differences in 2003 that did not come out in 2000. See Table 36.

Table 36 highlights the linkages that were significantly different, in terms of use, between the technology and non-technology firms and directly compares the 2000 results and the 2003 results.

Table 36

Significant Differences in Use of Linkages (Tech vs. Non-Tech Firms):
Comparing 2000 and 2003

	Technology – Non-Technology	t	P
2000 Usage:	Customers	-5.90	0.00
	Firms in Industry	-3.49	0.00
	Subcontractors	-2.11	0.04
	Research/Industry	-1.86	0.06**
	Professional Organizations	-1.84	0.07**
2003 Usage:	Suppliers	-2.10	0.04
	Customers	-3.17	0.00
	Firms in the Industry	-3.22	0.00
	Board of Trade	-1.75	0.08**

**At the .10 level of significance

Differences with two key relationships, customers and firms in the industry, are replicated in 2003. Technology firms still value significantly their linkages with

customers and firms in the industry. They also value less linkages with subcontractors and boards of trade but value more linkages with government research agencies (see Table 37).

Table 37 highlights the linkages that technology and non-technology firms valued significantly differently and directly compares the 2000 results and the 2003 results.

Table 37

Significant Differences in Value for Linkages (Tech vs. Non-Tech Firms):
Comparing 2000 and 2003

	Technology – Non-Technology	t	p
2000 Value:			
	Customers	-4.16	0.00
	Firms in the Industry	-2.43	0.02
2003 Value:			
	Customers	-3.71	0.00
	Research Gov't	1.85	0.07**
	Firms in the Industry	-2.31	0.02
	Subcontractors	-1.99	0.048
	Board of Trade	-1.72	0.09**

**At the .10 level of significance

In this 2003 version of the study, it was established that the non-technology firms valued significantly more than the technology firms their linkages with suppliers, customers, firms in the industry and boards of trade. The results that were replicated in this 2003 version of the research were the significant differences with respect to linkages with firms in the industry and customers. In both versions of the research, non-technology firms proved to significantly use more linkages with these particular linkage

categories. There are no other common results to the two studies when looking at differences in value of linkages between the two groups of firms. See Table 36.

The researchers in 2000 found that non-technology firms valued significantly more linkages with customers and firms in the industry. The non-technology firms in 2003 were found to replicate the results with respect to customers and firms in the industry. They were also shown to value significantly more linkages with subcontractors and boards of trade. What may be of interest is that technology firms in 2003 valued significantly more their linkages with government research agencies. This was something that didn't come out in the 2000 study. See Table 36 and Table 37 for direct comparison of significant results for usage and value of linkages in 2000 vs. 2003.

In summary, looking at the big picture, things have not changed dramatically in the Ottawa cluster since the 2000 study.

5.8.5 Networks and Linkages: The Role of Source of Company Technology

This section will test empirically the difference in use and value for linkages between firms based on technology developed in the public sector and firms based on technology developed in the private sector. The propositions being tested are listed below followed by a description of the research findings.

Proposition 7: Technology-based firms are likely to have more frequent linkages with organizations that are similar to the organization's original source of technology.

Proposition 8: Technology-based firms are likely to have more valued linkages with organizations that are similar to the organization's original source of technology.

Respondents were asked to report sources of knowledge upon which their company was founded. For the purpose of this research, those respondents who indicated that their company was founded on knowledge developed in a previous private sector employer were categorized as having developed company source technology in the private sector. Those respondents who reported that their company was founded on knowledge developed in a government lab, university or government department or agency were classified as having developed company source technology in the public sector. Respondents who had reported sources of knowledge that spanned both the public and private sectors were excluded, for the purposes of this research.

A total of 23 technology firms in the Ottawa Technology cluster were built on technology developed in the public sector. Slightly more firms (31) had built their companies on technology developed in the private sector. Note that 32 firms were excluded from analysis because they had identified sources of knowledge that spanned both the public and private sectors. Please refer to Table 38 and Table 39 for means per linkage and the means from the summated scales for both firms based on technology developed in the public sector and based in the private sector.

Table 38

Mean Use Per Linkage: Comparing Public and Private

		Public		Private	
		Mean	Sta. Dev.	Mean	Sta. Dev.
1	Suppliers	3.00	1.21	3.45	1.18
2	Service Firms	3.13	0.97	3.28	1.13
3	Customers	3.05	1.65	3.42	1.46
4	Research/Universities	2.35	1.40	1.81	1.05
5	Research/Government	2.70**	1.66	1.90	1.08
6	Research/Industry	1.87	1.10	1.97	1.22
7	Firms in Industry	2.26	1.10	2.48	1.36
8	Subcontractors	2.91	1.28	2.81	1.45
9	Professional Organizations	2.43	1.16	2.29	1.19
10	Board of Trade	1.68	0.89	1.32	0.60
11	Economic Dev. Office	1.91*	0.97	1.32	0.87
	Summated Mean	26.76	7.27	25.97	6.83

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 39

Mean Use Per Linkage: Comparing Public and Private

		Public		Private	
		Mean	Sta. Dev.	Mean	Sta. Dev.
1	Suppliers	3.30	1.22	3.30	1.26
2	Service Firms	3.04	1.07	3.19	1.01
3	Customers	2.52	1.47	3.20	1.49
4	Research/Universities	1.96	1.07	1.52	1.00
5	Research/Government	2.45	1.47	2.03	1.08
6	Research/Industry	1.65	0.93	1.97	1.14
7	Firms in Industry	2.22	1.17	2.52	1.23
8	Subcontractors	3.18	1.30	2.71	1.32
9	Professional Org.	2.61	1.16	2.48	1.09
10	Board of Trade	1.50	0.60	1.35	0.61
11	Economic Dev. Office	1.96**	0.98	1.47	0.86
	Summated Mean	26.60	6.08	25.72	6.64

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Comparing the means from the summated scale on use of linkages between the firms based on technology developed in the public sector and the firms based on technology developed in the private sector, there are no significant differences between the two groups (see Table 40).

Table 40

T-Test to Compare Overall Use for Linkages: Comparing Public versus Private

N1=21, N2=29

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Use	0.06	0.80	0.40	48.00	0.69	0.80	2.01	-3.25	4.84

Again, comparing the means from the summated scale on value for linkages, the firms based on technology developed in the public sector were not significantly different from the firms based on technology developed in the private sector (see Table 41).

Table 41

T-Test to Compare Overall Value for Linkages: Comparing Public versus Private

N1=20, N2=29

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Value	0.12	0.73	0.47	47.00	0.64	0.88	1.87	-2.88	4.63

Individual t-tests were conducted to test the technology firms on each of the 11 categories of linkages.

Firms that had derived their knowledge base from the public sector differed from those that had a basis in the private sector in terms of usage of government agencies as research collaborators and economic development offices. Public sector firms were significantly more likely to use economic development offices ($t=2.26$, $p=0.03$) and government agencies ($t=2.00$, $p=0.054$) (see Tables 70 and 71 of Appendix H). The significant differences are identified by the “*” and “**” in Table 38.

At the .10 level of significance, firms based on technology developed in the public sector are shown to value significantly more linkages with economic development offices than do the firms based on technology developed in the private sector ($t=1.94$, $p=0.06$) (see Tables 72 and 73 of Appendix H). The significant differences are identified by the “**” in Table 39.

In summary, the significant difference between firm categories in terms of links with government agencies provides some support for Proposition 7. However, the balance of evidence provides little or no support for Proposition 8.

5.8.6 Networks and Linkages: The Role of Risk Capital

This section will test empirically the difference in use and value for linkages between technology firms who have raised risk capital and technology firms who have not raised risk capital. The propositions being tested are listed below followed by a description of the research findings.

Proposition 9: Technology-based firms that have obtained financing from venture capitalists are likely to have more frequent linkages with organizations than are firms that have not received venture capital financing.

Proposition 10: Technology-based firms that have obtained financing from venture capitalists are likely to have more valued linkages with organizations than are firms that have not received venture capital financing.

The respondents were asked to report whether they had received angel financing and/or venture capital financing. Of the total number of technology firms, 46 indicated being venture-backed firms. See Table 42 and Table 43 for mean usage and value per linkage for venture-backed and non venture-backed firms.

Table 42

Mean Use of Linkage: Comparing Venture-backed and Non Venture-backed Firms

		Venture-backed		Non	
		Mean	St. Dev.	Mean	St. Dev.
1	Suppliers	3.15	1.15	3.23	1.18
2	Service Firms	3.33	1.11	3.28	1.11
3	Customers	3.23	1.57	3.60	1.42
4	Research/Universities	2.13	1.24	1.83	1.07
5	Research/Government	2.22	1.40	2.06	1.26
6	Research/Industry	1.78	0.97	2.02	1.20
7	Firms in Industry	2.22	1.26	2.43	1.17
8	Subcontractors	2.89	1.35	3.09	1.38
9	Professional Organizations	2.39	1.16	2.43	1.25
10	Board of Trade	1.35*	0.69	1.68	0.81
11	Economic Development Office	1.49	0.83	1.79	1.02
	Summated Mean	25.56	6.60	27.87	7.64

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 43

Mean Value for Linkage: Comparing Venture-backed and Non Venture-backed Firms

		Venture-backed		Non	
		Mean	St. Dev.	Mean	St. Dev.
1	Suppliers	3.29	1.24	3.29	1.18
2	Service Firms	3.41*	1.11	2.94	1.04
3	Customers	2.75*	1.42	3.42	1.50
4	Research/Universities	1.78	0.99	1.56	0.94
5	Research/Government	2.28*	1.34	1.79	1.00
6	Research/Industry	1.80	0.91	1.75	1.00
7	Firms in Industry	2.35	1.25	2.38	1.16
8	Subcontractors	2.91	1.28	2.71	1.37
9	Professional Organizations	2.61	1.22	2.52	1.25
10	Board of Trade	1.39	0.54	1.48	0.65
11	Economic Development Office	1.62	0.78	1.55	0.90
	Summated Mean	26.24	6.10	25.48	6.90

* Significant at the 95% confidence interval

To test the propositions on usage of linkages among firms, a scale measuring overall firm linkage and networking was constructed (as was done in previous analyses) by adding the scores on the frequency of usage of links with the 11 categories of potential linkages. A t-test comparing mean usage and value (as measured by this summated scale) between venture-backed and non venture-backed technology firms did not show any overall significant difference in their use and value of linkages. No significance was found between firm categories in terms of overall use ($t=-1.491$ and a $p=0.140$) and value ($t=0.546$ and $p=0.587$) of linkages. See Table 44 and 45.

Table 44

Independent Test for Use of Linkages Comparing Venture-backed Firms to Non

N₁=41 and N₂=45

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
VC Use	1.300	0.257	-1.491	84.000	0.140	-2.306	1.546	-5.380	0.769

Table 45

Independent Test for Value of Linkages Comparing Venture-backed Firms to Non

N₁=41 and N₂=46

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
VC Value	1.370	0.245	0.546	85.000	0.587	0.766	1.403	-2.024	3.555

To investigate a bit further, t-tests were run on the 11 categories of potential linkages. This is to see if any differences might exist between the two groups with respect to the particular types of linkages (refer to Tables 74 to 75 in Appendix H for t-test results).

The venture-backed firms in the sample reported significantly less use of linkages with boards of trade/chambers of commerce ($t = -2.09$, $p = 0.04$). The significant differences are identified by the “*” in Table 42.

The venture-backed firm valued significantly more their linkages, at the .05 level of significance, with service firms ($t = 2.148$, $p = 0.03$) and government agencies for

research ($t=2.014$, $p=0.047$). Interestingly, the venture backed firms value significantly less their linkages with customers than do the non-venture backed firms ($t=-2.19$, $p = 0.03$) (refer to Tables 76 and 77 in Appendix H). The significant differences are identified by the “*” in Table 43.

The results provide only partial answers to Propositions 9 and 10. Proposition 9 is directly contradicted with respect to usage of board of trade/chamber of commerce offices. Proposition 10 is supported with respect to the significant differences in perceived value with service firms and government agencies. Otherwise, it is contradicted with the significant difference in value for customers. Thus, Proposition 9 is directly rejected and overall results contradict it. Proposition 10 is partially supported.

5.8.7 Networks and Linkages: The Role of Distance

This section will test empirically the difference in use of regional, national and international linkages between technology and non-technology firms. The propositions being tested are listed below followed by a description of the research findings.

Proposition 11a: Technology-based firms are likely to have more intra-regional linkages, than firms in non-technology based industries.

Propositions 11b: Technology-based firms are likely to have less inter-regional (national) linkages, than firms in non-technology based industries.

Proposition 12: Technology-based firms are likely to have more internationally based linkages than non-technology based firms

The breakdown of averages per linkage category is found in Table 46 along with the summated mean scores for regional, national and international linkages.

Table 46

Mean per Linkage Category for Regional, National and International Linkages

	Technology			Non-Technology		
	Regional	National	Int'l	Regional	National	Int'l
Suppliers	44.66*	25.00	28.37*	56.04	19.73	19.10
Service Firms	58.80	16.86	16.80	67.04	15.88	11.46
Customers	31.30*	19.15	42.38*	55.34	20.61	19.93
Research/Universities	29.29	16.82**	6.60	28.50	9.44	7.06
Research/Government	41.53*	9.92	3.14	26.19	7.63	6.19
Research/Industry	24.26	10.36	23.25*	21.81	11.00	9.69
Firms in Industry	30.84*	14.22*	37.85*	48.60	21.29	18.89
Subcontractors	48.63*	13.93	17.24	62.52	15.00	11.36
Professional Organizations	51.02	10.17	14.94*	54.00	12.38	7.25
Board of Trade	32.68	4.06	3.49	33.63	6.13	1.50
Economic Development Office	34.37	2.01	1.55	31.23	4.29	2.61
Summated Mean	427.37	142.50	195.61	484.88	143.35	115.03

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

To test technology firms against the non-technology firms in terms of their use of intra-regional linkages (Proposition 11a), 85 technology and 80 non-technology firms had valid answers and formed the sample groups. The mean usage score for the technology firms was 424.19 (s.d. of 239.72) and 484.41 for non-technology firms (s.d. of 266.48).

The test indicates that technology firms are not significantly more likely to use intra-regional linkages as compared to non-technology firms, at the .05 level of significance (see Table 47).

Table 47**Independent Samples Test for Technology Firms' Use of Inter-Regional Linkages**N₁=85 and N₂=80

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Regional Use	0.679	0.411	-1.528	163.000	0.129	-60.218	39.417	-138.052	17.615

To test Proposition 11b, that the difference in use of inter-regional linkages, a summated table of scores was generated for national linkages. The mean usage scores generated for technology and non-technology firms were 139.72 (s.d. of 113.64) and 143.54 (s.d. of 120.03) respectively.

The test indicates that technology firms are not significantly less likely to use inter-regional linkages as compared to non-technology firms, at the .05 level of significance (see Table 48).

Table 48**Independent Samples Test for Technology Firms' Use of National Linkages**N₁=85 and N₂=80

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	T	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
National Use	0.807	0.370	-0.210	163.000	0.834	-3.814	18.191	-39.734	32.106

A summated table was also constructed for the scores on use of international linkages. To test Proposition 12, these scores were used to compare the technology firms

and non-technology. The means usage score for technology firms was 193.80 (s.d. of 166.55) and the score for non-technology firms was 115.17 (s.d. of 157.18).

This test indicates that the technology firms use significantly more international linkages than do the non-technology firms in the Ottawa cluster ($t=3.091$, $p=0.002$), at the .05 level of significance (see Table 49). These results support Proposition 12.

Table 49

Independent Samples Test for Technology Firms' Use of International Linkages

$N_1=83$ and $N_2=80$

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	T	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Int'l Use	0.551	0.459	3.091	161.000	0.002	78.632	25.441	28.392	128.873

To further test Propositions 11 and 12, and to find out any source of differences, t-tests were conducted on all 11 categories of linkages on a regional, national and international level.

Therefore, contrary to Proposition 11a, technology firms are significantly less likely to use intra-regional linkages than non-technology firms with suppliers, government agencies, firms in their industry and subcontractors. Technology firms were, however, significantly more likely than non-technology firms to use intra-regional linkages with government agencies as research collaborators. See Table 50 for t-test results (see Appendix H – Table 78 for N values). Thus, the evidence directly contradicts Proposition 11a.

Only one significant result is produced to support Proposition 11b at the .05 level of significance. Non-technology firms appear to use significantly more national linkages with firms in the industry than do the technology firms ($t=-1.99$, $p=0.048$). Technology firms are however found to use significantly more inter-regional linkages with universities ($t=1.83$, $p=0.07$). See Table 51 for t-test results (see Appendix H – Table 79 for N values). No support was found for Proposition 11b.

In terms of international linkages, technology firms are significantly more likely to use international linkages with suppliers ($t=2.15$, $p=0.03$), customers ($t=4.21$, $p=0.00$), industry collaborators ($t=2.94$, $p=0.004$), other firms in the industry ($t=3.61$, $p=0.004$), and professional organizations ($t=2.21$, $p=0.03$). See Table 52 for t-test results (see Appendix H – Table 80 for N values). Thus, Proposition 12 is again supported.

In summary, no support was established for propositions 11a and 11b but significant results are established in support of Proposition 12.

5.8.8 Local Networks and Linkages: The Impact of Subsidiaries

It had been the intent of this section to report on the research findings comparing subsidiaries of large technology firms and non-subsidiaries on their use and value for linkages. Unfortunately, the sample size for subsidiary firms was too small to test. The proposition is listed below followed by a description of why it cannot be tested.

Proposition 13: Subsidiaries of major technology organizations are more likely to engage in local networking.

Of the identified 96 technology firms, only 12 indicated being a subsidiary of a larger organization (78 confirmed that they weren't subsidiaries). When attempting to

compare the subsidiary firms and non-subsidiary firms, in terms of their use and value of linkages, only eight subsidiary firms provided valid answers to the measurement question. Therefore, there were only eight subsidiary technology firms included in the sample, which provided insufficient data to test this proposition.

5.8.9 Networks and Linkages: SMEs as Compared to Large Organizations

This section had been intended to test empirically the difference between SMEs and large organizations. Because of a low sample size for large organizations, the breakdown of companies had to be altered to produce appropriate and testable sample sizes. The proposition is listed below followed by a description of the research findings.

Proposition 14: SMEs are likely to have more frequent linkages with organizations in their cluster web than large organizations.

Proposition 15: SMEs are likely to have more valued linkages with organizations in their cluster web than large organizations.

Of the entire sample (96 technology plus 86 non-technology firms), the breakdown of employees per company is depicted in Table 53.

Table 53

Number of Full-Time Employees

Number of Employees	Frequency	Percent
0 to 9	68	38.0%
10 to 99	92	51.4%
100 to 499	8	4.5%
500 to 999	2	1.1%
1000 to 1999	3	1.7%
2000 to 4999	4	2.2%
5000 and more	2	1.1%
Total	179	100.0%

Table 50

Independent Samples T-Test for Regional Linkages: Comparing Tech and Non-Tech Firms

		Levene's Test Equality of Variances for		t-test for Equality of Means						
		F	Sig.	T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Suppliers	Equal variances assumed	7.08	0.01	-2.28	167.00	0.024	-11.375	4.980	-21.207	-1.542
	Equal variances not assumed			-2.26	156.05	0.025*	11.375	5.023	-21.296	-1.453
Service Firms	Equal variances assumed	1.26	0.26	-1.65	167.00	0.101	-8.234	4.996	-18.097	1.628
	Equal variances not assumed			-1.65	166.60	0.100	-8.234	4.980	-18.066	1.598
Customers	Equal variances assumed	0.06	0.81	-4.55	166.00	0.000*	-24.042	5.281	-34.470	-13.615
	Equal variances not assumed			-4.56	165.23	0.000	-24.042	5.274	-34.456	-13.628
Universities (Res)	Equal variances assumed	0.50	0.48	0.13	165.00	0.900	0.787	6.225	-11.503	13.078
	Equal variances not assumed			0.13	162.10	0.900	0.787	6.238	-11.531	13.105
Gov't (Research)	Equal variances assumed	5.50	0.02	2.37	165.00	0.019	15.341	6.479	2.549	28.134
	Equal variances not assumed			2.38	164.99	0.019*	15.341	6.458	2.590	28.093
Industry (Res)	Equal variances assumed	0.01	0.94	0.44	163.00	0.658	2.446	5.516	-8.446	13.339
	Equal variances not assumed			0.44	162.39	0.658	2.446	5.516	-8.447	13.339
Firms in Industry	Equal variances assumed	1.55	0.21	-3.11	164.00	0.002*	-17.763	5.715	-29.047	-6.479
	Equal variances not assumed			-3.10	161.18	0.002	-17.763	5.727	-29.073	-6.453
Subcontractors	Equal variances assumed	4.23	0.04	-2.38	167.00	0.019	-13.894	5.845	-25.434	-2.353
	Equal variances not assumed			-2.39	166.90	0.018*	-13.894	5.819	-25.382	-2.405
Prof. Orgs	Equal variances assumed	0.82	0.37	-0.47	166.00	0.639	-2.977	6.334	-15.483	9.559
	Equal variances not assumed			-0.47	162.64	0.640	-2.977	6.349	-15.514	9.559
Board of Trade	Equal variances assumed	0.01	0.91	-0.14	165.00	0.890	-0.947	6.839	-14.450	12.556
	Equal variances not assumed			-0.14	163.98	0.890	-0.947	6.837	-14.448	12.554
Eco. Dev. Office	Equal variances assumed	2.60	0.11	0.46	165.00	0.648	3.143	6.862	-10.406	16.692
	Equal variances not assumed			0.46	164.87	0.647	3.143	6.846	-10.374	16.660

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 51

Independent Samples T-Test for National Linkages: Comparing Tech and Non-Tech Firms

t-test for Equality of Means										
		Levene's Test Equality of Variances for		T	df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	F	Sig.							Lower	Upper
Suppliers	Equal variances assumed	0.60	0.44	1.56	167.00	0.120	5.275	3.375	1.388	11.938
	Equal variances not assumed			1.57	167.00	0.118	5.275	3.356	-1.350	11.900
Service Firms	Equal variances assumed	1.97	0.16	0.32	167.00	0.747	0.985	3.053	5.042	7.011
	Equal variances not assumed			0.33	166.27	0.745	0.985	3.025	-4.987	6.956
Customers	Equal variances assumed	0.02	0.89	-0.45	166.00	0.653	-1.465	3.249	-7.880	4.950
	Equal variances not assumed			-0.45	165.63	0.652	-1.465	3.242	-7.865	4.935
Universities (Res)	Equal variances assumed	8.03	0.01	1.81	165.00	0.072	7.379	4.070	-0.658	15.415
	Equal variances not assumed			1.83	159.42	0.069**	7.379	4.025	-0.570	15.327
Gov't (Research)	Equal variances assumed	1.61	0.21	0.75	165.00	0.454	2.295	3.056	-3.740	8.329
	Equal variances not assumed			0.76	163.49	0.450	2.295	3.033	-3.695	8.284
Industry (Res)	Equal variances assumed	0.72	0.40	-0.19	163.00	0.846	-0.635	3.262	-7.077	5.806
	Equal variances not assumed			-0.19	157.28	0.846	-0.635	3.275	-7.104	5.834
Firms in Industry	Equal variances assumed	1.86	0.17	-1.99	164.00	0.048*	-7.067	3.545	-14.067	-0.066
	Equal variances not assumed			-1.98	156.83	0.049	-7.067	3.564	-14.105	-0.028
Subcontractors	Equal variances assumed	0.57	0.45	-0.35	167.00	0.726	-1.068	3.044	-7.078	4.941
	Equal variances not assumed			-0.35	166.38	0.725	-1.068	3.026	-7.042	4.906
Prof. Orgs	Equal variances assumed	1.90	0.17	-0.77	166.00	0.443	-2.205	2.867	-7.865	3.456
	Equal variances not assumed			-0.76	153.00	0.447	-2.205	2.894	-7.922	3.513
Board of Trade	Equal variances assumed	2.76	0.10	-0.89	165.00	0.374	-2.068	2.320	-6.648	2.513
	Equal variances not assumed			-0.88	152.14	0.378	-2.068	2.340	-6.691	2.556
Eco. Dev. Office	Equal variances assumed	8.68	0.00	-1.46	165.00	0.145	-2.276	1.556	-5.348	0.796
	Equal variances not assumed			-1.43	125.82	0.154	-2.276	1.588	-5.418	0.866

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 52

Independent Samples T-Test for International Linkages: Comparing Tech and Non-Tech Firms

t-test for Equality of Means												
		Levene's Test Equality of Variances for		T	df	Sig.	Mean Difference	Std. Error Difference	95% Conf. Interval of the Difference			
	F	Sig.							Lower	Upper		
Suppliers	Equal variances assumed	0.09	0.76	2.15	167.00	0.033*	9.271	4.305	0.771	17.771		
	Equal variances not assumed			2.15	165.13	0.033	9.271	4.305	0.771	17.771		
Service Firms	Equal variances assumed	3.55	0.06	1.53	167.00	0.128	5.335	3.491	-1.557	12.227		
	Equal variances not assumed			1.54	166.92	0.126	5.335	3.467	-1.510	12.180		
Customers	Equal variances assumed	17.92	0.00	4.17	165.00	0.000	22.454	5.381	11.829	33.080		
	Equal variances not assumed			4.21	161.87	0.000*	22.454	5.331	11.926	32.982		
Universities (Res)	Equal variances assumed	0.24	0.62	-0.14	165.00	0.885	-0.465	3.212	-6.807	5.877		
	Equal variances not assumed			-0.14	153.19	0.886	-0.465	3.239	-6.863	5.933		
Gov't (Research)	Equal variances assumed	7.97	0.01	-1.31	165.00	0.191	-3.050	2.323	-7.635	1.536		
	Equal variances not assumed			-1.27	104.22	0.205	-3.050	2.392	-7.793	1.694		
Industry (Res)	Equal variances assumed	23.86	0.00	2.92	163.00	0.004	13.560	4.647	4.384	22.735		
	Equal variances not assumed			2.94	154.41	0.004*	13.560	4.605	4.462	22.657		
Firms in Industry	Equal variances assumed	24.92	0.00	3.57	164.00	0.000	18.961	5.307	8.483	29.440		
	Equal variances not assumed			3.61	156.72	0.000*	18.961	5.252	8.587	29.335		
Subcontractors	Equal variances assumed	2.63	0.11	1.41	166.00	0.161	5.883	4.181	-2.372	14.138		
	Equal variances not assumed			1.41	165.81	0.160	5.883	4.165	-2.340	14.107		
Prof. Orgs	Equal variances assumed	8.51	0.00	2.20	166.00	0.029	7.693	3.502	0.779	14.608		
	Equal variances not assumed			2.21	165.45	0.028*	7.693	3.477	0.829	14.557		
Board of Trade	Equal variances assumed	5.00	0.03	1.14	165.00	0.255	1.994	1.746	-1.453	5.442		
	Equal variances not assumed			1.17	136.00	0.245	1.994	1.707	-1.382	5.370		
Eco. Dev. Office	Equal variances assumed	2.84	0.09	-0.81	165.00	0.418	-1.061	1.307	-3.642	1.520		
	Equal variances not assumed			-0.80	135.65	0.426	-1.061	1.329	-3.688	1.567		

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

One commonly used definition of an SME is a firm who has less than 500 employees (Storey, 1994, p.13). The breakdown of SME vs. large firms in this sample would be 11 versus 168, which provides insufficient data to compare and test empirically. Rather, an analysis will be performed comparing micro enterprises (defined as firms with less than 10 employees) to all others (10 or more employees). Therefore, for this analysis a sample number of 68 micro enterprises will be compared to a sample number of 111 larger enterprises.

Tables 54 and 55 present the 11 categories of possible linkages along with the means for each scale for micro and other firms.

Table 54

Mean Use of Linkages: Comparing Micro and Larger Firms

		Micro		Other	
		Mean	Stan. Dev.	Mean	Stan. Dev.
1	Suppliers	3.36	1.39	3.42	1.09
2	Service Firms	3.28	1.33	3.41	1.03
3	Customers	3.97	1.38	3.64	1.48
4	Research/Universities	1.81	1.25	2.10	1.14
5	Research/Government	2.00	1.34	2.01	1.19
6	Research/Industry	1.89	1.28	1.93	1.04
7	Firms in Industry	2.64	1.38	2.65	1.19
8	Subcontractors	3.21	1.44	3.15	1.33
9	Professional Organizations	2.48	1.36	2.54	1.18
10	Board of Trade	1.55	0.96	1.66	0.83
11	Economic Development Office	1.48**	0.90	1.74	0.98
	Summated Mean	27.03	7.59	28.28	6.76

** Significant at the 90% confidence interval

Table 55

Mean Value for Linkages: Comparing Micro and Larger Firms

		Micro	Other	Micro	Other
1	Suppliers	3.10*	1.36	3.49	1.15
2	Service Firms	3.13	1.19	3.23	1.08
3	Customers	3.81*	1.40	3.29	1.49
4	Research/Universities	1.41*	0.81	1.69	0.91
5	Research/Government	1.81	1.13	1.90	1.18
6	Research/Industry	1.76	1.12	1.75	0.87
7	Firms in Industry	2.55	1.28	2.58	1.16
8	Subcontractors	2.96	1.35	3.08	1.36
9	Professional Organizations	2.42	1.41	2.60	1.17
10	Board of Trade	1.50	0.92	1.54	0.73
11	Economic Development Office	1.37*	0.69	1.65	0.91
	Summated Mean	25.63	6.52	26.96	6.36

* Significant at the 95% confidence interval

With the summated scores table, the same t-test is performed to see if there are any significant differences in the use of linkages between micro enterprises and larger firms. For this test, the micro enterprises generated a summated mean score for use of 27.03 and the larger firms generated a mean score of 28.28.

The t-test results do not indicate any significant differences between the two firm categories (see Table 56). Thus, there is no support for Proposition 14.

Table 56**Independent Samples Test for Use of Linkages: Comparing Micro and Larger firms** $N_1=64$ and $N_2=101$

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	T	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Use	1.51	0.22	-1.10	163.00	0.27	-1.25	1.13	-3.48	0.99

Using the summated value scores, a t-test is generated to compare the mean difference of value for linkages between the two groups of firms. In terms of their value for linkages, the mean overall score for the micro enterprises is 25.63 and 26.96 for the larger organizations.

A t-test comparing summated mean scores indicates no significant differences between larger organizations and the micro enterprises (see Table 55). Therefore, there is no support for Proposition 15.

Table 57**Independent Samples Test for Value of Linkages: Comparing Micro and Larger firms** $N_1=62$ and $N_2=100$

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Value	0.17	0.68	-1.28	160.00	0.20	-1.33	1.04	-3.38	0.72

To see if differences exist in specific categories of linkages between the two groups, t-tests were run with each of the 11 types of linkages. According to the t-test results, the larger organizations in the sample are significantly more likely to use linkages with economic development offices ($t = -1.80$, $p = 0.07$) than the micro enterprises. See Tables 81 and 82 in Appendix H for results of t-tests.

The larger organizations are also significantly more likely to value their linkages with suppliers ($t = -2.02$, $p = 0.04$), universities as research collaborators ($t = -2.15$, $p = 0.03$), and economic development offices ($t = -2.28$, $p = 0.02$). The micro enterprises value significantly more their linkages with customers than do the large organizations ($t = 2.29$, $p = 0.02$). See Tables 83 and 84 in Appendix H for all of the t-test results.

In summary, comparing the use of linkages between micro enterprises and larger firms provides no evidence to suggest that micro firms are more linked than the larger firms in the Ottawa cluster. Thus, there is no support for Proposition 14.

Although the overall summated means are not significantly different, the larger firms do value significantly more their linkages with suppliers, universities and economic development offices. On the other hand, micro firms value more their linkages with customers. Thus, there is little or no evidence to suggest that micro enterprises value more their linkages than do the larger firms, and hence, there is no support for Proposition 15.

5.9 Additional Research Insights: Effect of Economy

Two questions on the survey were designed strategically to provide some insight into the impact of the economy on organizational linkages. These were purposely not designed to measure any of the research propositions but merely to offer some type of explanation or reasoning for some of the research findings. The following two sections will cover the type of impact the firms in the sample think the economy might have had on their firms' use and value of linkages.

5.9.1 Effect of Economy on the Use of Linkages

The respondents were asked if they felt that with the downturn in the economy they had increased, decreased or remained the same in terms of their use of linkages with other sectors/firms.

Slightly fewer than 50% of the firms (for both tech and non-tech firm categories) indicated that they had remained the same. On the other hand, 36.6% and 33.7%, of non-technology and technology firms respectively, indicated that they had increased their use of linkages. Fewer firms thought they had decreased their use of linkages (18.9% Technology and 17.1% Non-Technology) (see Figure 9 below).

Figure 9

Effect of Downturn in Economy on Use of Linkages: Tech vs. Non-Tech

In summary, most respondents (nearly half) indicated that their use of linkages had remained the same, but a good portion of both groups indicated that their use of linkages had increased with the downturn in the economy. This could provide some explanation for the significant increase in use of linkages for technology firms in this 2003 research sample as compared to the results reported by the 2000 research sample.

5.9.2 Effect of Economy on the Value for Linkages

To further investigate the effect of the economy on organizational linkages, respondents were asked whether the downturn in the economy made them value more or less their linkages with other organizations than 3 years ago. They were given a 5-point scale, with 1 indicating that they value much more their linkages and 5 indicating that they value much less their linkages. See Table 58 below for results.

Table 58

Effect of Economy on Value of Linkage: Tech vs. Non-Tech

	Technology	Tech %	Non-Tech	Non-Tech %
Value Much More	11	11.96	12	15.38
2	27	29.35	26	33.33
3 (same)	42	45.65	35	44.87
4	12	13.04	5	6.41
Value Much Less	0	0	0	0

Overall, for both firm groupings, the results are noticeably skewed toward a score below 3. The technology firms' opinions had a slightly heavier weight placed on scores 3 and 4 (the side leading to "Value Much Less") than the non-technology firms. This slight skew is also reflected in the technology firms' mean score of 2.6 (as opposed to the non-technology firms' mean score of 2.4). Note also that both averages are below the middle score of 3. The distribution of scores across respondents is mostly skewed in the direction of "value same" or "value more". Both groups thus report placing more value on their linkages than three years past. In summary, the technology firms and non-technology firms reported similar mean scores indicating that, on average, the firms valued their linkages with other organizations a little more than three years ago.

Chapter 6: Conclusion and Implications

The conclusion and implications of the research findings will be examined in this section, including a summary of the key findings and a comparison to the 2000 Madill et al. study. Some important implications for the research including implications for policy, managers and future research will also be covered. Finally, some weaknesses and strengths of the research will be examined providing a better context for the research findings.

6.1 Research Overview

This research was formulated as a follow-up to the 2000 exploratory study of the networks and linkages of the Ottawa Technology Cluster.

Clusters are important for regional economic growth. They promote the development of new firms and entrepreneurship. They also attract investment and draw in skilled employees. The main focus of this study was to (a) compare technology based firms in the Ottawa cluster with non-technology based firms in terms of the extent and value of linkages within the cluster and outside the cluster (*market web*), and (b) examine technology firms in more detail with the goal of understanding particular patterns of networks and linkages.

The research study was based heavily on the Madill et al. (2002) research conducted in 2000. In fact, this was a follow-up study, using the same parameters of measurement and the same source of sampling frame.

The findings reported in 2000 contradicted many of the existing theories and views on the operation of technology firms such as that of Ryan et al. (2000) and

Saxenian (1994) who contended that technology firms need to be more adept at developing external relationships in order to be successful than do non-technology based companies. The 2000 Madill et al. research revealed that technology firms exhibit fewer linkages than non-technology based companies within the Ottawa cluster.

6.2 Summary of Key Findings

This section will present a summary and discussion surrounding the research findings, which will also tie in pieces of literature to help make sense of the results.

Looking at the frequency of linkages, overall, non-technology firms use significantly more linkages than technology firms within the cluster. Examining further, non-technology firms use more linkages with suppliers, customers, firms in their industry, and boards of trade than do the technology firms. It is interesting because past research, such as that conducted by Freel (2000) had confirmed that the most innovative firms are “significantly more likely to have been involved in some form of collaborative arrangement with their suppliers”. Freel (2000) also found that the most innovative firms were significantly more likely to have had some interaction with a university than were their less innovative counterparts and more contact with the government, support services and trade bodies.

Furthermore, two important types of linkages to firm success such as with customers and other firms in the industry, were shown to be used less by technology firms in this study as well as the previous 2000 study. The technology firms have not improved at all in terms of their cluster web linkages. The research findings in this area paint the same picture as they did in the 2000 study by Madill et al.

These findings contradict much of the research literature on this topic. For example, research by Keeble and Wilkinson (2000) suggests that high-technology SMEs are significantly more innovative and have demonstrated a higher level of local networking, collaboration, and linkage than the non-technology firms. Research theories by Ryans et al. (2000) contend that relationships with market chain members and with organizations and individuals beyond the market chain are important to strategy in technology-intensive businesses” (Ryans et al., 2000). In another study, In Munich, Germany, innovative firms were found to have more intra-regional (within the region) links than non-innovative firms (Sternberg, 1999).

There are, however, several reasons that could explain why technology firms might not be strong users of linkages with members of their cluster web. For one thing, building relationships with managers and executives from different cultures and business environments, according to Ryan et al. (2000), can be a “challenging and time consuming activity” (Ryans et al., 2000) and technology based firms work in a high speed environment where changes are made quite often. It has also been argued that the emphasis is on technology rather than relationships with people in high technology firms (Madill et al., 2002).

There was no overall difference in the value for linkages in the cluster web between the technology and non-technology firms. This suggests an improvement from the 2000 research results. It was however discovered that the non-technology firms value more their linkages with customers, other firms in the industry, subcontractors and boards of trade than the technology firms. On another front, the technology firms value more

their linkages with government research agencies than the non-technology firms. Two key relationships have again shown to be valued less by the technology firms (as was found in the 2000 study); customers and firms in the industry. This suggests that technology firms have not improved in areas that may matter the most.

Some of the differences between the technology and non-technology firms in use and value for linkages could be explained by their originating source of technology. There are clearly more non-technology firms based on technology developed in universities, in the government, and in previous public sector employers than are technology firms. Alternatively, there are many more technology firms based on technology developed by personal R&D activity. Given that personal R&D does not typically involve interaction with outside resources or people, this may provide an explanation for the technology firms' lack of use and value for linkages as compared to non-technology firms who have been built mainly based on technology developed in the public sector.

Another possible explanation for differences in use and value of linkages could be the range in functional responsibility of each founder previous to the founding company. The founders in the technology firms came from predominantly technical jobs. The founders for the non-technology firms came predominantly from sales/marketing, technical and general management roles. The mainly technical background of the founders in technology firms could offer a possible explanation for the lack of use for linkages. The concept of Relationship Marketing is not typically the number one priority of technically inclined workers. The fact that a large proportion of founders from the non-

technology firms came from Sales/Marketing roles may explain a predisposition to more networking outside the firm.

To add insight into these surprising 2000 findings, this research also undertook to examine linkages outside the Ottawa cluster both nationally and internationally.

When asked broadly about their use of *market web* linkages (outside the cluster region), technology firms did not use significantly more linkages than the non-technology firms.

The technology firms valued more their *market web* linkages with universities and the industry as research collaborators than did the non-technology firms. These two categories of linkages suggest that having research collaborators outside the cluster region is more important to the technology firms than to the non-technology firms.

As a test of reliability and validity, the respondents were asked to specifically think about their use of linkages on a regional, national and international basis. In essence, these results were testing the same propositions but using a different measurement question.

The technology firms confirmed that they use significantly less intra-regional (within cluster) linkages as compared to non-technology firms. This is exactly what was found when asked to score their use of linkages on a 5-point scale for 11 categories of linkages.

Technology firms reported, however, using significantly more international linkages than the non-technology firms in the Ottawa cluster. This is in contrast to the results in terms of linkages with the *market web* (outside cluster region). The additional

question was helpful in getting the respondents to specifically think of their linkages outside the cluster environment. The *market web* question may have been too general, combining any linkage outside the Ottawa cluster (i.e. national linkages).

Thus, technology firms are significantly more likely to use international linkages with suppliers, customers, industry collaborators, other firms in the Industry, and professional organizations. This suggests that technology firms are linked much more internationally than the non-technology firms. According to Keeble et al. (1998), networks within clusters, are not the only consideration for firms within high technology districts, because the markets for their products are often worldwide. For example, in Ottawa, a substantial amount (90%) high-tech revenue comes from sales abroad, mostly in the United States (Economist, 03/03/2001). These results confirm other research. In a study of Cambridge, it was reported that: “many Cambridge managers see themselves as networking more closely with firms abroad in supplier and customer relationships than with firms in the Cambridge area or with large British companies” (Garnsey and Cannon-Brookes, 1993, p. 27).

It was suggested that technology-based SMEs, which are more international in orientation, and thus likely have better growth prospects, also have stronger local links than those firms who have a narrower national orientation (Keeble *et al.*, 1996). Other research by Keeble et al. (1998) further suggests that successful globalization by high-technology SMEs may actually be enabled by local networking and research and technology collaboration (Keeble et al., 1998). Regional and global networking appear to be complementary and simultaneous rather than alternative processes (Keeble and

Wilkinson, 2000, p. 14). This idea has also been advanced by Hendry et al. (2000), who argue that a given cluster is found to have more links outside the region than within, questions are raised about what technology firms derive from proximity which will also invariably contribute to the debate about high technology industrial districts or clusters. The results in this study suggests that the Ottawa technology firms are more focused internationally than locally. There does not appear to be enough balance as per the prescriptions of Keeble et al. (1998) and Hendry et al. (2000).

On a different note, firms based on technology developed in the public sector were significantly more likely to use economic development offices and government agencies than were firms based on technology developed in the private sector. They also value significantly more their linkages with economic development offices than do the firms based on technology developed in the private sector. It should be noted, however, that the empirical tests were conducted with relatively low number of firms that were based on technology developed in the public sector (N=23). This causes some concern and may lower one's confidence in these results.

There were no overall significant differences between the venture-backed technology firms and the non venture-backed technology firms in terms of their use and value for linkages. That is, the venture-backed firms did not use or value more their linkages than the non-venture backed firms while past research suggests that venture capitalists help create a broader range of inter-firm linkages (Saxenian, 1994).

Venture-backed firms in the sample valued significantly less their linkages with customers than did the non venture-backed firms (same result as 2000 Madill et al.

study). This appears to be a valid finding. It is very possible that the firms in question (backed by venture capital funding) value less their linkages with customers because they are in the early stages of the product life cycle. Hence, R&D and such activities are more of a concern/focus than consumer relations. Venture capitalist fund early stage firms and their product development. Banks on the other hand fund mainly working capital financing and other forms of later stage financing. All of this is due to the element of risk involved. Venture capitalists take much larger risks with developing firms than banks do. Even if venture-backed firms were customer focused, such firms may still only have a limited number of customers. Venture capitalists' value for customers may simply be outweighed by more important linkages such as product or research related linkages.

Interestingly, the technology firms in the 2003 sample use significantly more linkages than did the technology firms in the 2000 sample. In fact, they use significantly more linkages with customers but use significantly less linkages with suppliers than do the technology firms in the 2000 study. This could be an indication of the rough economic period. Perhaps, the technology firms started focusing more on their source of revenue and less on the source of expenses. Even though the technology firms use more linkages than did the technology firms in the 2000 sample, they are still using their linkages less than the non-technology firms in the 2003 sample.

Even more interesting, is the fact that technology firms in the 2003 sample value significantly less their linkages with organizations than did the technology firms in the 2000 study. In effect, they value less their linkages with universities, industry research collaborators and customers. Hence, the technology firms in the 2003 sample use more

linkages with customers but value them less than the technology firms in the 2000 sample. It seems strange that the technology firms could use more linkages with customers than was shown in 2000, and yet value them less. When examining the impact of the economy on the use of linkages, 36.6% of technology firms indicated that they increased their usage of linkages in the last three years. Another possible explanation is the theory that linkages have a significant effect on the survival likelihood of a corporation and that relationships are attempts by organizations to influence the behaviours of others in their environment (Sheppard, 1994b). This means that through the manipulation of the firm's relationships with other firms, the organization can better ensure its continued existence. Longitudinal research has suggested further that failing firms gain linkages as they decline (Sheppard, 1994b). What was described as the recent "technology depression", however, by Madill et al. (2003) however has resulted in few business failures. Comparing the data from the 2000 Madill et al. study and the data from the sampling frame used in this study, it was discovered that at least 90 percent of technology firm respondents in the 2000 Madill et al. survey were still operating in 2003. Whether this is due to their increased use of linkages is unknown but would be a worthy topic for future research.

The balance of evidence in this study suggests, as was suggested three years ago, that the vitality of the Ottawa cluster could be further enhanced through the promotion of additional networking and linkages among regional firms. The technology firms that form the technology cluster in Ottawa appear to be using sufficiently better their linkages outside the region as opposed to within the region.

In general, many of the findings in 2003 confirm those reported in 2000. Looking at the big picture, things have not changed dramatically in the Ottawa cluster in the past three years.

6.3 Implications of Research

The following section will give a comprehensive account of the various implications this research has, including implications for policy, for managers and for future research. The implications of the study should be considered within the context of the strengths and limitations of the research (see section 6.3 and 6.4).

6.3.1 Implication for Policy

The fact that this research concentrates on a cluster region (innovative milieu) should create interest for policy makers. Armstrong and Taylor (2000, p.298) argue that policy makers are greatly drawn into the concept of innovative milieu because of the fact that the jobs created in this particular area are high quality and are in industries with excellent long-term growth prospects.

Policy makers might find value in focusing their attention on firms in regional growth areas. They are important in the growth process and “it may be possible for [policy makers] to replicate the conditions found within the best innovative milieu” (Armstrong and Taylor, 2000, pp. 298-299). Porter’s argument, according to Miller et al., is “not that governments can create clusters, but that they can help to provide the business, innovative and institutional environments vital for cluster success” (Miller et al., 2001).

The government has the power to encourage or discourage the formation of industry clusters in Canada. With a better understanding of the factors which encourage the growth of clusters, such as the one in Ottawa, policy makers will be better off at making decisions regarding cluster formation within certain regions. In fact, the new "Achieving Excellence", program, is now part of the Federal Government's Innovation Strategy. This strategy has set a target for 2010 to develop "at least 10 internationally recognized technology clusters" (Mallet, 2002).

According to Keeble and Wilkinson (2000, p.217), "the clear implication for policy here is that the fostering of a successful learning-based regional cluster of high-technology SMEs has to involve long term support and policy over several decades, even under favourable external and environmental circumstances". This means that policy makers might consider making an effort to support the development of the Ottawa technology cluster, whether it is by fostering linkages with the firms or through the promotion of them and increased political awareness.

It is hoped that this research provides helpful information about clusters that policy makers can use and refer back to when making decisions regarding economic development and cluster formation. This research may provide baseline data to inform the development of policies that will guide the financing, and foster the growth, of firms within Ottawa area. In particular, the findings of this research suggest a focus on approaches for stimulating partnerships and linkages among firms in the Ottawa cluster.

6.3.2 Implications for Managers

Managers in technology-based firms may, through these research findings, see the need to work towards establishing and maintaining additional valued relationships. The literature review demonstrated a link between networking performance and innovation (Madill et al., 2002). It is perhaps the lack of use of inter-organizational linkages by technology firms shown in the 2000 study by Madill et al. and again in this 2003 version of the study that may lead to questions about the health of the Ottawa technology cluster. In fact, the Ottawa Centre for Research and Innovation (OCRI) is taking active steps to improve and speed the growth of the Ottawa cluster (<http://www.ocri.ca>).

Gaining a competitive advantage through pricing strategies and through the expansion of distribution channels is becoming more and more difficult. Ryans et al (2000) prescribe that firms can gain a competitive advantage through the nature and strength of the relationships they build. This can potentially give them a *collaborative advantage* which Ryans et al. described as, “the linking of capabilities between organizations to create value for the end user, and strategic leverage for market chain members” (Ryans et al., 2000). If managers learn how to go down into the market chain and to collaborate with market chain members closer to the end user, it will allow firms to “tap into knowledge, trends, and emerging needs understood by those closer to the end user; a combination that can guide innovation” (Ryans et al., 2000).

6.3.3 Implications for Future

This study has the potential to make several key contributions to existing literature. Since this topic area is under researched, any new empirical contributions

should benefit academics in terms of broadening the current knowledge base surrounding technology clusters and market webs. This study will be useful to researchers and academics in that cluster studies are relatively uncommon in the Canadian context. Most of the research on regional technology clusters has been undertaken in the United States (mostly in the Silicon Valley) and now more and more research is emerging on European technology clusters.

This study suggests that perhaps more effort could be put toward the monitoring of relationships. With the bulk of the literature suggesting the positive impact of Relationship Marketing, future research should be dedicated in the area of technology firms and their use and value for organizational linkages, especially within cluster environments. It is somewhat disturbing that the very definition of a cluster suggests the use of linkages among regional firms, yet the evidence garnered from this research in Ottawa portrays quite a different picture. Inherent in the definition of a cluster is the concept of linkages and relationships (Porter, 1990,1998; Wever and Stam, 1999; De Langen, 2000; Mallet, 2002).

Since the majority of the cluster research has been performed overseas or in the United States, it would be beneficial to conduct a similar study in a Canadian technology cluster other than that of Ottawa. It would be interesting to see if these results replicate nationally, and across different types of clusters, or whether these research findings are characteristic of the Ottawa cluster only.

6.4 Weaknesses of the Research

This study has a few weaknesses that are important to mention, which will help to set the context for the research results.

The survey was essentially addressed to only one person per organization (i.e. the Chief Executive Officer). This could cause a single respondent bias such that one person's view may not be completely representative of the firm (Phillips, 1981). A limitation surrounding the integrity of the data could surface if the CEO of the firm is newly appointed and is not familiar with the history of the firm.

Because the survey was distributed using a fax-back format, it was near impossible to ensure that the addressee was in fact the person to complete the questionnaire and not an administrative assistant for example.

Since the last study was initiated and performed only three years ago, many of the participating firms will have completed a similar questionnaire before. This may have caused a resistance in terms of participation this time around. There were very few firms who participated in the 2000 study that agreed to participate again. Had there been a larger sample of firms who responded to both surveys, it would have been interesting to test and compare them against the new respondents

Being that the data collection was initiated during the summer months, lower response rates were generated. Mainly due to holidays, the fax survey may have gotten lost in the shuffle or put last on recipients' priority list. Consequently, as an example, the study generated poor sample numbers in terms of technology subsidiary firms, which prevented a proper analysis and comparative test for the respective proposition. It would

have likely been better to perform the data gathering in the Fall or Winter months.

Non-response bias was, however, tested with late and early respondents. Firms that responded in the first round of faxes are not significantly different than the firms who participated in response to the reminder fax (see *Appendix J*). There does not appear to be a non-response bias in this research.

Because this research was formulated based on the same measurement metrics as the Madill et al. (2002) study, some of the limitations were not all together eliminated. For instance, it must again be noted, as was done by Madill et al. in 2000, that the study may not have considered relationships that are important to technology-based firms. As mentioned by Madill et al. in their conclusions, it may once again be possible “that relationships with certain suppliers and or certain customers are stronger than others and that some are more valued than others” (2000). It would be beneficial for any research in the future to take a more qualitative approach to develop a more detailed and profound understanding of the nature and value of such linkages.

6.5 Strengths of the Research

Identification of technology intensive firms would have been near impossible without the purchase of the *Ottawa Business Journal Technology Database*. With the lack of control, it is difficult to ensure that each firm classified as a technology intensive business is in fact so, however analysis presented in Section 5.1 shows the SIC codes for these firms are consistent with what is considered to be technology firms. Likewise, the firms classified as non-technology appear to be distinctively not technology intensive. The *Ottawa Business Journal* is however considered an external expert and their

classification system is accepted as reasonable and accurate. In order to identify, under a controlled environment, the population of high technology firms, would require, among other things, measuring the level of R&D expenditures per firm. This would be extremely time consuming. Moreover, it may also not be entirely accurate in identifying technology intensive firms since investments in R&D may take time to come into fruition and may not be completely represented on SMEs' financial records. As such, the classification of high tech companies by the *Ottawa Business Journal* is viewed as an asset to this study rather than a limitation.

One of the major strengths of this study is that it dates from two different periods (longitudinal analysis). This sets a better context for the research results.

A longitudinal study of this nature could also have created problems in terms of "panel mortality" and (i.e. firms exiting market) the issue of a changing overall context over the studied periods (Johannisson, 1996, p. 258). That is, many of the firms in the original 2000 database are not present in the 2003 database. Moreover, the environment for the firms in the Ottawa cluster has changed in the last three years. The impact of the economy specifically has been addressed in this study. The concept that the respondents in this study are "new" and younger is looked upon as a strength. These new respondents allow us to view a different range of firms to see if the latest results are consistent with those found previously.

Because the research results from the 2000 study were somewhat surprising to the academic community, the addition of some questions made this study more reliable. The additional question, specifically, which asked respondents about their use of regional,

national and international linkages helped to dig deeper into the results. Not only did this question act as a reliability check of the other measurement questions on the use of linkages, but it also generated some very interesting and detailed findings.

For example, in the case of comparing the use of linkages between technology and non-technology firms, the “same question” was asked twice and the same results were generated both times. In the case of *market web* linkages, no differences were found, but when asked specifically about international linkages, a key difference was found between technology and non-technology firms.

Although this study generated a lower response rate than that generated in the 2000 study, an improved response rate was generated with the follow-up reminders and the addition of the online survey. This was a method not used in the 2000 study. It may prove to be effective in future research endeavors.

6.6 Research Benefits

This research may offer a number of benefits. First, it contributes to the literature on regional technology clusters and the nature of the networks that are to be important to the regional cluster formation, thus filling a gap that currently exists. This research also contributes to understanding of the topic area and helps make sense of the conflicting views surrounding the subject.

This research adds another dimension to the original study which is intended to contribute to existing literature. The concept of *market webs* is investigated to see if firms in the cluster use more intra-regional linkages (within the cluster) or more inter-

regional linkages (outside the cluster) and whether these linkages are mostly national or international.

Moreover, the research tracks changes in usage patterns of networks and linkages of technology firms within the Ottawa cluster. Much of the current research has been conducted in the UK (Cambridge) and the US (Silicon Valley, Route 128), with little research looking at the Canadian high technology clusters. This research contributes an examination of an important Canadian cluster.

Some additional benefits, as listed by Madill et al. (2002) could include: “incremental knowledge about the interactions of the factors leading to the development of clusters of growth oriented technology-based businesses; a yet better understanding of the role of public policy in the commercialization process; and an improved knowledge about the attributes of regional infrastructures that are conducive to fostering growth of new technology-based businesses”.

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Appendices

Appendix A: Cover Letter and Survey (package sent to sample)

Fax

To:	«Name», «Title»	From:	Ottawa Technology Cluster Research Team, Carleton University
Fax:	«Company_Fax»	Pages:	11
Phone:	«Company_Tel»	Date:	9/30/2003
Subject:	Regional Technology Cluster Study	CC:	

☐ Urgent	☐ For Review	☐ Please Comment	☒ Please Reply	☐ Please Recycle
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<Name>
 «Company_Name»
 «Company_Address»
 «City» «ProvinceState» «PostalZip_Code»

Dear <Name>,

We are writing to ask if you would be part of a research study that we are conducting on the development of the technology cluster located here in the Ottawa region. A major objective of our study is to achieve a better understanding of the forces that create and shape regional technology clusters. Your participation in the study is critical in allowing us to focus on the development of this region and its companies. The benefits of participation in the study are threefold. First, our resulting research report will provide insights useful to economic development practitioners and public policy makers working to foster the continued growth and prosperity of this region. Second, the research results will be distributed internationally in the form of a book, conference papers, and journal articles. This dissemination will further raise the profile and attractiveness of this region and help publicise Ottawa-Carleton as an international model. Third, we hope to identify, in more detail, those aspects of the community infrastructure that are necessary to continued development of the business community.

We ask that you complete the attached questionnaire and fax it back to us. For your convenience, we include a fax cover sheet for this purpose. Most of the questions are of the convenient 'check-off' variety and filling out the questionnaire should take no more than 10 minutes of your time. Alternatively, our researcher (Ms. Sylvie Ménard) will telephone you to follow up this letter. She will be happy to arrange a time to pose the questions on the attached questionnaire by means of a telephone interview.

As you may be aware, OCRI has established a task force on R&D commercialization and growing local technology companies to help identify barriers to business growth that might exist in this region - and if any are found, to try to identify action to remove or reduce such barriers. We are working with the taskforce. Our findings will be shared with them with a view to improving the local business climate. The Chair of the Task Force, Eli Fathi, supports our work and hopes that you will also contribute through completing this questionnaire to the success of the task force.

We do not think that we are seeking any confidential or proprietary information, but please be assured that all responses will be kept strictly confidential and only aggregated findings will be reported.

Thank you for considering our request. We look forward to learning from your experience. We also trust that this work will be a means of fostering yet better linkages and knowledge transfer opportunities between the University and Business communities.

Sincerely,

Sylvie Ménard
 MBA Student

Judith Madill
 Professor of Marketing

George Haines, Jr.
 Professor of Marketing

Allan Riding
 Professor of Finance

KNOWLEDGE TRANSFER IN REGIONAL TECHNOLOGY CLUSTERS: THE CASE OF OTTAWA

In the Spring of 2000, our research team conducted a study of the Ottawa Technology Cluster. The results of this study are posted on www.carleton.ca/sme/ottawacluster. To access this web site, you will need to use the password "OTC Thanks". We hope that you will find this info helpful and interesting. We are currently conducting a follow-up to this successful research. We would like to ask you to help us with this follow-up study.

There are a number of other studies that assess the factors that contribute to the success of various regional high technology clusters across North America and Europe. The first, and most influential, study is Saxenian's comparison of Silicon Valley and Boston's Route 128. A second interesting study is Pinch and Henry's (1999) analysis of the clustering of the British motor sports industry. Whereas these studies have been conceptually rich, the empirical approach has often been impoverished. Our research seeks to address these limitations by means of a study of regional collective learning and knowledge transfer in Ottawa, Canada's leading technology cluster.

A team of internationally known scholars is undertaking the work. The Canadian members include Dr. Allan Riding, Dr. Judith Madill and Dr. George Haines, Jr. of Carleton University. These researchers are well known for their work on both SME financing and on public policy relating to growth of new enterprises. In addition, international collaborators include: Dr. Colin Mason (University of Southampton), renowned for his research in economic geography; Dr. Richard Harrison (University of Aberdeen), a scholar highly regarded for his work on SME financing; and Dr. Sarah Cooper (Heriot-Watt University, Edinburgh) whose work on the growth of new technology-based enterprises has been widely disseminated.

By focusing on Ottawa's technology cluster we believe the research will make a valuable contribution to understanding enterprise development, commercialization of innovation, and how the development of trust and co-operation in the context of an interlocking and integrated web of supportive organizations enhance collective learning capabilities. Findings are expected to be useful to academics, policy-makers, economic development practitioners, and the organizations involved in the cluster themselves. Benefits will include: incremental knowledge about the interactions of the factors leading to the development of clusters of growth oriented technology-based businesses; a yet better understanding of the role of public policy in the commercialization process; and an improved knowledge about the attributes of regional infrastructures that are conducive to fostering growth of new technology-based businesses.

FAX TRANSMISSION

To: Judith Madill **Date:**
Fax #: (613) 520-5630 **Pages:**
From: Name, «Company_Name»
Subject: Regional Technology Cluster Study

RESPONSES:

☐ I have completed the questionnaire and it is attached.

☐ Yes, I agree to participate in this study and you may contact me at the following telephone number: (____)_____, and I am willing and available to participate in the telephone interview on

_____, 2003 at _____Hr.

☐ No, I am unable to participate in this study.

KNOWLEDGE TRANSFER IN REGIONAL TECHNOLOGY CLUSTERS: THE CASE OF OTTAWA

Section 1. FORMATION AND OWNERSHIP CHARACTERISTICS

1. In what year was your company founded? _____

2. Was your company formed in the Ottawa-Carleton region?

Yes ☒ No ☒ If not, please state the town/city where the company was founded

3. Was your company formed as an independent firm (i.e. with a controlling interest held by the founder or founders)?

Yes ☒ No ☒ What is the nationality of the parent company?

_____ Go to Q. 5

4. Does your company remain independent?

Yes ☒ If YES, Go to Question 5

No ☒ If not, in which year did this company cease to be independent?

5. Is your firm the subsidiary of a larger firm?

Yes ☒ No ☒

Section 2. THE FOUNDERS

6. How many people made up the founding team of your firm?

_____ founders of whom _____ founders are still with the firm

(If only ONE founder, Go to Question 7)

7. Had any of the original founding team previously worked together?

All ☒
 Some ☒
 None ☒

8. What type of organizations did the founder/founders work for immediately before your company was founded?

	Founder number			
	1	2	3	4
Federal government/Crown Corporation	☒	☒	☒	☒
Provincial government	☒	☒	☒	☒
University	☒	☒	☒	☒
Small firm (less than 100 employees)	☒	☒	☒	☒
Medium sized firm (100-500 employees)	☒	☒	☒	☒
Large firm (over 500 employees)	☒	☒	☒	☒
Other (please specify)				

9. How far was that organization away from the start-up location of this company?

	Founder number			
	1	2	3	4
Less than 30 miles	☒	☒	☒	☒
30-199 miles	☒	☒	☒	☒
200 miles or more	☒	☒	☒	☒

10. What was the main functional responsibility of each founder in the organization that they worked for immediately before starting this company? (Indicate all that apply)

	Founder number			
	1	2	3	4
Research	☒	☒	☒	☒
Technical	☒	☒	☒	☒
Production/operations	☒	☒	☒	☒
Sales/marketing	☒	☒	☒	☒
Finance	☒	☒	☒	☒
General management	☒	☒	☒	☒
Other (please specify)				

11. Where was the knowledge developed on which this company is based? (Indicate all that apply)

University	☒
Federal/provincial government/Crown Corporation	☒
A previous private sector employer	☒
A previous public sector employer	☒
Own personal R&D activity	☒
Another company	☒
Other (please specify)	

Section 3. LINKS AND NETWORKS WITHIN CLUSTER and OUTSIDE CLUSTER

- 12. Using the following set of 5-point scales, please rate the usage frequency of your firm's links with each of the following sectors WITHIN the Ottawa region (1 = not used at all frequently; 5 = used extremely frequently):**

	NOT USED AT ALL				USED FREQUENTLY
Suppliers	1-----	2-----	3-----	4-----	5-----
Firms providing professional, business and technical services	1-----	2-----	3-----	4-----	5-----
Customers	1-----	2-----	3-----	4-----	5-----
Research collaborators – universities	1-----	2-----	3-----	4-----	5-----
Research collaborators - government agencies	1-----	2-----	3-----	4-----	5-----
Research collaborators – industry	1-----	2-----	3-----	4-----	5-----
Firms in your industry	1-----	2-----	3-----	4-----	5-----
Subcontractors	1-----	2-----	3-----	4-----	5-----
Professional Organizations (e.g., OCRI, Zone5, etc.)	1-----	2-----	3-----	4-----	5-----
Board of Trade / Chamber of Commerce	1-----	2-----	3-----	4-----	5-----
Ottawa or other regional economic development office	1-----	2-----	3-----	4-----	5-----
Other (please specify)					

- 13. Using the following set of 5-point scales, please rate the usage frequency of your firm's links with each of the following sectors OUTSIDE the Ottawa region (1 = not used at all frequently; 5 = used extremely frequently):**

	NOT USED AT ALL				USED FREQUENTLY
Suppliers	1-----	2-----	3-----	4-----	5-----
Firms providing professional, business and technical services	1-----	2-----	3-----	4-----	5-----
Customers	1-----	2-----	3-----	4-----	5-----
Research collaborators – universities	1-----	2-----	3-----	4-----	5-----
Research collaborators - government agencies	1-----	2-----	3-----	4-----	5-----
Research collaborators – industry	1-----	2-----	3-----	4-----	5-----
Firms in your industry	1-----	2-----	3-----	4-----	5-----
Subcontractors	1-----	2-----	3-----	4-----	5-----
Professional Organizations (e.g., OCRI, Zone5, etc.)	1-----	2-----	3-----	4-----	5-----
Board of Trade / Chamber of Commerce	1-----	2-----	3-----	4-----	5-----
Ottawa or other regional economic development office	1-----	2-----	3-----	4-----	5-----
Other (please specify)					

14. Using the following set of 5-point scales, please rate the value of your firm's links with each of the following sectors WITHIN the Ottawa region
(1 = not at all valuable; 5 = extremely valuable):

	NOT AT ALL VALUABLE	1-----2-----3-----4-----5	VALUABLE
Suppliers	1-----2-----3-----4-----5		
Firms providing professional, business and technical services	1-----2-----3-----4-----5		
Customers	1-----2-----3-----4-----5		
Research collaborators – universities	1-----2-----3-----4-----5		
Research collaborators - government agencies	1-----2-----3-----4-----5		
Research collaborators – industry	1-----2-----3-----4-----5		
Firms in your industry	1-----2-----3-----4-----5		
Subcontractors	1-----2-----3-----4-----5		
Professional Organizations (e.g., OCRI, Zone5, etc.)	1-----2-----3-----4-----5		
Board of Trade / Chamber of Commerce	1-----2-----3-----4-----5		
Ottawa or other regional economic development office	1-----2-----3-----4-----5		
Other (please specify)			

15. Using the following set of 5-point scales, please rate the value of your firm's links with each of the following sectors OUTSIDE the Ottawa region
(1 = not at all valuable; 5 = extremely valuable):

	NOT AT ALL VALUABLE	1-----2-----3-----4-----5	VALUABLE
Suppliers	1-----2-----3-----4-----5		
Firms providing professional, business and technical services	1-----2-----3-----4-----5		
Customers	1-----2-----3-----4-----5		
Research collaborators – universities	1-----2-----3-----4-----5		
Research collaborators - government agencies	1-----2-----3-----4-----5		
Research collaborators – industry	1-----2-----3-----4-----5		
Firms in your industry	1-----2-----3-----4-----5		
Subcontractors	1-----2-----3-----4-----5		
Professional Organizations (e.g., OCRI, Zone5, etc.)	1-----2-----3-----4-----5		
Board of Trade / Chamber of Commerce	1-----2-----3-----4-----5		
Ottawa or other regional economic development office	1-----2-----3-----4-----5		
Other (please specify)			

- 16. Of the following list of sectors, for each please indicate what proportion (out of 100%) of linkages is local (within the Ottawa region), national (within Canada), and international.**

e.g. 25% (regional) + 25% (national) + 50% (international) = 100%

	REGIONAL	NATIONAL	INTERNATIONAL
Suppliers			
Firms providing professional, business and technical services			
Customers			
Research collaborators - universities			
Research collaborators - government agencies			
Research collaborators – industry			
Firms in your industry			
Subcontractors			
Professional Organizations (e.g., OCRI, Zone5, etc.)			
Board of Trade / Chamber of Commerce			
Ottawa or other regional economic development office			
Other (please specify):			

Section 4. GENERAL

- 17. With the downturn in the economy, do you feel you have increased, decreased, or remained the same in terms of your usage of linkages with other sectors/firms?**
- ☒ Increased
- ☒ Decreased
- ☒ Remained the same

- 18. With the downturn in the economy, do you feel, on an overall basis, that you value more or less your linkages than you did 3 years ago? Please circle on a scale of 1 to 5 (1 = value much more; 5 = much less).**
- Value much more Much less
- 1-----2-----3-----4-----5

23. The purpose of this questionnaire has been to gather important background information about your company. To further enrich our understanding of your company, we would like to interview you. Such interviews would take approximately one half hour of your time and we would conduct it, if you agree, at a time and place that is convenient for you. If you would be willing to participate in a brief follow-up telephone or face-to-face interview please provide contact details:

Name	
Company	
Address	
Telephone	
Fax	
E-mail	

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

Appendix B: Past Participant's Letter

«CEO»
 «Company»
 «Address»
 «City» «Province» «PostCode»

Dear «CEO»

We are writing to ask if you would be part of a research study that we are conducting on the development of the technology cluster located here in the Ottawa region. A major objective of our study is to achieve a better understanding of the forces that create and shape regional technology clusters. Your participation in the study is critical in allowing us to focus on the development of this region and its companies. The benefits of participation in the study are threefold. First, our resulting research report will provide insights useful to economic development practitioners and public policy makers working to foster the continued growth and prosperity of this region. Second, the research results will be distributed internationally in the form of a book, conference papers, and journal articles. This dissemination will further raise the profile and attractiveness of this region and help publicise Ottawa-Carleton as an international model. Third, we hope to identify, in more detail, those aspects of the community infrastructure that are necessary to continued development of the business community.

We would like to thank you for your participation in the previous study performed in the Spring of 2000. Your contribution was greatly appreciated and served to further the understanding of the development process and functioning of regional technology clusters. We hope that you will find the time to be a part of this follow-up research study.

We ask that you complete the attached questionnaire and fax it back to us. For your convenience, we include a fax cover sheet for this purpose. Most of the questions are of the convenient 'check-off' variety and filling out the questionnaire should take no more than 10 minutes of your time. Alternatively, our researcher (Ms. Sylvie Ménard) will telephone you <<Phone>> to follow up this letter. She will be happy to arrange a time to pose the questions on the attached questionnaire by means of a telephone interview.

We do not think that we are seeking any confidential or proprietary information, but please be assured that all responses will be kept strictly confidential and only aggregated findings will be reported.

Thank you for considering our request. We look forward to learning from your experience. We also trust that this work will be a means of fostering yet better linkages and knowledge transfer opportunities between the University and Business communities.

Sincerely,

Sylvie Ménard
 MBA Student

Judith Madill
 Professor of Marketing

George Haines, Jr.
 Professor of Marketing

Allan Riding
 Professor of Finance

Appendix C: Follow-Up Letter (Fax)

Fax

To:	<<CEO>>	From:	Ottawa Technology Cluster Research Team, Carleton University
Fax:	«Company_Fax»	Pages:	2 (incl. cover)
Phone:	«Company_Tel»	Date:	
Subject:	Follow-Up: Regional Technology Cluster Study	CC:	

☐ Urgent	☐ For Review	☐ Please Comment	☒ Please Reply	☐ Please
Recycle				

Please see letter to follow.

«Name»
 «Title»
 «Company_Name»
 «Company_Address»
 «City», «ProvinceState» «PostalZip_Code»

Dear «Name»,

We are following up with a gentle reminder asking if you would please participate in our study of the Ottawa Technology Cluster. You would have received a fax survey from us within the last few weeks. We would ask if you could take a few minutes (approximately 10 minutes of your time) to complete the survey and fax it back to us. If you require another copy of the survey, we can offer three ways for you to participate – please choose the one most convenient for you:

- 1) We can send you another fax survey. Check here if this is best for you. ☐
- 2) We can interview you over the telephone at a mutually agreeable time and date. Check here if this is best for you. Please also specify a convenient time, date and telephone number below: ☐

Name: _____ Date: _____
 Tel: _____ Time: _____

I would like you to fax me a copy of the survey so I have it in my hands during the telephone interview: ☐ Yes ☐ No

- 3) We have the questionnaire on a website at <http://www.carleton.ca/sme/ottawacluster>. You may go to the site and follow the instructions from there to fill out the form. Check here if this is best for you. ☐
- 4) I am not able to participate in this study. ☐

Please FAX Back to 520-5630

Thank you in advance for your time and support. Should you need to contact us, we can be reached by telephone at 520-2600 x 7611 or by email at sme@sprott.carleton.ca.

Sincerely,

Sylvie Ménard
MBA Student

Judith Madill
Professor of Marketing

George Haines, Jr.
Professor of Marketing

Allan Riding
Professor of Finance

p.s. Summary results from our 2000 study can be accessed at <http://www.carleton.ca/sme/ottawacluster> with the UserID "otcrespond" and the password "otcthanks".

Appendix D: Effect of Case Studies

Table 59

Effect of Case Studies on Technology-Based Firms

		% of Total
Technology Firms Contacted	68	8.9%
Tech Firms Interviewed	9	1.2%
Tech Firms Untouched	691	90.0%
Total Tech Firms in Database	768	100%

Figure 10

Effect of Case Studies on Technology-Based Firms

Table 60**Effect of Case Studies on Non-Technology Firms**

		% of Total
Firms Contacted	36	5.2%
Firms Interviewed	5	0.7%
Firms Untouched	656	94.1%
Total Firms in Database	697	100%

Figure 11**Effect of Case Studies on Non-Technology Firms**

Table 61

Measurement Questions and Data Analysis Techniques

Investigative Questions	Propositions	Measurement Questions	Data Analysis Technique
1. Do technology based firms a) use more linkages and b) value more highly their linkages with organizations in both their cluster and market web, than do non-technology based firms?	<p><i>Proposition 1:</i> Technology based firms use more linkages with organizations in their market web than do firms in non-technology sectors.</p> <p><i>Proposition 2:</i> Technology based firms value their linkages with organizations in their market web more than do firms in non-technology sectors.</p> <p><i>Proposition 3:</i> Technology-based firms value their linkages with organizations in their <u>cluster</u> more than do firms in non-technology based sectors.</p> <p><i>Proposition 4:</i> Technology-based firms value their linkages with organizations in their <u>market web</u> more than do firms in non-technology sectors.</p>	<p>Usage of linkages (cluster): Appendix A, Question 12</p> <p>Value of linkages (cluster): Appendix A, Question 13</p> <p>Usage of linkages (market web): Appendix A, Question 15</p> <p>Value of linkages (market web): Appendix A, Question 16</p>	T-Tests
2. Are technology-based firms more likely to have (a) more frequent and (b) more valued linkages with organizations that are similar to the organization's original source of technology?	<p><i>Proposition 7:</i> Technology-based firms are likely to have more frequent linkages with organizations that are similar to the organization's original source of technology.</p> <p><i>Proposition 8:</i> Technology-based firms are likely to have more valued linkages with organizations that are similar to the organization's original source of technology.</p>	<p>Usage of linkages: Appendix A, Questions 12 and 15</p> <p>Value of linkages: Appendix A, Questions 13 and 16</p> <p>Original Source of Technology: Appendix A, Questions 8, 10, 11, 19</p>	T-Tests

3. Are technology-based firms that have obtained financing from venture capitalists likely to have (a) more frequent and (b) more valued linkages with organizations than are organizations that have not received venture capital financing?	<i>Proposition 9:</i> Technology-based firms that have obtained financing from venture capitalists are likely to have more frequent linkages with organizations than are organizations that have not received venture capital financing. <i>Proposition 10:</i> Technology-based firms that have obtained financing from venture capitalists are likely to have more valued linkages with organizations than are organizations that have not received venture capital financing.	Usage of linkages: Appendix A, Questions 12 and 15 Value of linkages: Appendix A, Questions 13 and 16 Financing of firm: Appendix A, Questions 21, 21b, 22	T-Tests
4. Have technology-based firms' usage and value of linkages with organizations in the cluster changed in the last 3 years?	<i>Proposition 5:</i> Technology-based firms should have increased their frequency of networks in the time period covered by the two surveys. <i>Proposition 6:</i> Technology-based firms should have increased their value of networks in the time period covered by the two surveys.	Usage of linkages: Appendix A, Question 12 Value of linkages: Appendix A, Question 13 New view of usage: Appendix A, Question 17 New view of value: Appendix A, Question 18	T-Tests
5. Do technology-based firms within the Ottawa technology cluster have more intra-regional linkages than non-technology based firms (see page 37)?	<i>Proposition 11:</i> Technology-based firms are likely to have more intra-regional linkages, thus less inter-regional (national) linkages, than firms in non-technology based industries.	Intra/inter-regional linkages: Appendix A, Question 14	T-Tests
6. Do technology-based firms have more internationally based linkages than non-technology firms?	<i>Proposition 12:</i> Technology-based firms are likely to have more internationally based linkages than non-technology based firms.	International linkages: Appendix A, Question 14	T-Tests
7. Are subsidiaries of major organizations less likely to engage in local networking and partnerships because of easy access to external company-based large firms? (based on Keeble and Wilkinson, 2000, p. 217).	<i>Proposition 13:</i> Subsidiaries of major technology organizations are more likely to engage in local networking.	Local networking: Appendix A, Question 14 Subsidiary: Appendix A, Questions 5 & Question 8	T-Tests
8. Is there a difference between small and large businesses in the number and value of networks and linkages?	<i>Proposition 14:</i> SMEs are likely to have more frequent linkages with organizations in their market web than large organizations. <i>Proposition 15:</i> SMEs are likely to have more valued linkages with organizations in their market web than large organizations.	Usage of linkages: Appendix A, Questions 12 and 15 Value of linkages: Appendix A, Questions 13 and 16 Size of firm: Number of Employees, Appendix A, Question 20	T-Tests

Figure 12

2003 Ottawa Cluster Subsectors for Technology Firms

Figure 13

2000 Ottawa Cluster Subsectors for Technology Firms

Figure 14

Subsectors: Support Services and Suppliers to Technology Firms

* Includes: IT, Communications, Engineering, Environmental, HR, Marketing, Telecommunications, etc.

Appendix G: Original and Remaining Number of Founders

Table 62

Technology Firms: Original Number of Founders

		# Original Founders						
		1	2	3	4	5	6	Total # Founders
Year Founded	Before 1988	7	5	4	1	0	3	51
	1988 to 1999	12	20	5	2	3	0	90
	After 1999	4	8	8	3	3	3	89
	Total # Founders	23	66	51	24	30	36	230

Table 63

Technology Firms: Remaining Number of Founders

		# Founders Still With Firm								% of Original
		0	1	2	3	4	5	6	Total # Founders	
Year Founded	Before 1988	8	5	3	1	0	1	1	25	49.0%
	1988 to 1999	3	21	15	4	0	1	0	68	75.6%
	After 1999	0	7	7	7	3	4	1	80	89.9%
	Total	0	33	50	36	12	30	12	173	75.2%

Table 64**Non-Technology Firms: Original Number of Founders**

		# Original Founders								Total # Founders
		1	2	3	4	5	6	7	25	
Year Founded	Before 1988	5	7	4	0	0	0	0	1	56
	1988 to 1999	17	15	9	3	1	1	0	0	97
	After 1999	5	3	1	4	2	3	1	0	65
	Total # Founders	27	50	42	28	15	24	7	25	218

Table 65**Non-Technology Firms: Remaining Number of Founders**

		# Founders Still With Firm									Total # Founders	% of Original
		0	1	2	3	4	5	6	7	10		
Year Founded	Before 1988	8	3	5	0	0	0	0	0	1	23	41.1%
	1988 to 1999	1	22	17	3	2	1	0	0	0	78	80.4%
	After 1999	0	5	4	1	5	1	2	1	0	60	92.3%
	Total # Founders	0	30	52	12	28	10	12	7	10	161	73.9%

Appendix H: T-Test Results

Table 66

Use of Linkages Within Cluster Region: Comparing Technology and Non-Technology Firms

	N	Mean	Std. Deviation	Std. Error Mean	
Suppliers	Technology	95	3.21	1.17	0.12
	Supplier	85	3.59	1.25	0.14
Service Firms	Technology	93	3.31	1.09	0.11
	Supplier	86	3.43	1.22	0.13
Customers	Technology	93	3.45	1.50	0.16
	Supplier	86	4.12	1.31	0.14
Universities (Res)	Technology	95	2.00	1.19	0.12
	Supplier	86	1.99	1.22	0.13
Gov't (Research)	Technology	95	2.13	1.31	0.13
	Supplier	85	1.87	1.14	0.12
Industry (Res)	Technology	93	1.92	1.13	0.12
	Supplier	84	1.92	1.17	0.13
Firms in Industry	Technology	94	2.34	1.21	0.13
	Supplier	86	2.93	1.24	0.13
Subcontractors	Technology	94	3.01	1.36	0.14
	Supplier	86	3.30	1.39	0.15
Prof. Orgs	Technology	95	2.39	1.20	0.12
	Supplier	86	2.64	1.28	0.14
Board of Trade	Technology	92	1.51	0.76	0.08
	Supplier	85	1.75	1.05	0.11
Eco. Dev. Office	Technology	92	1.63	0.93	0.10
	Supplier	81	1.64	0.98	0.11

Table 67

Value of Linkages Within Cluster Region: Comparing Technology and Non-Technology Firms

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Technology	95	3.29	1.21	0.12
	Supplier	85	3.39	1.30	0.14
Service Firms	Technology	96	3.18	1.10	0.11
	Supplier	85	3.24	1.15	0.12
Customers	Technology	94	3.11	1.49	0.15
	Supplier	86	3.90	1.35	0.15
Universities (Res)	Technology	96	1.70	1.02	0.10
	Supplier	86	1.50	0.78	0.08
Gov't (Research)	Technology	95	2.01	1.20	0.12
	Supplier	85	1.69	1.08	0.12
Industry (Res)	Technology	96	1.79	0.97	0.10
	Supplier	85	1.75	0.99	0.11
Firms in Industry	Technology	96	2.36	1.19	0.12
	Supplier	84	2.77	1.19	0.13
Subcontractors	Technology	95	2.83	1.33	0.14
	Supplier	85	3.24	1.39	0.15
Prof. Orgs	Technology	96	2.54	1.23	0.13
	Supplier	84	2.52	1.29	0.14
Board of Trade	Technology	94	1.43	0.60	0.06
	Supplier	83	1.64	0.98	0.11
Eco. Dev. Office	Technology	94	1.57	0.84	0.09
	Supplier	82	1.49	0.84	0.09

Table 68

Use of Linkages Outside Cluster Region: Comparing Technology and Non-Technology Firms

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Technology	95	3.36	1.31	0.13
	Supplier	84	3.49	1.38	0.15
Service Firms	Technology	93	2.65	1.18	0.12
	Supplier	85	2.61	1.33	0.14
Customers	Technology	93	4.20	1.25	0.13
	Supplier	86	4.20	1.16	0.12
Universities (Res)	Technology	92	1.80	1.16	0.12
	Supplier	84	1.81	1.12	0.12
Gov't (Research)	Technology	92	1.66	1.03	0.11
	Supplier	84	1.63	1.05	0.11
Industry (Res)	Technology	93	2.00	1.22	0.13
	Supplier	84	1.99	1.28	0.14
Firms in Industry	Technology	93	2.90	1.30	0.14
	Supplier	85	2.73	1.30	0.14
Subcontractors	Technology	93	2.77	1.31	0.14
	Supplier	85	2.82	1.42	0.15
Prof. Orgs	Technology	93	2.08	1.30	0.14
	Supplier	85	1.91	1.09	0.12
Board of Trade	Technology	91	1.35	0.72	0.08
	Supplier	85	1.40	0.71	0.08
Eco. Dev. Office	Technology	90	1.39	0.76	0.08
	Supplier	83	1.30	0.66	0.07

Table 69

Value of Linkages Outside Cluster Region: Comparing Technology and Non-Technology Firms

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Technology	96	3.34	1.30	0.13
	Supplier	86	3.02	1.34	0.14
Service Firms	Technology	96	2.29	1.17	0.12
	Supplier	86	2.30	1.16	0.12
Customers	Technology	96	3.89	1.40	0.14
	Supplier	86	3.59	1.36	0.15
Universities (Res)	Technology	96	1.75	1.35	0.14
	Supplier	86	1.41	0.79	0.08
Gov't (Research)	Technology	96	1.56	1.15	0.12
	Supplier	86	1.37	0.90	0.10
Industry (Res)	Technology	96	2.00	1.36	0.14
	Supplier	86	1.67	1.07	0.12
Firms in Industry	Technology	96	2.67	1.34	0.14
	Supplier	86	2.70	1.37	0.15
Subcontractors	Technology	96	2.35	1.30	0.13
	Supplier	86	2.49	1.51	0.16
Prof. Orgs	Technology	96	1.89	1.11	0.11
	Supplier	86	1.72	1.01	0.11
Board of Trade	Technology	96	1.33	1.22	0.12
	Supplier	86	1.26	0.92	0.10
Eco. Dev. Office	Technology	96	1.46	1.48	0.15
	Supplier	85	1.56	1.76	0.19

Table 70

Use of Linkages: Comparing 2003 and 2000

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	2003 Tech	95	3.21	1.17	0.12
	2000 Tech	110	3.55	1.34	0.13
Service Firms	2003 Tech	93	3.31	1.09	0.11
	2000 Tech	110	3.20	1.19	0.11
Customers	2003 Tech	93	3.45	1.50	0.16
	2000 Tech	111	2.83	1.56	0.15
Universities (Res)	2003 Tech	95	2.00	1.19	0.12
	2000 Tech	110	1.76	1.06	0.10
Gov't (Research)	2003 Tech	95	2.13	1.31	0.13
	2000 Tech	109	1.94	1.16	0.11
Industry (Res)	2003 Tech	93	1.92	1.13	0.12
	2000 Tech	110	1.72	0.94	0.09
Firms in Industry	2003 Tech	94	2.34	1.21	0.13
	2000 Tech	111	2.18	1.21	0.11
Subcontractors	2003 Tech	94	3.01	1.36	0.14
	2000 Tech	111	2.77	1.33	0.13
Prof. Orgs	2003 Tech	95	2.39	1.20	0.12
	2000 Tech	110	2.23	1.11	0.11
Board of Trade	2003 Tech	92	1.51	0.76	0.08
	2000 Tech	109	1.50	0.86	0.08
Eco. Dev. Office	2003 Tech	92	1.63	0.93	0.10
	2000 Tech	106	1.53	0.83	0.08

Table 71

Value of Linkages: Comparing 2003 and 2000

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	2003 Tech	94	3.30	1.22	0.13
	2000 Tech	108	3.53	1.30	0.13
Service Firms	2003 Tech	95	3.18	1.11	0.11
	2000 Tech	108	3.40	1.16	0.11
Customers	2003 Tech	94	3.11	1.49	0.15
	2000 Tech	108	3.52	1.55	0.15
Universities (Res)	2003 Tech	96	1.70	1.02	0.10
	2000 Tech	108	2.08	1.25	0.12
Gov't (Research)	2003 Tech	95	2.01	1.20	0.12
	2000 Tech	108	2.28	1.41	0.14
Industry (Res)	2003 Tech	96	1.79	0.97	0.10
	2000 Tech	107	2.08	1.23	0.12
Firms in Industry	2003 Tech	96	2.36	1.19	0.12
	2000 Tech	107	2.45	1.31	0.13
Subcontractors	2003 Tech	95	2.83	1.33	0.14
	2000 Tech	109	3.12	1.42	0.14
Prof. Orgs	2003 Tech	96	2.54	1.23	0.13
	2000 Tech	107	2.19	1.18	0.11
Board of Trade	2003 Tech	94	1.43	0.60	0.06
	2000 Tech	107	1.57	0.86	0.08
Eco. Dev. Office	2003 Tech	94	1.57	0.84	0.09
	2000 Tech	107	1.66	0.95	0.09

Table 72

Use of Linkages: Comparing Firms With Technology Developed in the Public Sector to Those Developed in the Private

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Public	23	3.00	1.21	0.25
	Private	31	3.45	1.18	0.21
Service Firms	Public	23	3.13	0.97	0.20
	Private	29	3.28	1.13	0.21
Customers	Public	22	3.05	1.65	0.35
	Private	31	3.42	1.46	0.26
Universities (Res)	Public	23	2.35	1.40	0.29
	Private	31	1.81	1.05	0.19
Gov't (Research)	Public	23	2.70	1.66	0.35
	Private	31	1.90	1.08	0.19
Industry (Res)	Public	23	1.87	1.10	0.23
	Private	31	1.97	1.22	0.22
Firms in Industry	Public	23	2.26	1.10	0.23
	Private	31	2.48	1.36	0.24
Subcontractors	Public	23	2.91	1.28	0.27
	Private	31	2.81	1.45	0.26
Prof. Orgs	Public	23	2.43	1.16	0.24
	Private	31	2.29	1.19	0.21
Board of Trade	Public	22	1.68	0.89	0.19
	Private	31	1.32	0.60	0.11
Eco. Dev. Office	Public	22	1.91	0.97	0.21
	Private	31	1.32	0.87	0.16

Table 73

Independent Samples T-Test for Use of Linkages: Comparing Firms With Technology Developed in the Public Sector to Those Developed in the Private Sector

t-test for Equality of Means										
		Levene's Test Equality of Variances for		T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
	F	Sig.							Lower	Upper
Suppliers	Equal variances assumed	0.02	0.89	-1.38	52.00	0.174	-0.452	0.328	-1.109	0.206
	Equal variances not assumed			-1.37	46.94	0.176	-0.452	0.329	-1.113	0.210
Service Firms	Equal variances assumed	1.39	0.24	-0.49	50.00	0.626	-0.145	0.297	-0.741	0.450
	Equal variances not assumed			-0.50	49.67	0.620	-0.145	0.291	-0.730	0.440
Customers	Equal variances assumed	1.72	0.20	-0.87	51.00	0.387	-0.374	0.429	-1.234	0.486
	Equal variances not assumed			-0.85	41.75	0.398	-0.374	0.438	-1.257	0.510
Universities (Res)	Equal variances assumed	3.87	0.05	1.63	52.00	0.110	0.541	0.333	-0.126	1.209
	Equal variances not assumed			1.56	39.06	0.127	0.541	0.347	-0.161	1.244
Gov't (Research)	Equal variances assumed	14.13	0.00	2.12	52.00	0.038	0.792	0.373	0.044	1.541
	Equal variances not assumed			2.00	35.28	0.054	0.792	0.397	-0.013	1.598
Industry (Res)	Equal variances assumed	0.27	0.61	-0.30	52.00	0.762	-0.098	0.323	-0.746	0.550
	Equal variances not assumed			-0.31	50.04	0.759	-0.098	0.318	-0.736	0.540
Firms in Industry	Equal variances assumed	3.21	0.08	-0.64	52.00	0.522	-0.223	0.346	-0.917	0.471
	Equal variances not assumed			-0.67	51.62	0.508	-0.223	0.335	-0.895	0.449
Subcontractors	Equal variances assumed	1.83	0.18	0.28	52.00	0.780	0.107	0.379	-0.654	0.867
	Equal variances not assumed			0.29	50.38	0.776	0.107	0.372	-0.640	0.854
Prof. Orgs	Equal variances assumed	0.11	0.74	0.45	52.00	0.657	0.144	0.324	-0.506	0.794
	Equal variances not assumed			0.45	48.16	0.656	0.144	0.323	-0.504	0.793
Board of Trade	Equal variances assumed	5.58	0.02	1.75	51.00	0.086	0.359	0.205	-0.052	0.771
	Equal variances not assumed			1.64	34.11	0.110	0.359	0.219	-0.085	0.804
Eco. Dev. Office	Equal variances assumed	2.89	0.10	2.30	51.00	0.025	0.587	0.255	0.075	1.098
	Equal variances not assumed			2.26	42.19	0.029	0.587	0.260	0.063	1.110

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 74

Value of Linkages: Comparing Firms With Technology Developed in the Public Sector to Those Developed in the Private

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Public	23	3.30	1.22	0.25
	Private	30	3.30	1.26	0.23
Service Firms	Public	23	3.04	1.07	0.22
	Private	31	3.19	1.01	0.18
Customers	Public	23	2.52	1.47	0.31
	Private	30	3.20	1.49	0.27
Universities (Res)	Public	23	1.96	1.07	0.22
	Private	31	1.52	1.00	0.18
Gov't (Research)	Public	22	2.45	1.47	0.31
	Private	31	2.03	1.08	0.19
Industry (Res)	Public	23	1.65	0.93	0.19
	Private	31	1.97	1.14	0.20
Firms in Industry	Public	23	2.22	1.17	0.24
	Private	31	2.52	1.23	0.22
Subcontractors	Public	22	3.18	1.30	0.28
	Private	31	2.71	1.32	0.24
Prof. Orgs	Public	23	2.61	1.16	0.24
	Private	31	2.48	1.09	0.20
Board of Trade	Public	22	1.50	0.60	0.13
	Private	31	1.35	0.61	0.11
Eco. Dev. Office	Public	23	1.96	0.98	0.20
	Private	30	1.47	0.86	0.16

Table 75

Independent Samples T-Test for Value of Linkages: Comparing Firms With Technology Developed in the Public Sector to Those Developed in the Private

		Levene's Test Equality of Variances for		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Conf. Interval of the Difference	
Suppliers	Equal variances assumed	0.47	0.50	0.01	51.00	0.990	0.004	0.345	Lower -0.689	Upper 0.698
	Equal variances not assumed			0.01	48.25	0.990	0.004	0.344	-0.687	0.695
Service Firms	Equal variances assumed	0.00	0.96	-0.53	52.00	0.601	-0.150	0.285	-0.722	-0.422
	Equal variances not assumed			-0.52	46.21	0.604	-0.150	0.287	-0.728	-0.428
Customers	Equal variances assumed	0.10	0.75	-1.65	51.00	0.106	-0.678	0.412	-1.505	0.148
	Equal variances not assumed			-1.65	47.83	0.105	-0.678	0.411	-1.504	0.148
Universities (Res)	Equal variances assumed	0.30	0.58	1.56	52.00	0.125	0.440	0.282	-0.126	1.007
	Equal variances not assumed			1.54	45.69	0.129	0.440	0.285	-0.134	1.014
Gov't (Research)	Equal variances assumed	6.29	0.02	1.21	51.00	0.233	0.422	0.350	-0.280	1.125
	Equal variances not assumed			1.15	36.40	0.260	0.422	0.369	-0.325	1.170
Industry (Res)	Equal variances assumed	1.47	0.23	-1.08	52.00	0.283	-0.316	0.291	-0.900	0.269
	Equal variances not assumed			-1.12	51.42	0.269	-0.316	0.283	-0.883	0.252
Firms in Industry	Equal variances assumed	0.27	0.61	-0.90	52.00	0.372	-0.299	0.332	-0.965	0.367
	Equal variances not assumed			-0.91	48.98	0.368	-0.299	0.329	-0.960	0.363
Subcontractors	Equal variances assumed	0.01	0.94	1.29	51.00	0.202	0.472	0.365	-0.262	1.206
	Equal variances not assumed			1.30	45.92	0.201	0.472	0.364	-0.261	1.205
Prof. Orgs	Equal variances assumed	0.44	0.51	0.41	52.00	0.687	0.125	0.308	-0.494	0.743
	Equal variances not assumed			0.40	45.94	0.690	0.125	0.311	-0.501	0.751
Board of Trade	Equal variances assumed	0.27	0.60	0.86	51.00	0.393	0.145	0.168	-0.193	0.483
	Equal variances not assumed			0.86	45.87	0.392	0.145	0.168	-0.193	0.483
Eco. Dev. Office	Equal variances assumed	1.96	0.17	1.94	51.00	0.058**	0.490	0.253	-0.018	0.997
	Equal variances not assumed			1.91	44.14	0.063	0.490	0.257	-0.028	1.008

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 76

Use of Linkages: Comparing Venture-Backed Firms and Non Venture-Backed Firms

	Raised Risk Cap?	N	Mean	Std. Deviation	Std. Error Mean
Suppliers	YES	46	3.15	1.15	0.17
	NO	47	3.23	1.18	0.17
Service Firms	YES	45	3.33	1.11	0.17
	NO	46	3.28	1.11	0.16
Customers	YES	44	3.23	1.57	0.24
	NO	47	3.60	1.42	0.21
Universities (Res)	YES	46	2.13	1.24	0.18
	NO	47	1.83	1.07	0.16
Gov't (Research)	YES	46	2.22	1.40	0.21
	NO	47	2.06	1.26	0.18
Industry (Res)	YES	45	1.78	0.97	0.15
	NO	46	2.02	1.20	0.18
Firms in Industry	YES	45	2.22	1.26	0.19
	NO	47	2.43	1.17	0.17
Subcontractors	YES	45	2.89	1.35	0.20
	NO	47	3.09	1.38	0.20
Prof. Orgs	YES	46	2.39	1.16	0.17
	NO	47	2.43	1.25	0.18
Board of Trade	YES	43	1.35	0.69	0.10
	NO	47	1.68	0.81	0.12
Eco. Dev. Office	YES	43	1.49	0.83	0.13
	NO	47	1.79	1.02	0.15

Table 77

Independent Samples T-Test for Use of Linkages: Comparing Venture-Backed Tech Firms to Non Venture-Backed Tech Firms

t-test for Equality of Means										
Levene's Test Equality of Variances for			T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
F	Sig.	Lower						Upper		
Suppliers	Equal variances assumed	0.09	-0.34	91.00	0.736	-0.082	0.242	-0.563	0.400	
	Equal variances not assumed		-0.34	91.00	0.736	-0.082	0.242	-0.563	0.400	
Service Firms	Equal variances assumed	0.04	0.22	89.00	0.828	0.051	0.232	-0.411	0.512	
	Equal variances not assumed		0.22	88.96	0.828	0.051	0.232	-0.411	0.512	
Customers	Equal variances assumed	1.49	-1.17	89.00	0.243	-0.368	0.314	-0.992	0.255	
	Equal variances not assumed		-1.17	86.72	0.245	-0.368	0.315	-0.994	0.257	
Universities (Res)	Equal variances assumed	0.86	1.25	91.00	0.214	0.301	0.240	-0.176	0.777	
	Equal variances not assumed		1.25	88.49	0.214	0.301	0.240	-0.177	0.778	
Gov't (Research)	Equal variances assumed	1.22	0.56	91.00	0.579	0.154	0.276	-0.394	0.701	
	Equal variances not assumed		0.56	89.58	0.579	0.154	0.276	-0.395	0.702	
Industry (Res)	Equal variances assumed	1.59	-1.06	89.00	0.291	-0.244	0.230	-0.700	0.212	
	Equal variances not assumed		-1.06	86.06	0.290	-0.244	0.229	-0.699	0.211	
Firms in Industry	Equal variances assumed	0.36	-0.80	90.00	0.425	-0.203	0.254	-0.708	0.301	
	Equal variances not assumed		-0.80	88.86	0.426	-0.203	0.254	-0.708	0.302	
Subcontractors	Equal variances assumed	0.10	-0.69	90.00	0.493	-0.196	0.285	-0.763	0.370	
	Equal variances not assumed		-0.69	89.95	0.493	-0.196	0.285	-0.762	0.370	
Prof. Orgs	Equal variances assumed	0.45	-0.14	91.00	0.891	-0.034	0.250	-0.531	0.463	
	Equal variances not assumed		-0.14	90.80	0.891	-0.034	0.250	-0.531	0.462	
Board of Trade	Equal variances assumed	3.91	-2.09	88.00	0.040*	-0.332	0.159	-0.648	-0.016	
	Equal variances not assumed		-2.10	87.49	0.038	-0.332	0.158	-0.646	-0.018	
Eco. Dev. Office	Equal variances assumed	2.03	-1.52	88.00	0.133	-0.299	0.197	-0.690	0.092	
	Equal variances not assumed		-1.53	86.79	0.129	-0.299	0.195	-0.687	0.089	

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 78

Value of Linkages: Comparing Venture-Backed Tech Firms and Non Venture-Backed Tech Firms

	Raised Risk Cap?	N	Mean	Std. Deviation	Std. Error Mean
Suppliers	YES	45	3.29	1.24	0.18
	NO	48	3.29	1.18	0.17
Service Firms	YES	46	3.41	1.11	0.16
	NO	48	2.94	1.04	0.15
Customers	YES	44	2.75	1.42	0.21
	NO	48	3.42	1.50	0.22
Universities (Res)	YES	46	1.78	0.99	0.15
	NO	48	1.56	0.94	0.14
Gov't (Research)	YES	46	2.28	1.34	0.20
	NO	47	1.79	1.00	0.15
Industry (Res)	YES	46	1.80	0.91	0.13
	NO	48	1.75	1.00	0.14
Firms in Industry	YES	46	2.35	1.25	0.18
	NO	48	2.38	1.16	0.17
Subcontractors	YES	45	2.91	1.28	0.19
	NO	48	2.71	1.37	0.20
Prof. Orgs	YES	46	2.61	1.22	0.18
	NO	48	2.52	1.25	0.18
Board of Trade	YES	44	1.39	0.54	0.08
	NO	48	1.48	0.65	0.09
Eco. Dev. Office	YES	45	1.62	0.78	0.12
	NO	47	1.55	0.90	0.13

Table 79

Independent Samples T-Test for Value of Linkages: Comparing Venture-Backed Tech Firms and Non Venture-Backed Tech Firms

t-test for Equality of Means										
		Levene's Test Equality of Variances for		T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Conf. Interval of the Difference	
		F	Sig.						Lower	Upper
Suppliers	Equal variances assumed	0.30	0.58	-0.01	91.00	0.991	-0.003	0.251	-0.501	0.496
	Equal variances not assumed			-0.01	89.95	0.991	-0.003	0.251	-0.502	0.497
Service Firms	Equal variances assumed	0.82	0.37	2.15	92.00	0.034*	0.476	0.221	0.036	0.915
	Equal variances not assumed			2.14	90.99	0.035	0.476	0.222	0.035	0.916
Customers	Equal variances assumed	1.29	0.26	-2.19	90.00	0.031*	-0.667	0.305	-1.272	-0.061
	Equal variances not assumed			-2.19	89.91	0.031	-0.667	0.304	-1.271	-0.063
Universities (Res)	Equal variances assumed	0.15	0.70	1.11	92.00	0.272	0.220	0.199	-0.175	0.615
	Equal variances not assumed			1.10	91.29	0.272	0.220	0.199	-0.176	0.616
Gov't (Research)	Equal variances assumed	6.39	0.01	2.02	91.00	0.046	0.495	0.245	0.008	0.982
	Equal variances not assumed			2.01	83.04	0.047*	0.495	0.246	0.006	0.985
Industry (Res)	Equal variances assumed	1.63	0.20	0.28	92.00	0.784	0.054	0.197	-0.338	0.446
	Equal variances not assumed			0.28	91.76	0.783	0.054	0.197	-0.337	0.446
Firms in Industry	Equal variances assumed	0.40	0.53	-0.11	92.00	0.913	-0.027	0.249	-0.521	0.467
	Equal variances not assumed			-0.11	90.73	0.913	-0.027	0.249	-0.522	0.468
Subcontractors	Equal variances assumed	1.47	0.23	0.74	91.00	0.462	0.203	0.275	-0.343	0.749
	Equal variances not assumed			0.74	91.00	0.461	0.203	0.274	-0.342	0.747
Prof. Orgs	Equal variances assumed	0.06	0.80	0.34	92.00	0.732	0.088	0.255	-0.419	0.595
	Equal variances not assumed			0.34	91.98	0.731	0.088	0.255	-0.419	0.595
Board of Trade	Equal variances assumed	2.77	0.10	-0.74	90.00	0.461	-0.093	0.125	-0.342	0.156
	Equal variances not assumed			-0.75	89.04	0.457	-0.093	0.124	-0.340	0.154
Exec. Dev. Office	Equal variances assumed	0.47	0.50	0.39	90.00	0.696	0.069	0.176	-0.281	0.419
	Equal variances not assumed			0.39	88.98	0.695	0.069	0.176	-0.280	0.418

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 78

Regional Linkages Only: Comparing Technology and Non-technology Firms

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Technology	89	44.66	29.77	3.16
	Supplier	80	56.04	34.95	3.91
Service Firms	Technology	89	58.80	33.30	3.53
	Supplier	80	67.04	31.42	3.51
Customers	Technology	88	31.30	34.64	3.69
	Supplier	80	55.34	33.69	3.77
Universities (Res)	Technology	87	29.29	39.22	4.20
	Supplier	80	28.50	41.21	4.61
Gov't (Research)	Technology	87	41.53	43.31	4.64
	Supplier	80	26.19	40.15	4.49
Industry (Res)	Technology	85	24.26	35.41	3.84
	Supplier	80	21.81	35.42	3.96
Firms in Industry	Technology	86	30.84	35.72	3.85
	Supplier	80	48.60	37.91	4.24
Subcontractors	Technology	88	48.63	39.87	4.25
	Supplier	81	62.52	35.77	3.97
Prof. Orgs	Technology	88	51.02	40.05	4.27
	Supplier	80	54.00	42.02	4.70
Board of Trade	Technology	87	32.68	44.27	4.75
	Supplier	80	33.63	44.02	4.92
Eco. Dev. Office	Technology	87	34.37	45.47	4.87
	Supplier	80	31.23	42.99	4.81

Table 80

National Linkages Only: Comparing Technology and Non-technology Firms

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Technology	89	25.00	22.97	2.44
	Supplier	80	19.73	20.65	2.31
Service Firms	Technology	89	16.86	21.35	2.26
	Supplier	80	15.88	17.94	2.01
Customers	Technology	88	19.15	21.51	2.29
	Supplier	80	20.61	20.49	2.29
Universities (Res)	Technology	87	16.82	29.43	3.16
	Supplier	80	9.44	22.35	2.50
Gov't (Research)	Technology	87	9.92	21.34	2.29
	Supplier	80	7.63	17.81	1.99
Industry (Res)	Technology	85	10.36	19.57	2.12
	Supplier	80	11.00	22.31	2.49
Firms in Industry	Technology	86	14.22	21.20	2.29
	Supplier	80	21.29	24.45	2.73
Subcontractors	Technology	88	13.93	21.08	2.25
	Supplier	81	15.00	18.24	2.03
Prof. Orgs	Technology	88	10.17	16.70	1.78
	Supplier	80	12.38	20.41	2.28
Board of Trade	Technology	87	4.06	13.38	1.43
	Supplier	80	6.13	16.53	1.85
Eco. Dev. Office	Technology	87	2.01	7.29	0.78
	Supplier	80	4.29	12.36	1.38

Table 82

International Linkages Only: Comparing Technology and Non-technology Firms

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Technology	89	28.37	27.96	2.96
	Supplier	80	19.10	27.93	3.12
Service Firms	Technology	89	16.80	23.98	2.54
	Supplier	80	11.46	21.09	2.36
Customers	Technology	87	42.38	38.22	4.10
	Supplier	80	19.93	30.51	3.41
Universities (Res)	Technology	87	6.60	18.68	2.00
	Supplier	80	7.06	22.76	2.54
Gov't (Research)	Technology	87	3.14	8.34	0.89
	Supplier	80	6.19	19.85	2.22
Industry (Res)	Technology	85	23.25	33.79	3.66
	Supplier	80	9.69	24.95	2.79
Firms in Industry	Technology	86	37.85	38.54	4.16
	Supplier	80	18.89	28.73	3.21
Subcontractors	Technology	87	17.24	28.42	3.05
	Supplier	81	11.36	25.56	2.84
Prof. Orgs	Technology	88	14.94	24.25	2.59
	Supplier	80	7.25	20.79	2.32
Board of Trade	Technology	87	3.49	13.81	1.48
	Supplier	80	1.50	7.61	0.85
Eco. Dev. Office	Technology	87	1.55	6.66	0.71
	Supplier	80	2.61	10.02	1.12

Table 83

Use of Linkages: Comparing Micro Enterprises and Larger Firms

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Micro	67	3.36	1.39	0.17
	Larger Firms	110	3.42	1.09	0.10
Service Firms	Micro	67	3.28	1.33	0.16
	Larger Firms	109	3.41	1.03	0.10
Customers	Micro	67	3.97	1.38	0.17
	Larger Firms	109	3.64	1.48	0.14
Universities (Res)	Micro	67	1.81	1.25	0.15
	Larger Firms	111	2.10	1.14	0.11
Gov't (Research)	Micro	66	2.00	1.34	0.16
	Larger Firms	111	2.01	1.19	0.11
Industry (Res)	Micro	65	1.89	1.28	0.16
	Larger Firms	109	1.93	1.04	0.10
Firms in Industry	Micro	67	2.64	1.38	0.17
	Larger Firms	110	2.65	1.19	0.11
Subcontractors	Micro	67	3.21	1.44	0.18
	Larger Firms	110	3.15	1.33	0.13
Prof. Orgs	Micro	67	2.48	1.36	0.17
	Larger Firms	111	2.54	1.18	0.11
Board of Trade	Micro	66	1.55	0.96	0.12
	Larger Firms	108	1.66	0.83	0.08
Eco. Dev. Office	Micro	65	1.48	0.90	0.11
	Larger Firms	105	1.74	0.98	0.10

Table 84

Independent Samples T-Test for Use of Linkages: Comparing Micro Enterprises and Larger Firms

t-test for Equality of Means										
		Levene's Test Equality of Variances for		T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Conf. Interval of the Difference	
		F	Sig.						Lower	Upper
Suppliers	Equal variances assumed	9.55	0.00	-0.32	175.00	0.75	-0.06	0.19	-0.43	0.31
	Equal variances not assumed			-0.30	114.72	0.76	-0.06	0.20	-0.45	0.33
Service Firms	Equal variances assumed	9.22	0.00	-0.72	174.00	0.47	-0.13	0.18	-0.48	0.22
	Equal variances not assumed			-0.68	113.77	0.50	-0.13	0.19	-0.51	0.25
Customers	Equal variances assumed	3.36	0.07	1.47	174.00	0.14	0.33	0.22	-0.11	0.77
	Equal variances not assumed			1.49	146.87	0.14	0.33	0.22	-0.11	0.76
Universities (Res)	Equal variances assumed	0.60	0.44	-1.60	176.00	0.11	-0.29	0.18	-0.65	0.07
	Equal variances not assumed			-1.57	130.03	0.12	-0.29	0.19	-0.66	0.08
Gov't (Research)	Equal variances assumed	2.37	0.13	-0.05	175.00	0.96	-0.01	0.19	-0.39	0.37
	Equal variances not assumed			-0.05	124.83	0.96	-0.01	0.20	-0.40	0.39
Industry (Res)	Equal variances assumed	4.46	0.04	-0.19	172.00	0.85	-0.03	0.18	-0.39	0.32
	Equal variances not assumed			-0.18	114.35	0.85	-0.03	0.19	-0.41	0.34
Firms in Industry	Equal variances assumed	3.28	0.07	-0.02	175.00	0.99	0.00	0.20	-0.39	0.38
	Equal variances not assumed			-0.02	123.66	0.99	0.00	0.20	-0.41	0.40
Subcontractors	Equal variances assumed	1.49	0.22	0.30	175.00	0.77	0.06	0.21	-0.36	0.48
	Equal variances not assumed			0.29	130.60	0.77	0.06	0.22	-0.37	0.49
Prof. Orgs	Equal variances assumed	3.83	0.05	-0.32	176.00	0.75	-0.06	0.19	-0.45	0.32
	Equal variances not assumed			-0.31	124.09	0.75	-0.06	0.20	-0.46	0.33
Board of Trade	Equal variances assumed	0.01	0.91	-0.81	172.00	0.42	-0.11	0.14	-0.38	0.16
	Equal variances not assumed			-0.78	122.46	0.44	-0.11	0.14	-0.40	0.17
Eco. Dev. Office	Equal variances assumed	2.76	0.10	-1.77	168.00	0.08	-0.27	0.15	-0.56	0.03
	Equal variances not assumed			-1.80	144.24	0.07**	-0.27	0.15	-0.56	0.03

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 85

Value of Linkages: Comparing Micro Enterprises and Larger Firms

		N	Mean	Std. Deviation	Std. Error Mean
Suppliers	Micro	67	3.10	1.36	0.17
	Larger Firms	110	3.49	1.15	0.11
Service Firms	Micro	67	3.13	1.19	0.15
	Larger Firms	111	3.23	1.08	0.10
Customers	Micro	68	3.81	1.40	0.17
	Larger Firms	109	3.29	1.49	0.14
Universities (Res)	Micro	68	1.41	0.81	0.10
	Larger Firms	111	1.69	0.91	0.09
Gov't (Research)	Micro	67	1.81	1.13	0.14
	Larger Firms	110	1.90	1.18	0.11
Industry (Res)	Micro	67	1.76	1.12	0.14
	Larger Firms	111	1.75	0.87	0.08
Firms in Industry	Micro	67	2.55	1.28	0.16
	Larger Firms	110	2.58	1.16	0.11
Subcontractors	Micro	67	2.96	1.35	0.17
	Larger Firms	110	3.08	1.36	0.13
Prof. Orgs	Micro	67	2.42	1.41	0.17
	Larger Firms	110	2.60	1.17	0.11
Board of Trade	Micro	66	1.50	0.92	0.11
	Larger Firms	108	1.54	0.73	0.07
Eco. Dev. Office	Micro	67	1.37	0.69	0.08
	Larger Firms	106	1.65	0.91	0.09

Table 86

Independent Samples T-Test for Value of Linkages: Comparing Micro Enterprises and Larger Firms

t-test for Equality of Means												
		Levene's Test Equality of Variances for		T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Conf. Interval of the Difference			
	F	Sig.							Lower	Upper		
Suppliers	Equal variances assumed	1.44	0.23	-2.02	175.00	0.04*	-0.39	0.19	-0.76	-0.01		
	Equal variances not assumed			-1.94	121.69	0.05	-0.39	0.20	-0.78	0.01		
Service Firms	Equal variances assumed	0.26	0.61	-0.52	176.00	0.60	-0.09	0.17	-0.43	0.25		
	Equal variances not assumed			-0.51	129.08	0.61	-0.09	0.18	-0.44	0.26		
Customers	Equal variances assumed	2.23	0.14	2.29	175.00	0.02*	0.52	0.23	0.07	0.96		
	Equal variances not assumed			2.33	149.50	0.02	0.52	0.22	0.08	0.95		
Universities (Res)	Equal variances assumed	4.25	0.04	-2.09	177.00	0.04	-0.28	0.14	-0.55	-0.02		
	Equal variances not assumed			-2.15	154.11	0.03*	-0.28	0.13	-0.54	-0.02		
Gov't (Research)	Equal variances assumed	0.03	0.86	-0.52	175.00	0.60	-0.09	0.18	-0.45	0.26		
	Equal variances not assumed			-0.53	144.17	0.60	-0.09	0.18	-0.45	0.26		
Industry (Res)	Equal variances assumed	5.25	0.02	0.09	176.00	0.93	0.01	0.15	-0.28	0.31		
	Equal variances not assumed			0.08	113.93	0.93	0.01	0.16	-0.30	0.33		
Firms in Industry	Equal variances assumed	1.58	0.21	-0.16	175.00	0.87	-0.03	0.19	-0.40	0.34		
	Equal variances not assumed			-0.15	128.83	0.88	-0.03	0.19	-0.41	0.35		
Subcontractors	Equal variances assumed	0.00	0.95	-0.60	175.00	0.55	-0.13	0.21	-0.54	0.29		
	Equal variances not assumed			-0.60	140.26	0.55	-0.13	0.21	-0.54	0.29		
Prof. Orgs	Equal variances assumed	4.58	0.03	-0.93	175.00	0.35	-0.18	0.20	-0.57	0.20		
	Equal variances not assumed			-0.89	120.24	0.38	-0.18	0.20	-0.59	0.22		
Board of Trade	Equal variances assumed	0.95	0.33	-0.29	172.00	0.77	-0.04	0.13	-0.29	0.21		
	Equal variances not assumed			-0.28	114.65	0.78	-0.04	0.13	-0.30	0.23		
Eco. Dev. Office	Equal variances assumed	7.58	0.01	-2.14	171.00	0.03	-0.28	0.13	-0.53	-0.02		
	Equal variances not assumed			-2.28	164.75	0.02*	-0.28	0.12	-0.52	-0.04		

* Significant at the 95% confidence interval

** Significant at the 90% confidence interval

Table 87

Results of T-Tests: Examining the Propositions

Propositions	Results	Conclusion
<i>Proposition 1:</i> Technology-based firms use more linkages with organizations in their <u>cluster</u> than do firms in non-technology based sectors.	Summated mean comparison – Non-technology firms significant more likely to use linkages than technology firms ($t = -1.767$, $p = 0.0791$).	Directly Contradicted.
<i>Proposition 2:</i> Technology-based firms use more linkages with organizations in their <u>market web</u> than do firms in non-technology based sectors.	Non-tech firms use more linkages than tech firms with: Suppliers, Customers, Firms in Industry, and Board of Trade Summated mean comparison – no significant results Technology based firms do not have significantly more linkages (0.05 level of significance) than non-technology firms across the board.	No Support.
<i>Proposition 3:</i> Technology-based firms value their linkages with organizations in their <u>cluster</u> more than do firms in non-technology based sectors.	Summated mean comparison – no significant results Technology based firms value significantly less than non-technology firms linkages with: Customers and Other Firms in the industry (.05 level of significance). Technology firms value their linkages significantly less than non-technology firms with Subcontractors and Boards of Trade (.10 level of significance). But; technology firms also value significantly more their linkages with government research agencies ($t = 1.85$, $p = 0.07$).	No Support.

<p><i>Proposition 4:</i> Technology-based firms value their linkages with organizations in their <u>market web</u> more than do firms in non-technology sectors.</p>	<p>Summated mean comparison – no significant results</p> <p>Technology firms value significantly more their linkages (p-value=0.05) with universities as research collaborators ($t=2.12$, $p=0.05$) than do non-technology firms.</p> <p>At the .10 level of significance, the technology firms also value more their linkages with industry research collaborators ($t=1.78$, $p=0.07$).</p>	<p>Partially Supported.</p>
<p><i>Proposition 5:</i> The technology-based firms in the 2003 sample will use more linkages with organizations in their cluster web than was reported by the technology firms in the 2000 research sample.</p>	<p>Summated mean comparison –technology firms in the 2003 sample use significantly more linkages than did the technology firms in the 2000 sample.</p> <p>Technology firms in the sample of 2003 use significantly more linkages with customers ($t=2.89$, $p=0.00$) but use significantly less linkages with suppliers ($t=-1.97$, $p=0.05$) than do the technology firms in the 2000 study.</p>	<p>Supported.</p>
<p><i>Proposition 6:</i> The technology-based firms in the 2003 sample will value more their linkages with organizations in their cluster web than was reported by the technology firms in the 2000 research sample.</p>	<p>Summated mean comparison - technology firms in the 2003 sample value significantly <u>less</u> their linkages with organizations than do the technology firms in the 2000 study ($t=-1.72$, $p=0.09$), at the .10 level of significance.</p> <p>Technology firms in the sample of 2003 value significantly less their linkages with universities as research collaborators ($t=-2.43$, $p=0.02$), industry research collaborators ($t=-1.89$, $p=0.06$) and customers ($t=-1.92$, $p=0.06$). In contrast, the tech firms in the 2003 sample value significantly more their linkages with professional organizations than did the technology firms in the 2000 sample ($t=2.09$, $p=0.04$).</p>	<p>Directly Contradicted.</p>
<p><i>Proposition 7:</i> Technology-based firms are likely to have more frequent linkages with organizations that are similar to the organization's original source of technology.</p>	<p>Summated mean comparison – no significant results</p> <p>Firms based on technology developed in the public sector were significantly more likely to use economic development offices ($t=2.30$, $p=0.03$) and government agencies ($t=2.00$, $p=0.05$), at the .05 level of significance, than were firms based on technology developed in the private sector.</p>	<p>Partial Support.</p>

<i>Proposition 8:</i> Technology-based firms are likely to have more valued linkages with organizations that are similar to the organization's original source of technology.	Summated mean comparison – no significant results At the .10 level of significance, firms based on technology developed in the public sector value significantly more their linkages with economic development offices ($t=1.94$, $p=0.06$) than do the firms based on technology developed in the private sector.	Little or no Support.
<i>Proposition 9:</i> Technology-based firms that have obtained financing from venture capitalists are likely to have more frequent linkages with organizations than are organizations that have not received venture capital financing.	Summated mean comparison – no significant results ($t=-1.491$ and a $p=0.140$). Therefore, no overall significant differences. Venture-backed firms in the sample reported significantly less use of linkages with boards of trade ($t = -2.09$, $p = 0.04$).	No Support.
<i>Proposition 10:</i> Technology-based firms that have obtained financing from venture capitalists are likely to have more valued linkages with organizations than are organizations that have not received venture capital financing.	Summated mean comparison – no significant results ($t=0.546$ and $p=0.587$). Therefore, no overall significant differences. The venture-backed firms valued significantly more their linkages, at the .05 level of significance, with service firms ($t = 2.148$, $p = 0.03$) and government agencies for research ($t=2.014$, $p=0.047$). Venture backed firms value significantly less their linkages with customers than do the non-venture backed firms($t = -2.19$, $p = 0.03$).	Partial Support.
<i>Proposition 11a:</i> Technology-based firms are likely to have more intra-regional linkages, than firms in non-technology based industries.	Summated mean comparison -Technology firms are significantly less likely to use intra-regional linkages as compared to non-technology firms, at the .05 level of significance. Technology firms are significantly less likely to use intra-regional linkages than non-technology firms with Suppliers, Government Agencies, Firms in the Industry and Subcontractors.	Directly Contradicted.
<i>Propositions 11b:</i> Technology-based firms are likely to have less inter-regional (national) linkages, than firms in non-technology based industries	There were no significant differences between the technology firms and non-technology firms in their use of inter-regional linkages, at the .05 level of significance.	No Support.

<i>Proposition 12:</i> Technology-based firms are likely to have more internationally based linkages than non-technology based firms.	Technology firms use significantly more international linkages than do the non-technology firms in the Ottawa cluster ($t=3.091$, $p=0.002$), at the .05 level of significance. Technology firms are significantly more likely to use international linkages with Suppliers ($t=2.15$, $p=0.03$), Customers ($t=4.21$, $p=0.00$), Industry Collaborators ($t=2.94$, $p=0.004$), Other Firms in the Industry ($t=3.61$, $p=0.004$), and Professional Organizations ($t=2.21$, $p=0.03$).	Supported
<i>Proposition 13:</i> Subsidiaries of major technology organizations are more likely to engage in local networking.	There were only 8 subsidiary technology firms included in the sample, thus, there was insufficient data to test this proposition.	Insufficient Data.
<i>Proposition 14:</i> SMEs are likely to have more frequent linkages with organizations in their cluster web than large organizations.	Summated mean comparison – no significant results Larger organizations in the sample are significantly more likely to use linkages with Economic Development Offices ($t=-1.80$, $p=0.07$) than the micro enterprises.	No Support.
<i>Proposition 15:</i> SMEs are likely to have more valued linkages with organizations in their cluster web than large organizations.	Summated mean comparison – no significant results Larger organizations in the sample use significantly more linkages with Suppliers ($t=-2.02$, $p=0.04$), Universities ($t=-2.15$, $p=0.03$) and Economic Development Offices ($t=-2.28$, $p=0.02$) than the micro enterprises.	No Support.

Appendix J: Testing Non-Response Bias

Test on Use and Value of Linkages Within the Cluster

The following will test using all of the respondents in the sample (182) and will compare the early respondents (those who responded in the first round of fax-outs) to the late respondents (those who participate in response to the follow-up reminder fax). It is assumed that had the reminder fax not gone out, that these “late respondents” would not have participated at all in this study. Tables 86 to 88 detail the t-tests comparing the overall mean use and value for linkages, as per the summated scales. The *early* and *late* respondents are not significantly different in use or value of linkages. Tables 89 and 90 compare the early and late respondents on firm size (number of employees). They were again not significantly different. The same tests were calculated using a sample of only technology firms to see, again, if the early and late respondents were different (see Tables 91 to 95). There were no significant findings, thus the early and late respondents have similar tendencies, and the results are assumed to be free of non-response bias.

Table 88

Comparing Early and Late Respondents on Use and Value of Linkages

		N	Mean	Std. Deviation	Std. Error Mean
Use	First Round of Faxes	128	27.71	7.14	0.63
	Follow-up	40	27.95	7.02	1.11
Value	First Round of Faxes	128	26.54	6.67	0.59
	Follow-up	37	26.16	5.51	0.91

Table 89

T-Test: Comparing Early and Late Respondents on Use of Linkages

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Use	0.00	0.96	-0.19	166.00	0.85	-0.24	1.29	-2.78	2.30

Table 90

T-Test: Comparing Early and Late Respondents on Value of Linkages

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Value	2.28	0.13	0.31	163	0.75	0.38	1.20	-1.99	2.75

Test of Firm Size (all data)**Table 91**

Comparing Early and Late Respondents on Size of Firms

		N	Mean	Std. Deviation	Std. Error Mean
Number of Full-Time Employees	First Round of Faxes	137	1481.50	13551.92	1157.82
	Follow-up	42	232.88	698.46	107.77

Table 92

T-Test: Comparing Early and Late Respondents on Size of Firms

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
# of Employees	1.38	0.24	0.60	177	0.55	1248.62	2096.04	-2887.82	5385.06

Test on Use and Value of Linkages Within the Cluster (tech firms only)**Table 93**

Comparing Early and Late Technology Firm Respondents on Use and Value of Linkages

		N	Mean	Std. Deviation	Std. Error Mean
Use	First Round of Faxes	69	26.88	7.23	0.87
	Follow-up	19	26.74	7.16	1.64
Value	First Round of Faxes	70	26.06	6.63	0.79
	Follow-up	19	25.16	6.10	1.40

Table 94

T-Test: Comparing Early and Late Technology Firm Respondents on Use of Linkages

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Use	0.06	0.81	0.08	86.00	0.94	0.15	1.87	-3.57	3.86

Table 95

T-Test: Comparing Early and Late Technology Firm Respondents on Value of Linkages

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Value	0.31	0.58	0.53	87.00	0.60	0.90	1.69	-2.45	4.25

Test of Firm Size (tech firms only)

Table 96

Comparing Early and Late Technology Firm Respondents on Size of Firm

		N	Mean	Std. Deviation	Std. Error Mean
Number of Full-Time Employees	First Round of Faxes	75	2650.68	18285.17	2111.39
	Follow-up	20	229.20	634.52	141.88

Table 97

T-Test: Comparing Early and Late Technology Firm Respondents on Size of Firm

	Levene's Test Equality of Variances for		t-test for Equality of Means						
	F	Sig.	t	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
# of Employees	1.37	0.25	0.59	93.00	0.56	2421.48	4105.41	-5731.05	10574.01