

**COMMERCIALIZATION STRATEGY AND COMPETITIVE
AGGRESSIVENESS FOR TECHNOLOGY STARTUPS IN OTTAWA**

by

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in partial fulfillment of the requirements for the degree of
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ABSTRACT

The objective of this research is to examine the relationship between commercialization strategy and competitive aggressiveness for technology start-ups organized into two groups: (i) start-ups that address global market and (ii) start-ups that address US and Canada markets. Data on 60 technology start-ups founded in Ottawa between 1998 and 2001 was used to examine how venture capital financing, asset ownership, and patent possession affect two dimensions of competitive aggressiveness: action diversity and action volume. Results suggest that: i. the start-ups with global market scope are more aggressive than start-ups with Canada/US market scope; ii. venture capital financing affects the action diversity of both global and Canada/US start-ups, and the action volume of the Canada/US start-ups; iii. asset ownership affects the action diversity of start-ups with global market scope; and iv- patent possession has no effect on start-up competitive aggressiveness.

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My parents have always been a great source of strength, encouragement and love throughout my life. My only regret today is that they are not able to share this day. My special thanks go to all of my family members for their understanding and support, especially my wife Shazia and our six months old son Zuhair. We all share the delight of this accomplishment.

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At the request of the examination committee, the data used in this research has been provided in a compact disk to my supervisor. The data is organized as:

- Appendix C. Venture capital financing
- Appendix D. Asset ownership
- Appendix E. Patent possession
- Appendix F. List of actions by the companies

1. INTRODUCTION

This thesis examines the relationship between commercialization strategy and competitive aggressiveness using data for Ottawa-based technology start-ups organized into two groups based on the market they serve. Specifically, the objectives of this research are:

- to develop and test a model that relates three dimensions of a start-up's commercialization strategy: venture capital financing, assets ownership, and patent possession, with two dimensions of its competitive aggressiveness: action diversity and action volume
- to identify how the relationship between commercialization strategy and competitive aggressiveness for start-ups that address global market opportunities differs from that for start-ups that address market opportunities in the United States and Canada.

Previous empirical studies use data on large companies to examine how internal factors such as top management team diversity, company liquidity, past performance, and organizational slack affect competitive aggressiveness (Ferrier, 2001; Hambrick, Cho & Chen, 1996; Hao, 2004). This study examines a different set of antecedents for competitive aggressiveness: venture capital financing, asset ownership and patent possession. These three variables have been associated with the commercialization strategy of technology start-ups by Gans, Hsu, and Stern (2002), and Gans and Stern (2003). Moreover, Jorde and Teece (1990), Teece, (1986, 1988) and Teece, Pisano and Shuen (1997) examined asset ownership and patent possession as keys to successful

commercialization efforts. Hsu (2004) and Hui (2004) studied the role of venture capital financing in start-ups' commercialization efforts.

Building on Ferrier (2001) and Ferrier, Smith and Grimm (1999), a start-up's competitive aggressiveness is measured using two dimensions: action diversity and action volume.

Competitive aggressiveness research has been popular in the strategy literature. Most studies, however, have not focused on differences between the competitive aggressiveness that results from addressing global market opportunities and that which results from addressing regional market opportunities. This research examines whether or not market scope affects the relationship between commercialization strategy and competitive aggressiveness.

Market scope is expected to mediate the relationship between commercialization strategy and competitive aggressiveness for technology start-ups. Market scope may affect the number and types of activities that start-ups undertake when executing their production and go-to-market strategies.

This research focuses on Ottawa start-up companies for two reasons. First, a significant number of start-ups develop new technology in Ottawa. The technology sector ranks as the region's third-largest revenue generator behind the federal government and the retail

sector, and employs more than 70,000 people.¹ As of December 2003, more than 30% of the technology companies in Ottawa were founded in the last 5 years.²

The second reason for the focus on Ottawa start-ups was that the researcher had access to a unique database with information on the multiple markets that Ottawa start-ups service or expect to service. The Ottawa Centre for Research and Innovation (OCRI) developed the database and made it available to the researcher.

This research is interesting because it examines new antecedents to competitive aggressiveness, focuses on start-ups instead of large firms, and examines market scope as a mediating variable to the commercialization-competitive aggressiveness relationship.

This research will be of particular interest to: i. researchers working in the area of competitive aggressiveness as it is focused on start-ups' competitive aggressiveness whereas most of existing work on aggressiveness deal with the established companies; ii. start-ups' managers as it identifies new factors that affect competitive aggressiveness; and iii. local policy makers as they can define regional clusters based on market scope.

This research makes at least three contributions. First, it examines how technology start-ups' commercialization strategy affects their competitive aggressiveness. It is expected

¹ Canadian Advanced Technology Association white paper *Turning ideas into prosperity*-2003

² Technology Industry Survey December 2003- Ottawa Centre for Research Institute (OCRI).

that an increase in competitive aggressiveness results in an increase in company performance.

The second contribution is that the results of this research suggest that the breadth of the market served by the start-up mediates the relationship between venture capital financing and action volume, and the relationship between asset ownership and action diversity.

The third contribution of this research is the suggestion that defining regional clusters based on the breadth of the market addressed by technology start-ups may lead to the design and delivery of systems better able to support the growth of these start-ups. The literature on clusters as economic elements (Learmonth, Munro & Swales, 2003; Lundequist & Power, 2002; Newlands, 2003; Porter, 1998, 2002) defines clusters on the basis of technology field or industry. Defining clusters on the basis of the scope of the market addressed by start-up companies may help policy makers and other local organizations better support technology start-ups.

This thesis has been structured into seven chapters. Chapter 1 is the introduction. Chapter 2 provides the results of the literature review on commercialization practices, competitive aggressiveness and industrial clusters. Chapter 3 describes the research model and hypotheses used in this research. Chapter 4 describes the research design. Chapter 5 provides the results obtained when testing the hypotheses. Chapter 6 discusses the results obtained. Finally, chapter 7 presents the conclusions, limitations and suggestions for future research.

2. LITERATURE REVIEW

The literature that is relevant to this research includes: start-ups' commercialization strategy, competitive aggressiveness, and industrial clusters. This chapter is organized into four sections. The first section reviews the company level factors that influence a start-up's commercialization strategy. The second section reviews the studies on competitive aggressiveness. The third section examines the literature on the significance of industrial clusters. Finally, the fourth section summarizes the lessons learned from the literature review.

2.1 Start-up's commercialization strategy

Commercialization begins when a business identifies a way to use scientific or engineering advances to meet a market need and continues through design, development, manufacturing ramp-up, and marketing, and includes later efforts to improve the product (Nevens, Summe & Uttal, 1990). Start-ups usually have little experience and a key management challenge is the commercialization of their technologies (Gans & Stern, 2003). Start-up firms usually restrict themselves to a single strategy due to fewer numbers of projects running simultaneously and limited financial and human resources (Veugelers & Cassiman, 1999).

More recently, the literature on commercialization strategy for the start-up technology firms is centred on the competition versus cooperation approaches with the existing firms when start-ups bring their own products or technologies in the market (Gans et al., 2002; Gans & Stern, 2003; Hsu, 2004; Jorde & Teece, 1989).

The literature describes venture capital financing, asset ownership and patent possession as three main drivers of a start-up's commercialization strategy. Gans et al. (2002), and Gans and Stern (2003) examined these three factors. Jorde and Teece (1990), Teece (1986, 1988), and Teece et al. (1997) examined asset ownership and patent possession. Tripas (1997) examined asset ownership. Hellmann and Puri (2000, 2002), Hsu (2004) and Hui (2004) studied effect of venture capital financing on start-ups' commercialization.

2.1.1 Venture capital financing

Venture capital (VC) financing impacts the development path of a start-up company (Hellmann & Puri, 2000). The effect of venture capital is particularly pronounced in the early stages of a company's development (Hellmann & Puri, 2002; Hsu, 2004). Venture capital backing skews commercialization strategies across industries toward cooperation (Hsu, 2004). Access to a network of contacts such as venture capital relationships reduces the search and transaction costs associated with identifying and contracting with incumbents (Gans et al., 2002; Hsu, 2004). Established firms are often reluctant to commence negotiations with start-up companies, discounting the potential commercial value of external technology (Gans & Stern, 2003). Venture capitalists, who have long-term reputations with incumbents and can therefore credibly certify the expected value of specific innovations, may increase the relative likelihood of cooperation (Gans et al., 2002). Using a data set of Silicon Valley start-ups, Hellmann & Puri (2002) found that venture capitalists play a role, that is over and beyond those of traditional financial intermediaries, at every level of the organization in activities like introduction of stock

option plans, the hiring of a VP of sales and marketing, and the formulation of human resource policies. They also found that venture-capital-backed companies are also more likely and faster to replace the founder with an outside CEO. Using a data set of all U.S.-based business-to-business dot-coms founded between 1988 and 2001, Hui (2004) concluded that more direct ties to VCs and more indirect ties to other companies via VCs gave start-ups lower failure likelihood and higher sales revenues and the strength of a VC may not depend on its financial depth, but rather, on the number of contacts it has.

2.1.2 Complementary asset ownership

The second determinant of commercialization strategy is the start-up's relative investment costs of acquiring complementary assets. Complementary assets are defined as assets that need to be employed to package new technology so that it is valuable to the end user (Jorde & Teece, 1990, p. 83). As the sunk costs of complementary assets increase, start-ups are more likely to cooperate with the incumbents for higher gains (Gans et al., 2002; Gans & Stern, 2003; Teece, 1988).

Teece (1986,1988) distinguishes between generic, specialized, and cospecialized complementary assets. Complementary assets may be "generic" if they are not tailored to the innovation. They may be "specialized" if there is unilateral dependence between the innovation and the complementary asset, or they may be "co-specialized" if there is a bilateral dependence. Whereas generic assets have multiple applications and can be easily contracted for, specialized and cospecialized assets are useful only in the context of a given innovation (Teece, 1986,1988; Tripas, 1997).

Teece (1986, 1988) identified a set of four important complementary assets: manufacturing, distribution channels, and sales and servicing resources. These assets may reside in-house. If not, they are conceivably available through merger, acquisition, or contract. Gans et al. (2002) found that manufacturing, distribution channels, brand development, and servicing are the four key assets the innovators must effectively control to earn major returns from their innovation. Dale and Fathi (2004, 19-22) identify marketing, internal operations, direct sales execution, channel sales execution, fulfillment, and support as commercialization assets requirements.

2.1.3 Patent possession

Patent possession protects against replication and imitation (Jorde & Teece, 1989; Teece et al., 1997). With patent possession, the start-up can clearly present its technology specifications without the threat of expropriation during bargaining. Clear legal ownership reduces the costs of reaching an agreement (Gans et al., 2002; Gans & Stern, 2003, Teece, 1986, 1988). When start-ups do not have patent possession, strong disclosure effects will prevent the start-ups to adopt a cooperation strategy with the incumbent firms (Gans & Stern, 2003).

2.2 Competitive aggressiveness

Various previous studies of competitive dynamics at the firm level suggest that firms that are more competitively aggressive experience better performance (Ferrier et al., 1999; Ferrier, 2001). These firms carry out more competitive actions and respond to competitive challenges more quickly (Ferrier, 2001) and company performance increases with the increase in its competitive activity (Yong, Smith, & Grimm, 1996).

Firm-level factors affect a company's competitive aggressiveness. Factors found to contribute to a firm's competitive aggressiveness include top management team heterogeneity (Ferrier, 2001; Hambrick et al., 1996), past performance (Ferrier, 2001; Miller & Chen, 1994, 1996) and organizational slack (Ferrier, 2001).

2.2.1 Action types

Ferrier (2001) argues that a company's strategy can be defined as a sequence of competitive actions where competitive actions refer to a sequence of activities that a firm carries out over time.

In competitive aggressiveness studies, competitive action types are classified into six types: marketing actions, capacity-related actions, new product actions, signaling actions, pricing actions, and service actions (Ferrier et al., 1999; Ferrier, 2001). Ferrier (2001) uses these six action types to measure the four dimensions of competitive aggressiveness: attack volume, attack duration, attack complexity, and attack unpredictability. To study simplicity of a competitive repertoire, Miller and Chen (1996) categorized competitive actions into: product introductions, pricing or advertising decisions, and changes in market scope.

2.2.2 Action volume

A company that carries out more competitive actions over a time period is defined as competitively more aggressive than a company, which carries out a fewer number of actions. (Ferrier et al., 1999; Ferrier, 2001; Yong et al., 1996).

2.2.3 Action diversity

The action diversity of a firm is assessed by its degree of concentration on fewer or larger different types of competitive actions over a given period of time. Companies that carry out a wide range of action types are defined as more aggressive. A company that is able to undertake many different types of actions may be able to suppress competitors' capability of competing and responding quickly, thereby enhancing the company's performance (Ferrier et al., 1999; Ferrier, 2001).

2.3 Industrial clusters

Clusters are the geographic concentrations of interconnected companies, specialized suppliers, service providers, and firms in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate (Porter, 2000). Members of a cluster are mutually dependent, good performance by one can boost the success of others and vice versa (Porter, 1998). Clusters facilitate commercialization as opportunities for new companies are more apparent and commercializing new products is easier because of available skills and suppliers (Porter, 2003).

Literature relevant to the industrial clusters is arranged into role of clusters in regional development and policy makers' significance in cluster creation and enhancement.

2.3.1 Industrial clusters and regional development

Lundequist & Power (2002) and Porter (2003) suggest that the cluster concept is a useful tool for regional development. A cluster adds to the prosperity of the region by stimulating the formation of new businesses in the area, causes existing companies to operate more productively, and supports rising wages (Porter, 1998). A region's competitiveness and standard of living (wealth) is determined by the productivity with which it uses its human, capital, and natural resources (Porter, 2002).

Clusters affect regional competitiveness in three ways: (i) they increase the productivity of constituent firms, (ii) they increase firms' capacity for innovation and (iii) they stimulate new business formation (Porter, 1998a).

Clusters facilitate private sector development among broad divisions of the population, resulting in more employment, higher incomes and more dynamic development in the concerned regions or cities (Dijk & Sverrisson, 2003).

2.3.2 Policy makers' role in cluster creation and enhancement

National policies can favorably influence the creation of new clusters and help undertake risky R & D locally (Maggioni, 2002). Policy makers may develop high-tech industrial clusters (Maggioni, 2002) and may enhance cluster productivity by direct investments or through other public institutions - such as public spending for specialized infrastructure or educational programs (Lundequist & Power, 2002; Porter, 1998).

2.3.3 Defining clusters

It is difficult to define the boundaries and compositions of clusters (Lundequist & Power, 2002; Rosenfeld, 2003).

A widely used definition for what clusters are goes as follows: clusters are composed of several key inter-linked elements (the cluster firms), and infrastructures including suppliers of specialized inputs such as components, machinery and downstream channels, and customers (Learmonth et al., 2003; Porter, 1998). For example, Porter (1998) defines Italian fashion leather culture comprising of shoemakers, equipment manufacturing, and designers that use computer assisted design tools.

Table 1 summarizes the defining characteristics of clusters proposed by Dijk and Sverrisson (2003).

Table 1. Defining characteristics of clusters

<p>Directly observable characteristics</p> <ol style="list-style-type: none">1. Relative spatial proximity (or nearness) of the enterprises2. A high density of economic activities generally3. Presence of numerous firms involved in same, similar, and subsidiary activities
<p>Foundational and universal characteristics</p> <ol style="list-style-type: none">4. Inter-firm linkages between enterprises as a result of (vertical) subcontracting5. Inter-firm linkages between enterprises in specific forms of (horizontal) co-operation6. Some degree of specialization

Source: Dijk & Sverrisson, 2003

2.4 Lessons learned

This section provides the lessons learned from the literature review.

Determinants of start-up's commercialization strategy

Venture capital financing, asset ownership and patent possession are important elements of a start-ups commercialization strategy.

Dimensions of competitive aggressiveness

Action diversity and action volume can be used to measure the competitive aggressiveness of a company. Action diversity refers to the extent to which the company carries out different types of actions. Action volume refers to the number of competitive actions carried out by the company. The company that carries out more and different types of competitive actions over a time period is defined as being competitively more aggressive.

Industrial clusters' role in regional development

Industrial clusters facilitate the commercialization of new products and the start of new companies. It is more productive for regional policy makers to consider clusters of firms recognizing functional interconnectivities and systems as compared to individual firms.

Lack of studies on the relationship between a start-ups commercialization strategy and its competitive aggressiveness

The existing literature focuses on top management team heterogeneity, liquidity and past performance as the antecedents for competitive aggressiveness. To the writer's knowledge, there is no empirical study that links the competitive aggressiveness of a start-up to its commercialization strategy.

No competitive aggressiveness study considering market scope

The early competitive aggressiveness literature makes no mention of the significance of market scope or any difference expected in aggressiveness for companies addressing different market scopes. The samples used in these empirical studies do not distinguish firms on the basis of market scope.

Lack of competitive aggressiveness studies on start-ups

Most empirical studies on competitive aggressiveness focus on established firms. To the writer's knowledge no empirical study examines the competitive aggressiveness of technology based start-ups.

Criterion to cluster firms using market scope is not used

Prior studies normally use location, industry and/or technology to cluster companies. To the author's knowledge, no previous study uses market scope as the basis for clustering.

3. MODEL AND HYPOTHESES

This chapter is organized into three sections. The first section describes the research model used in this study. The hypotheses are developed in the second section. The third section lists the hypotheses developed for this research.

3.1 Research model

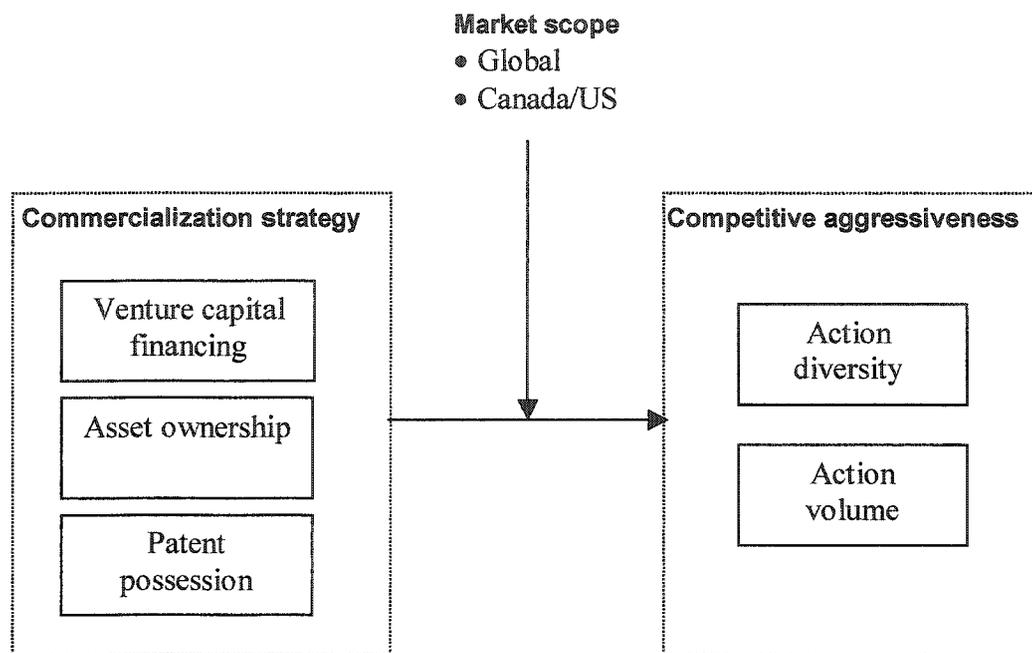
The objectives of this research are:

- to develop and test a model that relates three dimensions of a start-up's commercialization strategy: venture capital financing, assets ownership, and patent possession, with two dimensions of its competitive aggressiveness: action diversity and action volume
- to identify how the relationship between commercialization strategy and competitive aggressiveness for start-ups that address global market opportunities differs from that for start-ups that address market opportunities in the United States and Canada.

Figure 1 provides the research model used to anchor the hypotheses tested in the thesis. This model describes how three constructs associated with a start-up's commercialization strategy affect two dimensions of its competitive aggressiveness and how this relationship is mediated by market scope. In this research, market scope refers to the breadth of the market addressed by the technology start-up. Ottawa based start-ups were classified into two groups based on their market scopes: global and Canada/US. The global market was comprised of all the firms that are based in Ottawa and sell their

products globally. Similarly, the Canada/US market was comprised of all the companies that are based in Ottawa and sell their products to Canadian and/or US customers.

Figure 1. Research model



The left side of Figure 1 identifies the three factors of a start-up's commercialization strategy deemed to affect its competitive aggressiveness: venture capital financing, asset ownership, and patent possession. These three factors were identified from the commercialization of start-ups literature (Gans et al., 2002; Gans & Stern, 2003; Hsu, 2004; Hui, 2004) and the commercialization literature (Jorde & Teece, 1990; Teece, 1986, 1988; Teece et al., 1997).

On the right side of Figure 1, the two measures of competitive aggressiveness used in this research are identified: action diversity and action volume. These are two of the four

measures used in the literature that examines the antecedents and consequences of competitive aggressiveness (Ferrier, 2001; Ferrier et al., 1999). The other two measures of competitive aggressiveness, duration and unpredictability, were used were used by Ferrier (2001) to examine company competition between paired companies. He considered attack duration and unpredictability between a focal firm and a rival firm. This research does not examine the pair wise competition between a focal company and a competitor the same way that Ferrier's work did. Thus, duration and unpredictability were not used in this research.

Figure 1 suggests that the relationship between commercialization strategy and competitive aggressiveness for start-ups is moderated by market scope. It is surmised that, given the identical antecedent conditions, the number and types of actions undertaken by global and Canada/US start-ups to plan and execute their development, production and go-to-market actions are different.

3.2 Hypotheses development

In this section, six sets of hypotheses anchored around the model shown in Figure 1 are developed.

3.2.1 Venture capital financing

Venture capital (VC) financing results in an increase in the diversity of the start-up's top management team (TMT) and an increase in the liquidity position of the start-up. Having VC representatives on the board of directors increases TMT diversity. TMT diversity

refers to the degree to which its members are different with respect to working related backgrounds (Bunderson & Sutcliffe, 2002). These backgrounds include team member's company tenure background, function background, and education background (Hambrick et al., 1996). TMT with high diversity have a greater awareness in sensing strategic problems, which facilitates them in undertaking complex actions (Ferrier, 2001). Greater TMT diversity is associated with a greater likelihood of strategic change, flexibility, complexity, and aggressiveness (Hambrick et al., 1996; Lant, Milliken & Batra, 1992; Wiersema & Bantel, 1992). They tend to carry out a broad range of competitive actions to match their complex strategy.

VC financing also increases the liquidity position of the start-up. Company liquidity is defined as "the cushion of actual or potential resources which allows an organization to adapt successfully to internal pressures for adjustment or to external pressure for change in policy as well as to initiate change in strategy with respect to external environment" (Bourgeois, 1981). Many organizational routines and structures take shape during the early days of an organization's life cycle (Hui, 2004). The availability of financial capital can dictate the initial size of a start-ups and its initial marketing strategy (Morris, Schindehutte & LaForge, 2002). High level of liquidity allows the company to explore new strategies (Hambrick & Snow, 1977). Companies with high liquidity can undertake a greater number of actions and actions of many different types. Companies with low liquidity can only carry out a smaller number of actions and a narrow range of actions. Therefore:

Hypothesis 1: VC financing is associated with higher action diversity.

Hypothesis 1a: VC financing is associated with higher action diversity for global start-ups.

Hypothesis 1b: VC financing is associated with higher action diversity for Canada/US start-ups.

High liquidity gives a firm greater leeway on the number of actions it can carry out (Cyert & March, 1963). Companies with high levels of liquidity have the ability to execute a greater number of actions (Ferrier, 2001).

High TMT diversity results in low action volume (Ferrier, 2001). A TMT with high diversity experiences high interpersonal conflicts that have a negative impact on the agreement-seeking behaviors (Knight, Pearce, Smith, Olian, Sims, Smith & Flood, 1999). These conflicts need more time to be resolved and slow down the action-execution speed (Hambrick et al., 1996). Therefore, TMT diversity diminishes the efficiency and ability to sustain a large number of serial actions (Ferrier, 2001). In contrast, a homogeneous TMT is capable of taking greater number of actions when potential actions fall within the working background fields of the TMT members. Once homogeneous teams reach a consensus in their field, they can act quickly (Hambrick et al., 1996). Therefore, homogeneous teams can increase the volume of actions that fall in their working background field.

VC financing, however, is carried out only after there is an agreement about the future strategic direction of the start-up. Therefore, presence of a VC representative in the TMT

would result in less interpersonal conflicts given that an agreement of what needs to be done is already in place. This suggests that the increase in TMT due to VC representation in the board of the start-up increases execution speed of the actions that need to be undertaken. VC financing is expected to increase TMT diversity and that this increase in TMT diversity results in an increase in action volume. Therefore:

Hypothesis 2: VC financing is associated with higher action volume.

Hypothesis 2a: VC financing is associated with higher action volume for global start-ups.

Hypothesis 2b: VC financing is associated with higher action volume for Canada/US start-ups.

3.2.2 Asset ownership

A company's capability to execute actions depends on its resource availability (Bourgeois, 1981). When a start-up does not own the complementary assets required for the commercialization of its products and the sunk costs of acquiring these assets are high, the start-up has little choice in terms of the actions that they can undertake (Gans et al., 2002). High level of asset ownership gives the start-up more resources to execute a large number of actions and actions of different types. High level of asset ownership enables the start-up to be more aggressive, explore more options and take broader range of actions. Low levels of asset ownership inhibit a start-up number and range of actions. Therefore:

Hypothesis 3: Greater asset ownership is associated with higher action diversity.

Hypothesis 4: Greater asset ownership is associated with higher action volume.

The following corresponding hypotheses will also be tested.

Hypothesis 3a: Greater asset ownership is associated with higher action diversity for global start-ups.

Hypothesis 3b: Greater asset ownership is associated with higher action diversity for Canada/US start-ups.

Hypothesis 4a: Greater asset ownership is associated with higher action volume for global start-ups.

Hypothesis 4b: Greater asset ownership is associated with higher action volume for Canada/US start-ups.

3.2.3 Patent possession

Patent possession serves as a legal barrier to imitation. A start-up will find it easier to undertake actions if patents protect its innovations (Gans et al., 2002; Gans & Stern, 2003). For a start-up, patent possession reduces the risk of expropriation when discussing or negotiating its technology with other firms (Veugelers & Cassiman, 1999).

Patent possession gives start-ups greater freedom to carry out more and diverse actions whereas absence of patent increases the threat of expropriation and inhibits the start-up to disclose its technology. Therefore:

Hypothesis 5: Patent possession is associated with higher action diversity.

Hypothesis 6: Patent possession is associated with higher action volume.

The following corresponding hypotheses will also be tested.

Hypothesis 5a: Patent possession is associated with higher action diversity for global start-ups.

Hypothesis 5b: Patent possession is associated with higher action diversity for Canada/US start-ups.

Hypothesis 6a: Patent possession is associated with higher action volume for global start-ups.

Hypothesis 6b: Patent possession is associated with higher action volume for Canada/US start-ups.

3.3 List of hypotheses

The following hypotheses are tested in this thesis.

Hypothesis 1: VC financing is associated with higher action diversity.

Hypothesis 1a: VC financing is associated with higher action diversity for global start-ups.

Hypothesis 1b: VC financing is associated with higher action diversity for Canada/US start-ups.

Hypothesis 2: VC financing is associated with higher action volume.

Hypothesis 2a: VC financing is associated with higher action volume for global start-ups.

Hypothesis 2b: VC financing is associated with higher action volume for Canada/US start-ups.

Hypothesis 3: Greater asset ownership is associated with higher action diversity.

Hypothesis 3a: Greater asset ownership is associated with higher action diversity for global start-ups.

Hypothesis 3b: Greater asset ownership is associated with higher action diversity for Canada/US start-ups.

Hypothesis 4: Greater asset ownership is associated with higher action volume.

Hypothesis 4a: Greater asset ownership is associated with higher action volume for global start-ups.

Hypothesis 4b: Greater asset ownership is associated with higher action volume for Canada/US start-ups.

Hypothesis 5: Patent possession is associated with higher action diversity.

Hypothesis 5a: Patent possession is associated with higher action diversity for global start-ups.

Hypothesis 5b: Patent possession is associated with higher action diversity for Canada/US start-ups.

Hypothesis 6: Patent possession is associated with higher action volume.

Hypothesis 6a: Patent possession is associated with higher action volume for global start-ups.

Hypothesis 6b: Patent possession is associated with higher action volume for Canada/US start-ups.

4. RESEARCH DESIGN

4.1 Unit of analysis

The unit of analysis is a technology start-up that develops products for sale and was established in Ottawa between January 01, 1998 and Dec 31, 2001.

4.2 Study period

The study period includes the first two and one half years of a technology start-up. Thus, for a company established on December 31, 2001, the study period is comprised of December 31, 2001 to June 30, 2004.

4.3 Sample selection

The company sample was drawn from the list of companies included in a database developed by the Ottawa Centre for Research and Innovation (OCRI) in December 2003. This database provides information on 1,532 Ottawa companies. For each company, the following information is provided: postal address, web address, telephone numbers, number of local employees, first five target markets, and industry sector. OCRI assigns companies to one or more industry sectors. A total of 25 industry sectors are used to classify companies in the OCRI-database.

The following method was used to select the sample:

1. Select companies in the OCRI database that were established between 1998 and 2001

2. Eliminate the companies that offer only services, i.e., do not develop products for sale
3. Eliminate the companies with fewer than six employees
4. Eliminate the companies that are part of multinational companies or branch offices of other companies
5. Eliminate the companies that have no website or its website is not accessible
6. Eliminate the companies that did not maintain press releases on their web sites
7. Eliminate the companies that were merged or acquired by other companies or were only a reseller of products developed by other companies

4.4 Coding variables

For each company, the OCRI database identifies the top five markets where the companies sell their products from the most important one (first market), to the least important one. This includes the company's first market, second market and so forth. Six new variables were defined to specify the target markets for the companies in the sample. These variables are Global, Canada, USA, Europe, Asia, and Other.

- Global:** Indicates that the company is operating in the global market. A company is assumed to be operating in global market if the OCRI database reports that the company is addressing i. global customers or ii. customers in more than three different markets. This is further explained in table 2.
- Canada:** Indicates that the company is operating in the Canadian Market

- USA: Indicates that the company is operating in the United States of America
- Europe: Indicates that the company is operating in Europe
- Asia: Indicates that the company is operating in Asia
- Other: Indicates that the company is operating in a market other than global, Canada, USA, Europe, or Asia

The significance of a target market (US, Canada) varies if it appears as a first market, or as a second market and so forth in the OCRI database. A scheme for coding the above variables was developed³. This coding scheme is given in table 2.

Table 2. Variables coding scheme

Markets defined in OCRI database	Coding Scheme	Example	No of companies in sample
Only first market is defined. (this may be defined as global)	Variable corresponding to value of first market is coded as 100. All other variables are coded as 0.	First market is defined as Canada. Variable 'Canada' is coded as 100. Variables USA, Europe, Asia, Other and Global are coded as 0.	42
First market is defined as North America or Canada/US	Variable Canada and USA are coded as 50. All other variables	First market is defined as North America. Variable Canada and USA are coded as 50.	5

³ This coding scheme was prepared after consultation with Dr. Sorin Cohn of orbitIQ .

	are coded as 0.	Variables Europe, Asia, Other and Global are coded as 0.	
First and second markets are defined	Variable corresponding to value of first market is coded as 70. Variable corresponding to value of second market is coded as 30. All others variables are coded as 0.	First market is defined as Canada and second market as USA. Variable Canada is coded as 70 and Variable USA is coded as 30. Variables Europe, Asia, Others and Global are coded as 0.	8
First, second and third markets are defined	Variables corresponding to values of first, second and third markets are coded as 60, 30 and 10 respectively. All other variables are coded as 0.	First market is defined as Canada, second market as USA and third market as Europe. Variables Canada, USA and Europe are coded as 60, 30 and 10 respectively. Variables Asia, Others and Global are coded as 0.	4
Four or all five markets are defined in the data,	Assume that the company is selling globally. Variable Global is coded as 100. All other variables are coded as 0.	First, second, third and fourth markets are defined as Canada, USA, Europe, and Asia respectively. Variable Global is coded as 100. Variables Canada, USA, Europe, Asia, and Other are	1

		coded as 0.	
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4.5 Data collection

4.5.1 Venture capital financing

Three sources were used to obtain venture capital financing information such as investors' names, amount of funding received, and the time when the funding was received by the start-up (year and quarter). The three sources of information were:

- Ottawa Capital Network's website
<http://www.ottawacapitalnetwork.com/fundingsummary.cfm>
- OCRI Entrepreneurship Centre's spreadsheet – Risk Activity In Ottawa
- Companies' websites

The Ottawa Capital Network's website is operated by OCRI's Entrepreneurship Centre. The following information was obtained from this website: investors' names, amount of funding received for the first three quarters of the year 2000 and from the first quarter of year 2001 to the second quarter of 2004. Information prior to 2000 and for the fourth quarter of the year 2000 is not available on this site.

Investors' names, amount of funding received for the year 1998, 1999 and fourth quarter of 2000 were obtained from OCRI's Entrepreneurship Centre spreadsheet – Risk Activity in Ottawa.

If the VC funding event was not reported in the Ottawa Capital Network's website or OCRI's Entrepreneurship Centre spreadsheet, investors names and amount of funding were obtained from the company's website.

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4.5.2 Asset ownership

Seven asset types were used in this research:

1. Marketing/brand development
2. Internal operations/manufacturing
3. Direct sales execution
4. Channel sales execution
5. Fulfillment
6. Support
7. Services/consulting/training

The seven asset types identified above were drawn from the literature. Teece (1986, 1988) identified four assets: manufacturing, distribution channels, sales and servicing resources. Gans et al. (2002) identified: manufacturing, distribution channels, brand development, and servicing as the four key assets of start-ups. Dale and Fathi (2004 –slides 19-22) identified marketing, internal operations, direct sales execution, channel sales execution, fulfillment, and support as the required assets.

For each company in the sample, information on the company's website and news releases were used to determine whether or not the company had an 'in-house' asset. The sections of the company's website examined were: corporate overview, management team introduction and responsibilities, about us, success stories and customer testimonials.

Marketing/brand development

A "1" was assigned to a company's marketing brand development variable if the company had a person in the VP marketing role or had trademarks or copyrights with the company's name or the company product's name.

Internal operations/manufacturing

A "1" was assigned to a company's internal operations/manufacturing variable if the company had any of the following: a manufacturing facility location, a VP manufacturing or VP operations. In case of a company that only developed software products, operation/manufacturing variable was a "1" unless it was mentioned that software development was outsourced.

Direct sales execution

A "1" was assigned to a company's direct sales execution variable if any of the following was true: the company or an organization owned by the company provided the product to the customer, the user ordered the products directly from the field sales force or telesales organization of the company, products were purchased from the company's website or the company had sales offices only.

Channels sales execution

A “1” was assigned to a company’s channel sales execution variable if any of the following was true: company had distributors, resellers, value added resellers, authorized representatives or the TMT team included a VP of channel sales.

Fulfillment

A “1” was assigned to a company’s fulfillment variable if the company was delivering products directly to the customer or software could be downloaded directly from the company’s website.

Support

A “1” was assigned to a company’s support variable if any of the following was true: company had product support centres, company had on-duty support staff to ensure optimum user experience and assist with system maintenance, company was also selling its support services e.g. via comprehensive maintenance agreements, company had extensive telephonic support and web-support such as support area for customers on its web site providing access to product manuals, application notes, issue tracking or company had live chat support.

Services/Consulting/Training

A “1” was assigned to a company’s Services/Consulting/Training variable if any of the following was true: company in addition to the product, also provided other related services or training. Services included ROI analysis, revenue at risk analysis,

customization, implementation, configuration, operation, documentation, complaints investigation, solutions, repair and replacement. Training included offering courses and programs to customers and partners, scheduled product training, train the trainer programs, web-based training to users or training staff. This includes both real-time instructor lead training and self-paced online courses.

4.5.3 Patent possession

The Canadian patent database maintained by the Canadian Intellectual Property Office (CIPO) on the Industry Canada website (<http://strategis.ic.gc.ca>) was used to search for the patents registered against the companies in the sample. The search was done using company's name in 'owner' field in the advanced search option at: (http://patents1.ic.gc.ca/srch_adv-e.html).

4.5.4 Competitive actions

Information on companies' actions was collected from the following four sources.

- 1- Companies' web sites.
- 2- Ottawa Business Journal' archives
- 3- Canadian News Stand
- 4- Business Source Premier

Companies' websites maintain news/press releases and events information.

Ottawa Business Journal has a searchable database for previous Ottawa Business Journal issues at its web site <http://archive.ottawabusinessjournal.com>. The archives were searched using the companies' names. If a company had changed its name, the previous name was also used for searching for articles or news items.

Canadian News Stand is a commonly used database to search for news sources. It contains full text of articles, columns, editorials and features from Canadian newspapers such as The Ottawa Citizen, Toronto Star, and National Post. The contents of the database are updated on a daily basis. The database was searched using a company's name as criteria. If the company had changed its name, the previous name was also used to search for articles or news items.

Business Source Premier is a widely used database for business research. It includes 3300 scholarly journals and business periodicals such as InfoWorld, PC week, Computing Canada, Computer World, PC Magazine, and Byte.com. Online searches of the database Business Source Premier were performed using the company's name and any previous name, if applicable.

When the company's website did not maintain news collection from previous years, the information was searched in the Ottawa Business Journal' archives, Canadian News Stand and Business Source Premier. Care was taken to include only the news releases issued by the company or the articles written by members of the company's management team. Analysts or industry reports were not considered except for news regarding

company's participation in trade shows or conferences, financing, or major sales. The same news from multiple sources was considered as one item.

Information on companies actions were classified into following ten action types:

1. New product introduction or new features on existing products

When the news release, article referred to any of the following:

- First ever mention of the product
- New features or new technology integrated into the existing product.
- Date when the product will be available for customer use or shipping.
- Product availability for beta use

2. Company/technology/product promotion

When the news release, article referred to any of the following:

- An award or a certificate the company or product had received or the placement the company or product had received in an award category
- Demonstration of the product at a trade show
- Demonstration of value offered by the technology at different conferences, forums, and technology magazines, TV shows.
- Joining associations for promotion of industry, lobbying, business networking, or information. Examples: membership in the Wireless Multimedia Forum or Remote Direct Memory Access (RDMA) Consortium.

3. Interoperability or integration

When the news release, article referred to any of the following:

- Information noting interoperability testing between the product and some other vendor's equipment
- Information indicating that a new product (or a different product family) can be integrated with the existing product

4. Partnerships, alliances, mergers

When the news release, article refers to any of the following:

- Collaboration with other companies for joint R & D, manufacturing.
- Information that the company will use someone's products or technology for its products
- Establishment of market and sales alliances, technology licensing agreement or reseller agreements to downstream partner
- Merger/acquisition of other companies

5. Analyst/customer comments

When the news release, article referred to any of the following:

- Comments from industry analysts that mention the product specifically
- Comments from the customer with respect to the product. Comments must come from company press releases at the time of customer sign-up

6. Testing

When the news release, article referred to any of the following:

- Product and technology trials to determine quality, safety, performance, usefulness, interoperability, or customer acceptance. It includes product trials for customers and trials between vendors' products
- Information indicating that the customer performed testing on the product
- Information indicating that someone other than the customer performed testing on the product

7. Investment in innovation, sales or support

When the news release, article referred to any of the following:

- Investments in improvement in the existing or new functionality, activities on R&D facilities, manufacturing, and integration/logistic capabilities
- Information noting that the company will expand the product target market, open new product support center, or enhance the sale force for the product.
- Investing in locations for core customer support

8. Changes in top management team and company's board of directors

When the news release, article referred to the following:

- Making changes in the TMT membership, board directors or Chief Executive Officer.

9. Financing

When the news release, article referred to the following:

- Activities including raising capital other than venture capital

10. Headcount reduction, changing product pricing or fighting lawsuits

When the news release, article referred to any of the following:

- Headcount reduction
- Changes in product pricing
- Fighting lawsuits

Headcount reduction has seven incidents, product-pricing changes has two and fighting lawsuits has only one. As there were very few actions in these three categories, they are placed under one category.

4.6 Variable measurement

4.6.1 Venture capital financing

A dummy variable “VC” was used to differentiate firms that were venture capital financed (VC=1) and firms that were not venture capital financed (VC=0).

4.6.2 Asset ownership

Gans et al. (2002- p.577) state that the importance of each complementary asset element can be perceived by the effectiveness of ownership of that element. In this study, asset

ownership was calculated as the number of elements of complementary asset taxonomy the company owns. This taxonomy has 7 elements - marketing/brand development, internal operations/manufacturing, distribution direct sales execution, channel sales execution, fulfillment, support, and services/consulting/training.

4.6.3 Patent possession

A dummy variable “patent” was used to differentiate the firms that had received at least one patent associated with the technology (patent=1) and firms that had no registered patent (patent=0).

4.6.4 Competitive aggressiveness

Action diversity

Action diversity is derived from the different types of the competitive actions taken by the company.

Action diversity, D, was calculated using the following formula:

$$D = 1 - \sum_{i=1}^{10} p_i^2$$

Where p is the proportion of actions in each of the ten action types. The basis of this measure is Herfindahl index, which is commonly used to measure the level of diversification (Ferrier, 2001; Ferrier et al., 1999). In this research, the range of values of

D is from 0 to 0.9. The value of D is zero for companies that take only one kind of actions whereas the value of D is 0.9 for companies that take equal number of actions from all the ten different action types. Companies with high diversity scores carry out competitive actions that typically consist of a broad range of action types. Low diversity scores indicate that a company typically carries out competitive actions with just a few action types.

Action volume

Action volume was measured as the total number of competitive actions carried out by the company during the first two and half years after its establishment. These actions were of the following ten types:

- New product introduction or new features on existing products
- Company/Technology/Product promotion
- Interoperability or integration
- Partnerships, alliances, mergers
- Analyst/Customer comments
- Testing
- Investment in innovation, sales or support
- Changes in top management team and company's board of directors
- Financing
- Headcount reduction, changing product pricing or fighting lawsuits

The number of competitive action events in each type was counted according to the date of company's announcements for starting taking the actions, not the date of closing off the actions.

4.7 Testing hypotheses

Hypotheses 1, 2, 5 and 6 were tested using the two independent samples t test for comparing means. The procedure tests the null hypothesis that the population mean of a variable is the same for two groups of cases. The level of significance for accepting the hypothesis was set at $p < 0.1$. That level of significance meant that the two groups of cases are different with respect to the tested variable. The procedure is explained below using hypothesis 1 as an example.

Hypothesis 1: VC financing is associated with higher action diversity.

The variable tested is action diversity and the two groups of cases to compare are the start-ups with VC financing and start-ups with no VC financing. The null hypothesis (H_0) is that the action diversity of start-ups with VC financing and start-ups with no VC financing is the same. If the t test reports $p > 0.1$, we cannot reject the null hypothesis that action diversity is the same. But we can reject hypothesis 1 since we have not concluded that start-ups with VC financing and start-ups with no VC financing have different action diversity. If the t test reports $p < 0.1$, we can conclude that the action diversity is different for start-ups with VC and with no VC financing. But we cannot accept hypothesis 1 yet. We first need to discover which diversity mean (with VC or with no VC financing) is higher.

Included in the results is the "mean difference" which is defined as the mean of group 1 minus the mean of group 2. In the above example, the mean difference would be:

Mean Difference = Mean action diversity (start-ups with VC financing) - Mean action diversity (start-ups with no VC financing).

A positive mean difference means that start-ups with VC financing have a higher mean for action diversity. So, if the t test results is significant at $p < 0.1$ and the mean difference is positive, hypothesis 1 will be accepted. Same logic was used for hypotheses 2, 5 and 6.

Hypotheses 3 and 4 were tested using correlation. Correlation coefficients were used to determine associations between asset ownership and the two dimensions of competitive aggressiveness for the full sample as well as for global and Canada/US market scopes. First normality of the data was checked and Spearman correlation was used, as all the variables were not normally distributed.

The bivariate correlations procedure computes the pair wise associations for a set of variables and displays the results in a matrix. The null hypothesis is that the two variables are not related to each other. The level of significance for accepting the hypothesis was set at $p < 0.1$. For example, testing hypothesis 3 (greater asset ownership is associated with higher action diversity), if the correlation coefficients in correlation test result is positive and significant at $p < 0.1$, it will conclude that greater asset

ownership is positively associated with action diversity in the full sample and thus hypothesis 3 can be accepted.

5. RESULTS

This chapter has four sections. The first section describes the sample. The second section provides descriptive statistics. The third section provides the results obtained when testing the hypotheses. The fourth section summarizes the results.

5.1 Sample

The sample was drawn from the OCRI-2003 database. This database includes the results of a survey conducted in 2003. It includes information on 1,532 companies operating in Ottawa as of December 2003.

Of the 1,532 companies in the OCRI database, 1,472 were excluded. The sample is comprised of 60 product companies (1,532 – 1,472) founded between 1998 and 2001.

Table 3 provides the breakdown of 1,472 companies excluded from the sample based on the reasons for their exclusion.

Table 3. Breakdown of the reasons companies were excluded from the sample

Reason for exclusion	No of companies
Founded prior to 1998	862
Founded after 2001	128
No information about starting date	26
Offer professional services only, do not develop products	227
Have five or fewer employees	135
Part of a multinational company or a branch office	22
Website is not accessible	48

No press releases on the web sites	16
Renamed or registered during 1998-2001, however, they were founded prior to 1998	5
Merged or acquired by other companies	2
Reseller of products developed by other companies	1
Total number of companies excluded from the OCRI database	1,472

5.1.1 Missing information on defining markets

For each company, the OCRI database identifies the five top markets. However, for eight of the 60 companies in the sample this information was missing. Information on the top markets was obtained from the eight companies' websites.

5.1.2 Results of the two-step cluster analysis

The two-step cluster analysis technique included in the SPSS software was used to classify start-ups in the global and Canada/US sub samples.

Table 4 provides descriptive statistics for the two sub samples and the overall sample.

Table 4. Descriptive statistics of the full sample and the Canada/US and Global sub-samples

	Market Scope		
	Canada/US	Global	Combined
Number of companies	30	30	60
Average number of employees in Ottawa	22.1	38.1	30.6
Number of companies with patent possession	10	9	19
Companies with venture capital financing	13	18	31

Appendix A provides industrial sector information for the companies in the two sub samples.

5.2 Data analysis

For the companies in the Canada/US and Global sub samples, Figure 2 provides the number of companies that were founded in each year.

Figure 2. Companies in the sample by year company started operating

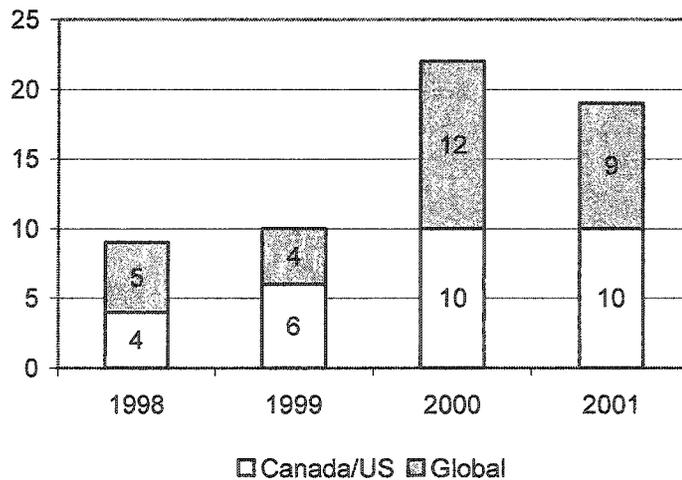


Figure 3 shows the number of companies for each industrial sector represented in the sample. It shows that 32 of the 60 companies in the sample develop and market software products.

Figure 3. Companies in the sample by industrial sector

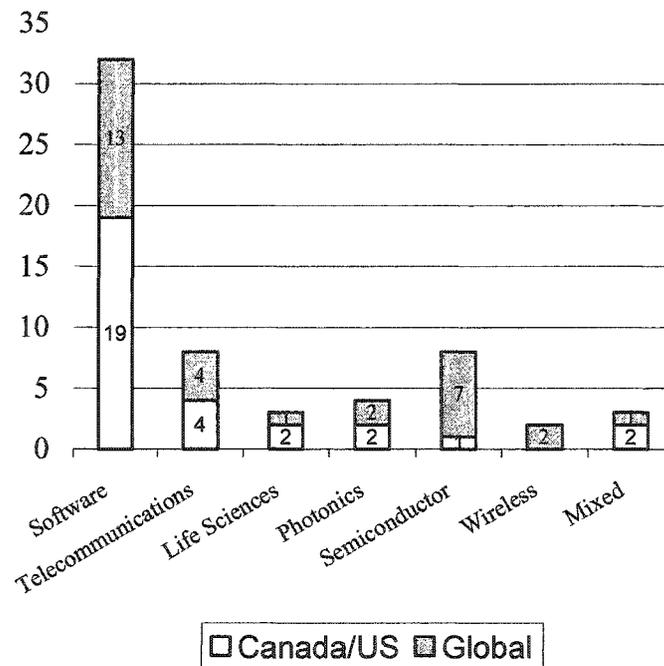


Table 5 provides the results for two independent sample t-tests undertaken to find differences in action diversity and action volume between the global and Canada/US start-ups. The "Mean Difference" column reports the difference in mean value between the global and the Canada/US start-ups.

Table 5. Two independent samples t test results

	Market scope	N	t-test for equality of means			
			t	Sig. (2-tailed)	Mean diff	Std. error diff.
Action diversity	Full sample	Global=30 Canada/US=30	2.047	.045**	.120	.059
Action volume	Full sample	Global=30 Canada/US=30	3.945	.000***	7.000	1.774

*p < 0.1, ** p < 0.05, *** p < 0.01

The level of significance and the positive mean suggest that:

- Action diversity was greater for companies in the global sub sample with $p < 0.05$.
- Action volume was greater for the companies in the global sub sample with $p < 0.01$.

Descriptive statistics

Table 6 provides descriptive statistics for asset ownership, action volume and action diversity for the full sample and for both sub samples.

Table 6. Descriptive statistics

	Market scope	N	Min	Max	Mean	Standard deviation	Skewness		Kurtosis	
							Statistic	Std. Error	Statistic	Std. Error
Action volume	Full Sample	60	0	38	9.40	7.674	1.438	.309	2.773	.608
Action diversity		60	.000	.872	.575	.234	-1.332	.309	1.258	.608
Asset ownership		60	1	6	3.72	1.208	-.143	.309	-.338	.608
Action volume	Global	30	0	38	12.90	8.759	1.010	.427	1.148	.833
Action diversity		30	.000	.872	.635	.215	-1.815	.427	3.421	.833
Asset ownership		30	1	6	3.70	1.236	-.085	.427	-.399	.833
Action volume	Canada /US	30	0	14	5.90	4.213	.368	.427	-1.058	.833
Action diversity		30	.000	.816	.515	.240	-1.136	.427	.674	.833
Asset ownership		30	1	6	3.73	1.202	-.212	.427	-.093	.833

Examination of the skewness and kurtosis statistics suggests that four variables are normally distributed: asset ownership for the full sample, asset ownership for the global sub-sample, asset ownership for the US/Canada sub-sample, and action volume for the Canada/US sub-sample. For each of these variables, skewness is within 2 times the

standard error of the skewness statistic and kurtosis is within -2 and +2. The other five variables are not normally distributed.

5.3 Hypotheses testing

Table 7 provides the two independent samples t test results for hypotheses 1, 2, 5 and 6. The "Mean Difference" column reports the difference in mean value between the two groups compared in the test. The "Sig. (2-tailed)" column represents the significance of the comparison result. The numbers of cases in both groups for each t-test are given in the column 'N'

Table 7. Two independent samples t test results for hypotheses testing

		Market Scope	N	t-test for Equality of Means			
				t	Sig. (2-tailed)	Mean Diff	Std. Error Diff.
VC financing is associated with higher action diversity.	H1	Full	VC financing =31 No VC financing =29	5.465	.000***	.274	.050
	H1a	Global	VC financing =18 No VC financing =12	3.077	.005***	.217	.071
	H1b	Canada/US	VC financing =13 No VC financing =17	4.850	.000***	.305	.063

VC financing is associated with higher action volume.	H2	Full	VC financing =31 No VC financing =29	3.167	.002***	5.846	1.846
	H2a	Global	VC financing =18 No VC financing =12	1.608	.119	5.111	3.178
	H2b	Canada/US	VC financing =13 No VC financing =17	3.402	.002***	4.520	1.329
Patent possession is associated with higher action diversity.	H5	Full	Patent=19 No patent=41	.450	.654	.029	.065
	H5a	Global	Patent=9 No patent=21	1.111	.276	.095	.085
	H5b	Canada/US	Patent=10 No patent=20	-.248	.806	-.023	.094
Patent possession is associated with higher action volume.	H6	Full sample	Patent=19 No patent=41	-.597	.553	-1.279	2.141
	H6a	Global	Patent=9 No patent=21	-.408	.686	-1.444	3.541
	H6b	Canada/US	Patent=10 No patent=20	-.362	.720	-.600	1.657

*p < 0.1, ** p < 0.05, *** p < 0.01

The t test results indicate that:

- We can reject the null hypothesis that the mean difference is equal for H1, H1a, H1b, H2 and H2b with $p < 0.01$. The mean difference is also positive for these five hypotheses. Together, the level of significance and the positive mean difference tells us that action diversity was greater for the start-ups with VC financing for full sample as well as for global and Canada/US start-ups' market scopes; actions volume was greater for the start-ups with VC financing for the full sample and Canada/US start-up's market scope. We can thus accept hypotheses H1, H1a, H1b, H2, and H2b.
- We cannot reject the null hypothesis that the mean difference is equal for hypotheses H2a, H5, H5a, H5b, H6, H6a, and H6b. So we can reject those hypotheses since we cannot conclude that there is a difference in the means of those variables.

Hypotheses H3 and H4 posit that greater asset ownership is associated with higher action diversity and action volume respectively.

Table 8 provides the Spearman correlation coefficients between asset ownership and the two dimensions of competitive aggressiveness.

Table 8. Spearman correlation coefficients between asset ownership and the two dimensions of competitive aggressiveness (two tailed)

	Asset ownership		
	Full sample (n=60)	Global (n=30)	Canada/US (n=30)
Action diversity	.224 (.086*)	.329 (.076*)	.137 (.471)
Action volume	.082 (.535)	.167 (.377)	.012 (.949)

p < 0.1, ** p < 0.05, *** p < 0.01

Two tailed tests of the alternative hypotheses at $p < 0.1$ show the following associations:

1. Greater asset ownership is positively associated with action diversity in the full sample.
2. Greater asset ownership is positively associated with action diversity in the global market scope.

Therefore, the results support hypotheses 3 and 3a.

We cannot reject the null hypothesis that asset ownership is not related to action diversity for the Canada/US subsample. Therefore, we reject hypothesis 3b. Also we cannot reject the null hypotheses that asset ownership is not related to action volume for total sample and the global and Canada/US subsamples. Therefore, we reject hypotheses 4, 4a and 4b.

5.4 Summary of the results organized by hypothesis

Table 9 provides the results of testing the hypotheses using the independent sample t-test and the Spearman correlation results shown in Tables 7 and 8 respectively.

A hypothesis was supported when:

The corresponding t-test given in table 7 was significant at $p < .10$ and were in the same direction as expected.

or

The result from the Spearman's correlation analysis shown in Tables 8 supports the hypothesis at $p < .10$

A hypothesis was not supported when the corresponding t-test or Spearman's correlation were not significant at $p < .10$ or was in the opposite direction.

Table 9. Summary of test results organized by hypothesis

Hypothesis	Decision based on test results	Rationale
Hypothesis 1: VC financing is associated with higher action diversity.	Supported	t-test result shown in table 7 is significant at $p < 0.01$ and also the 'mean' difference is positive
Hypothesis 1a: VC financing is associated with higher action diversity for global	Supported	t-test result shown in table 7 is significant at $p < 0.01$ and also the 'mean' difference is

start-ups.		positive
Hypothesis 1b: VC financing is associated with higher action diversity for Canada/US start-ups.	Supported	t-test result shown in table 7 is significant at $p < 0.01$ and also the 'mean' difference is positive
Hypothesis 2: VC financing is associated with higher action volume.	Supported	t-test result shown in table 7 is significant at $p < 0.01$ and also the 'mean' difference is positive
Hypothesis 2a: VC financing is associated with higher action volume for global start-ups.	Failed to support	t-test result shown in table 7 is not significant at $p < 0.1$
Hypothesis 2b: VC financing is associated with higher action volume for Canada/US start-ups.	Supported	t-test result shown in table 7 is significant at $p < 0.01$ and also the 'mean' difference is positive
Hypothesis 3: Greater asset ownership is associated with higher action diversity.	Supported	Spearman correlation shown in table 8 is significant at $p < 0.1$
Hypothesis 3a: Greater asset ownership is associated with higher action diversity for global start-ups.	Supported	Spearman correlation shown in table 8 is significant at $p < 0.1$

Hypothesis 3b: Greater asset ownership is associated with higher action diversity for Canada/US start-ups.	Failed to support	Spearman correlation shown in table 8 is not significant at $p < 0.1$
Hypothesis 4: Greater asset ownership is associated with higher action volume.	Failed to support	Spearman correlation shown in table 8 is not significant at $p < 0.1$
Hypothesis 4a: Greater asset ownership is associated with higher action volume for global start-ups.	Failed to support	Spearman correlation shown in table 8 is not significant at $p < 0.1$
Hypothesis 4b: Greater asset ownership is associated with higher action volume for Canada/US start-ups.	Failed to support	Spearman correlation shown in table 8 is not significant at $p < 0.1$
Hypothesis 5: Patent possession is associated with higher action diversity.	Failed to support	t-test result shown in table 7 is not significant at $p < 0.1$
Hypothesis 5a: Patent possession is associated with higher action diversity for global start-ups.	Failed to support	t-test result shown in table 7 is not significant at $p < 0.1$

Hypothesis 5b: Patent possession is associated with higher action diversity for Canada/US start-ups.	Failed to support	t-test result shown in table 7 is not significant at $p < 0.1$
Hypothesis 6: Patent possession is associated with higher action volume.	Failed to support	t-test result shown in table 7 is not significant at $p < 0.1$
Hypothesis 6a: Patent possession is associated with higher action volume for global start-ups.	Failed to support	t-test result shown in table 7 is not significant at $p < 0.1$
Hypothesis 6b: Patent possession is associated with higher action volume for Canada/US start-ups.	Failed to support	t-test result shown in table 7 is not significant at $p < 0.1$

6. DISCUSSION OF RESULTS

The objective of this research was to study the relationship between commercialization strategy and competitive aggressiveness for technology start-ups. A research model that integrates the literature on a start-up's commercialization strategy and its competitive aggressiveness was developed. Six sets of hypotheses anchored around the research model were generated. These hypotheses were tested using a sample of 60 start-ups, 30 of which addressed global markets and 30 of which addressed the Canada/US market. Independent sample t-tests and Spearman's correlation analysis were used for the purpose of testing the hypotheses.

6.1 Commercialization strategy and action diversity

The results suggest that:

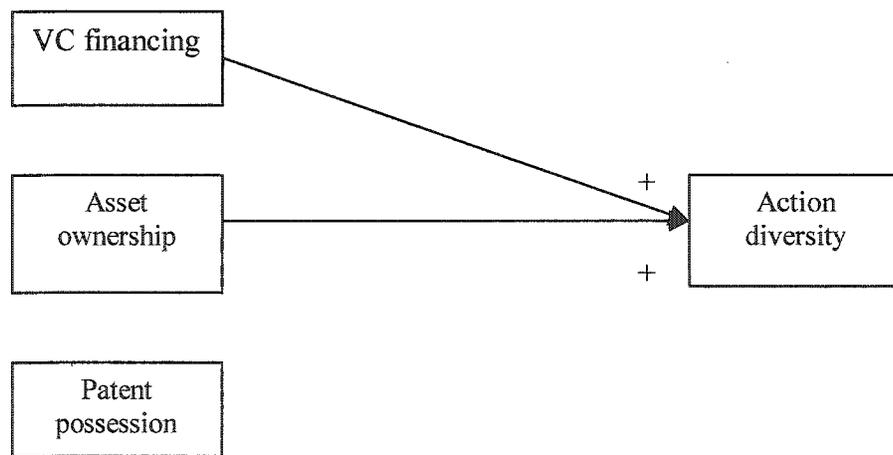
1. VC financing and complementary assets ownership are positively related to a start-up's action diversity.
2. Patent possession does not affect a start-up's action diversity.

VC financing increases TMT diversity and company liquidity and in turn, higher TMT diversity and liquidity increase action diversity. Based on the literature it was expected that start-ups with greater asset ownership would have greater action diversity. The literature on commercialization strategy (Gans et al., 2002; Gans & Stern, 2003; Teece, 1988) suggests that start-ups have limited options at their disposal when they have less asset ownership. The results of the study suggest that the extent of a start-up's asset ownership affects action diversity.

The commercialization literature (Gans et al., 2002; Jorde & Teece, 1989; Teece et al., 1997) also suggests that patent possession reduces the start-up's fear of imitation of its technology. It was expected that a start-up could carry out more types of actions when it possesses a patent. However, the results suggest that the start-up's ability to make diverse types of actions does not depend on patent possession.

Figure 4 illustrates the findings discussed above.

Figure 4. Results of testing the relationship between start-up's commercialization strategy and its action diversity



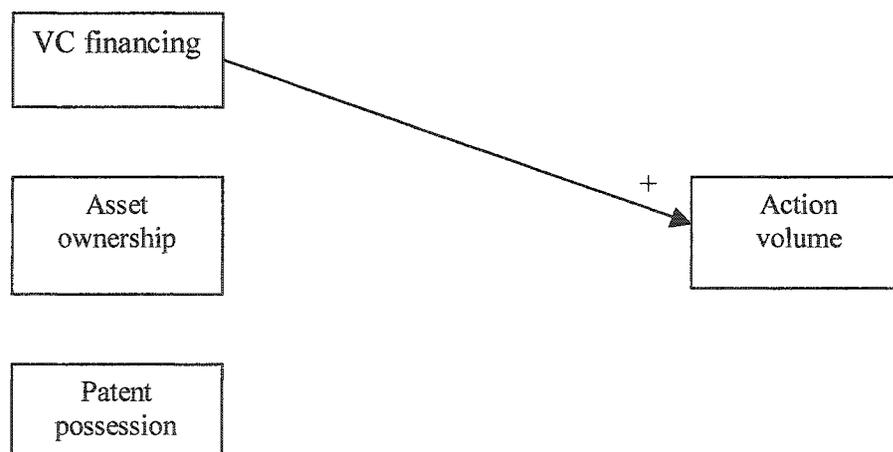
6.2 Commercialization strategy and action volume

The results suggest that VC financing is positively associated with the start-up's action volume and that the extent of asset ownership and patent possession do not affect action volume.

VC financing increases TMT diversity. Competitive aggressiveness research (Hambrick et al., 1996; Knight et al., 1999) suggests that greater TMT diversity results in low action volume. The rationale is that a TMT with high diversity will have more conflicts to resolve and this reduces the number of actions undertaken in a period. The results from this research suggest that an increase in TMT diversity as a result of VC financing increases action volume. A potential explanation may be that the competitive aggressiveness literature focuses on the identification and selection of the actions, not the execution of actions. Once VC financing is obtained, the start-up will execute quickly. VC financing is not obtained before the decisions on what actions to undertake are made. This results in low interpersonal conflicts because of the lower ambiguity.

Figure 5 illustrates the results discussed above.

Figure 5. Results of testing the relationship between a start-up's commercialization strategy and its action volume



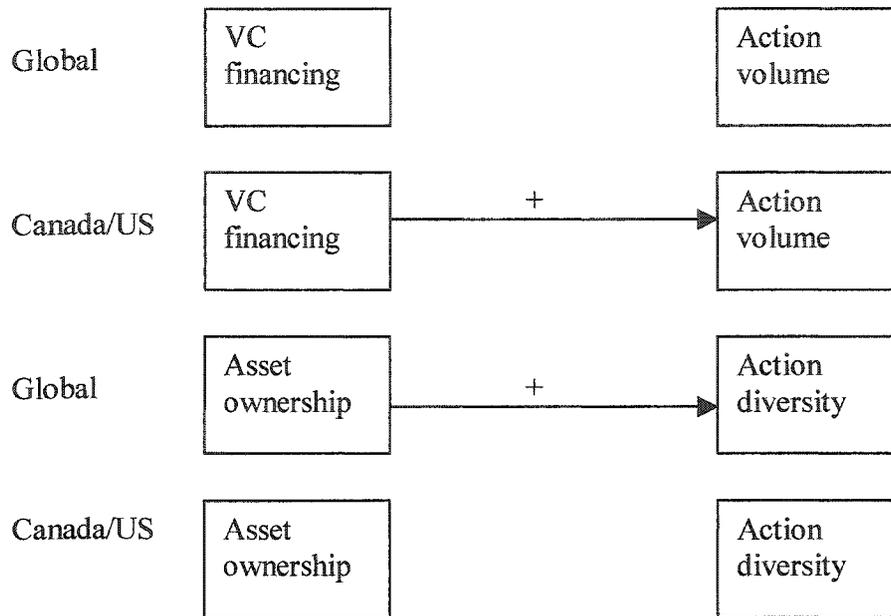
The findings presented in sections 6.1 and 6.2 provide new antecedents for competitive aggressiveness. To date the literature focused on top management heterogeneity, liquidity and past performance whereas this study put forward VC funding and asset ownership as two new factors contributing to competitive aggressiveness of start-ups.

Existing studies on competitive aggressiveness suggest that company's aggressiveness is positively related to its performance. The results of this study suggest that start-up's aggressiveness (and therefore performance) can be enhanced via venture capital financing and greater assets ownership. This study recommends that policy makers can help the start-ups by giving incentives to venture capital firms for their investment in the start-ups. Also, most start-ups don't have enough resources to buy the required assets. Regional policy makers can arrange common assets required by the majority of start-ups for commercialization of their products. This arrangement will help reduce the commercialization cost for the start-ups as they have access to these assets without paying for their ownership.

6.3 Market scope as a moderating variable

The results suggest that a start-up's market scope affects (i) the relationship between VC financing and action volume, and (ii) the relationship between asset ownership and action diversity. Figure 6 illustrates these results.

Figure 6. Market scope as a mediating variable



VC financing affects the action volume of the Canada/US start-ups, not the global start-ups. This means that the increase in the TMT diversity and start-up's liquidity as a result of VC financing, affects competitive aggressiveness only when it is selling to Canada/US customers and not globally. A possible explanation could be that action execution speed is less due to uncertainty of operating globally in spite of an agreement on the strategic direction of the start-up with the VCs.

Greater asset ownership increases the action diversity of global start-ups. This could be explained as a start-up, with the freedom of more asset ownerships, executes more types of actions to overcome different challenges if it is operating in global market. On the

other hand, a start-up operating only in Canada/US may not need to execute many kinds to actions even with more assets ownership.

We reason that start-ups addressing global markets could help each other by arranging a common pool of complementary assets required for the commercialization of their products in the global markets. Regional policy makers can facilitate this effort. Start-ups can have access to a greater number of assets at much lower costs compared to the alternative of owning these assets themselves.

7. CONCLUSIONS, LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

7.1 Conclusions

The results of this thesis suggest that global start-ups are more aggressive than Canada/US start-ups in terms of the diversity and volume of the actions that they carry out.

For the full sample and Canada/US sub-sample, VC financing is positively related to action diversity and action volume. For the global sample, VC financing is positively associated with action diversity and is not related to action volume.

For the full sample and the two sub-samples (global and Canada/US), greater asset ownership is not related to action volume. Moreover, for the full sample and the global sub-sample, greater asset ownership is positively related to action diversity.

Market scope was found to mediate two relationships: i. the relationship between VC financing and action volume; and ii. the relationship between asset ownership and action diversity.

7.2 Limitations

The sales data required to measure start-up's performance was not available in the OCRI database. This prevented the researcher from studying the relationship for commercialization, aggressiveness and performance.

The sample drawn for this research was comprised of Ottawa start-ups only. The results of this research cannot be generalized to companies founded outside of Ottawa.

The third limitation is that this research studied only start-ups founded between 1998 and 2001. Results could be stronger if multiple cross section studies of the commercialization-aggressiveness relationship had been undertaken.

The fourth limitation is that the role of market scope as a mediator for the relationship between commercialization strategy and aggressiveness is tested only for two subsamples: global and Canada/US. There is no attempt in this thesis to generalize the results to other markets (e.g., European or Asian markets).

7.3 Suggestions for future research

This study can be replicated to identify the differences in relationship between commercialization strategy and aggressiveness for pure product companies and companies that offer products and services.

Another suggestion for future research is to explore the consequences of competitive aggressiveness for start-ups. This requires using data other than sales to measure a start-ups performance.

The study of the relationship between commercialization strategy and competitive aggressiveness for start-ups can be extended by defining market segments other than global and Canada/US.

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Appendix A. Cluster analysis results

<u>Cluster No. 1</u>	
Size=30 (50 %)	
Market Scope = Canada/USA	
<u>Industrial sectors</u>	<u>No. of Companies</u>
Software	=19
Telecommunications	=4
Life Sciences	=2
Photonics	=2
Semiconductor	=1
Wireless, Life Sciences	=1
Software, Semiconductor	=1

<u>Cluster No. 2</u>	
Size= 30 (50 %)	
Market Scope = Global	
<u>Industrial sectors</u>	<u>No. of Companies</u>
Software	=13
Semiconductor	=7
Telecommunications	=4
Photonics	=2
Wireless	=2
Life Sciences	=1
Telecommunications; Semiconductor	=1

Note: Some companies are operating in more than one industrial sector.

Appendix B. Companies in the sample

	Company Name	Website
1	Advanced Bioelectric Corporation (AB)	www.advancedbioelectric.com
2	AmikaNow! Corporation	www.amikanow.com
3	Atreus Systems	www.atreus-systems.com
4	Atsana Semiconductor Corp. (formerly LUMIC Electronics Inc.)	www.atsana.com
5	Blueair Networks	www.blueairnetworks.com
6	BTI Photonic Systems Inc.	www.btiphotonics.com
7	Circumference Technology Services Inc.	www.circumference.ca
8	Customer Expressions	www.customerexpressions.com
9	DataJungle Corp.	www.datajungle.com
10	DNA Genotek	www.DNAGenotek.com
11	DragonWave Inc.	www.dragonwaveinc.com
12	Eedo Knowledgeware Corporation (formerly Knowledgelinx)	www.eedo.com
13	EION Inc.	www.eion.com
14	Elliptic Semiconductor	www.ellipticsemi.com
15	eManage Inc.	www.emanagecorp.com
16	GALAZAR Networks	www.galazar.com
17	GoodContacts	www.goodcontacts.com
18	GreenButton Studio Inc.	www.greenbutton.ca
19	GridIron Software Inc.	www.gridironsoftware.com
20	Halogen Software	www.halogensoftware.com
21	HR-DEPT.COM	www.hr-dept.com
22	IceFyre Semiconductor Inc.	www.icefyre.com
23	Icinergy Software	www.icinergy.com
24	Idokorro Mobile	www.idokorro.com
25	Information Mediary Corporation (IMC)	www.informationmediary.com
26	Intelligent Photonics Control Corp.	www.photonicscontrol.com
27	Ionalytics Corporation	www.ionalytics.com
28	IP Unwired Inc.	www.ipunwired.com
29	Iridian Spectral Technologies	www.iridian.ca
30	klocwork Inc.	www.klocwork.com
31	LPI Level Platforms Inc.	www.levelplatforms.com
32	March Networks Corp.	www.marchnetworks.com
33	Meriton Networks (formerly edgeflow Inc.)	www.meriton.com
34	MetroPhotonics Inc.	www.metrophotonics.com
35	N-able Technologies (Nitrosoft Linux)	www.n-ableit.com
36	Nakina Systems	www.nakinasystems.com
37	Natural Convergence Inc.	www.naturalconvergence.com
38	Axentra™ Corporation (OEone Corporation)	www.OEone.com

39	Pleora Technologies Inc.	www.pleora.com
40	Potentia Semiconductor Corp.	www.potentialsemi.com
41	PrairieFyre Software Inc.	www.prairiefyre.com
42	Precidia Technologies	www.precidia.com
43	Quake Technologies Inc.	www.quaketechnology.com
44	Roaring Penguin Software Inc.	www.roaringpenguin.com
45	S2io Technologies	www.s2io.com
46	Seaway Networks Inc.	www.seawaynetworks.com
47	SiberCore Technologies	www.sibercore.com
48	Signiant Inc	www.signiant.com
49	Sigpro Wireless Inc.	www.sigprowireless.com
50	SiteBrand Inc.	www.sitebrand.com
51	SofTV.net	www.softv.net
52	Spotwave Wireless (Formerly DPS Wireless Inc.)	www.spotwavewireless.com
53	StorageQuest	www.storagequest.com
54	Tomoye	www.tomoye.com
55	Tropic Networks Inc.	www.tropicnetworks.com
56	TrueContext Corporation	www.truecontext.com
57	Unlimi-Tech Software Inc.	www.utechsoft.com
58	Versatel Networks Inc.	www.versatelnetworks.com
59	VisionSphere Technologies	www.visionspheretech.com
60	webHancer Corp.	www.webhancer.com