# Innovation and Firm Survival in Start-Ups

Joseph Floyd

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Telfer School of Management
University of Ottawa

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**Abstract**

Using data from the Kauffman Firm Survey (KFS), this thesis explores the effects that innovation activities has on the survival of new firms. The KFS follows 4,928 American start-ups from 2004 to 2011. A probit model is used to examine the relationships that may exist between a number of different variables relating to innovation and survival. The results indicate that firms that invest in research and development (R&D) and machinery and equipment persistently are more likely to survive than those that do not, or those that only invest once in these types of innovative business activities. Also, with regards to intellectual property (copyrights, trademarks and patents), firms that hold these types of intellectual property have a better chance of survival than those that do not hold any intellectual property.

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## 1. Introduction

This thesis will investigate the characteristics of start-ups that survive and grow, using a freely available statistical database on newly-established firms. The Kauffman Foundation collected data on newly-founded firms that were started in 2004, from 2004 until 2011 through the Kauffman Firm Survey (KFS). The KFS investigated the strategy of newly-established firms, the characteristics of the founders, and the financial and organizational structure of newly-established firms.

The results of this thesis are of keen interest to policy makers in Canada and abroad. Policy makers would like to better understand not only why firms survive but the drivers of business growth - growth that can lead to increased taxation revenues as well as more employment opportunities. Moreover, policy makers could use the results for the purpose of developing evidence-based interventions aimed at facilitating greater business survival rates and growth. The results will also be of interest to academics in the entrepreneurship domain.

The focus of this thesis is to address the above-mentioned gaps in the research literature. This thesis provides an impetus for the following questions:

1. Does spending on innovation activities help or hinder the survival of start-ups?

2. If so, should investment innovation activities be persistent or is a "one and done" approach sufficient?

## 2. Literature Review

Over the past three decades, there has been a great deal of interest in using basic financial/business data collected on firms, typically by national statistical agencies, to explore the topic of firm growth and survival. Academics tend to view growth and survival as important because they want to understand the reasoning and rationale for why those firms have superior

business performance and fit within the economic environment compared to those that either do not grow or do not survive. Governments from across the economic development spectrum are keenly interested in these growth firms, given their belief (not always well established by research) that such firms are essential for creating jobs, increasing exports and taxation revenues required to serve the wants and needs of their populations. Governments' beliefs appear to be stubbornly related to early research by Birch (1979, 1981, 1989) that suggests that a small number of high-growth firms were responsible for the vast majority of all job creation in developed economies. However, this research has been criticized, by Brown et al. (1990), Davis et al. (1996) and Haltiwanger and Krizan (1999) as they do not believe small firms are the most important source of job creation.

While primarily methodological problems have questioned previous work, for example; Gibrat's Law (firm growth is unrelated to initial firm size), subsequent work has not been capable of moving the study of growth firms substantially forward. Furthermore, very little has been established, and almost nothing has been said about the relationship between firm strategy and growth using anything more generalizable than multi-firm case studies (Prahalad & Hamel, 1994; Christensen, 1994,1996).

The United Kingdom may well have the most highly developed research initiatives into the characteristics of growth firms. In particular, a recent report supported by the independent UK research organization NESTA identified the 'Vital 6%', which is the percentage of high-growth firms which accounted for over half of all employment growth in the UK over the period of 2002-2008. These firms spanned the ranges of firm size and age.

The implications of this work for entrepreneurship researchers and policy makers have, to date, not been well considered. The previous belief that new firms accounted for the vast majority of employment growth in developed countries has been sufficiently discredited, and the NESTA work indicates that employment growth is highly concentrated, however, not

necessarily within newly-established small firms (NESTA, 2009). Thus, entrepreneurship researchers and policy makers need to decide where to focus their attentions, if they aspire to encourage firm survival and employment growth in entrepreneurial firms. Shane (2009) has persuasively argued that governments should not take the simplistic view that entrepreneurship is good, and more entrepreneurship is better, given the serious consequences of business failure, and the strong likelihood of failure for start-ups. However, this argument is one against starting new businesses that are likely to fail, and not against the survival of existing firms.

Logically, a relationship should exist between firm survival and growth, in that firms which are able to grow (for example as measured by revenues) should be more capable of survival than those firms which are not able to grow. This argument is based on the assumption that firms that are growing are performing better than those that remain stagnant or are in decline. The relationship, however, may not be linear, as expenses can be volatile and exceed even strong revenue growth. Innovative firms, in particular, can experience such volatility when they are required to make investments into both physical capital (such as machinery and equipment) and intellectual capital (such as patents, trademarks and copyrights) where the benefits may only be realized over an extended period of time (say three to five years).

**Firm Age**

The literature with regards to growth and firm age does not vary much and is fairly consistent. Researchers tend to agree that growth seems to happen primarily in the first few years of firm existence. David Birch was one of the first researchers to look at how an enterprise's age affects its growth. Birch reports that about 80 percent of the replacement jobs are created by establishments four years old or younger, which led to the conclusion that mature and large firms were not the major source of job creation in the United States (Birch, 1981).

In the United States, Acs (2005) finds that net job creation in the US comes from businesses in their first or second year of operation. Fritsch and Mueller (2004), Mueller, Van Stel and Storey (2008) and Acs and Mueller (2008) all find compelling evidence that a high share of the employment growth is accounted for by new firm start-ups. These findings fit perfectly with what Birch (1981) and Acs (2005) have already suggested and why we see a push from governments from around the globe to promote start-ups and small businesses. This work would seem to suggest a relationship akin to the 'Vital 6%' as identified in work by NESTA (2009). With regards to survival and sustainability in Canada, about 80 percent of enterprises that entered the marketplace in 2008 survived for one full year and 72 percent of enterprises that entered the marketplace in 2007 survived for two years (Industry Canada, 2013).

Schreyer (2000) goes a step further to suggest a link between age, size and growth and suggests that for any given size, the proportional growth rate of firms tends to decline with age. At the same time, older firms have a greater probability of survival than younger ones. This result is a catch twenty-two for entrepreneurs as young enterprises are more likely to grow, but older enterprises are more likely to survive.

Audretsch (1995) also finds that compared to incumbent firms, new firms are naturally more likely to fail because of the higher risks associated with starting-up businesses. But when they do survive for a certain period of time, their growth trajectory leaps past that of incumbent firms, which is why their contribution to job growth is so important.

**Firm Size**

The relationship between enterprise size and growth varies from study (Harhoff and Stahl, 1995 and Hart and Oulton, 1996) to study (Dixon and Rollin, 2012 and Wagner, 1992), while the relationship between size and survival is more definitive. Many studies find a negative relationship between size and growth, while others disagree and argue that little to no relationship exists between the two. For example, Harhoff and Stahl (1995)

and Hart and Oulton (1996) both find that firm growth is negatively related to firm size. However, Dixon and Rollin (2012) and Wagner (1992) find little evidence to support the contention that small firms have proportionately higher rates of employment growth. Moreover, they find that it is not true that as we move across the spectrum of size classes from the very smallest to the very largest, growth rates decline monotonically with size. Dixon and Rollin (2012) also find that there is evidence that average growth rates increase initially as firms grow in size and move across the spectrum of size classes from the very smallest to the very largest.

Geroski (1995) reports that when a broad spectrum of firm sizes is included in samples of enterprises in the United States, smaller firms exhibit systematically higher growth rates than their larger counterparts. This result would suggest that smaller firms have a better chance to grow than larger firms, and if these smaller firms do grow, they are more likely to survive. Geroski's findings seem to match those of Birch (1981), in that of all the net new jobs created in his sample of 5.6 million businesses between 1969 and 1976 in the United States, two-thirds were created by firms with 20 or fewer employees. Moreover, firms with fewer than 100 employees created 82 percent of the jobs over the same period of time. Picot, Baldwin and Dupuy (1994) report that the small firm sector has accounted for a disproportionate share of both gross job gains and job losses, and in the aggregate, has accounted for a disproportionate share of employment increase over the 1978-1992 period.

With regards to size and survival, research results indicate that firm size is an important predictor of survival. Several studies have established that larger firms have been found to experience higher survival probabilities than smaller firms (Dunne, Roberts and Samuelson 1989, Audretsch and Mahmood 1994, Mata and Portugal 1994, Mitchell 1994, Haverman 1995, Sharma and Kesner 1996). Mata and Portugal (1994) find that a relationship exists between survival rates and initial firm size that persists across size classes. Furthermore, survival increases monotonically with size, regardless as to how many years later

that survival is observed. Geroski (2010) reports similar results, as he suggests that there is a non-instantaneous increase in survival prospects as a firm's size increases. However, this situation puts new firms in a predicament as Audretsch (1995) contends that initial size is positively related to survival, but negatively related to post-entry growth. This apparent contradiction means that an entrepreneur must make a difficult decision to either enter the market small and hope to survive because if they do survive, they are more likely to grow, or to enter the market bigger and have a better chance of survival but have a harder time growing than those that started smaller.

**Firm Growth**

Looking at Canadian growth firms, we see that strong rates of growth on employment growth firms, which Industry Canada defines as firms with between 50 and 150 percent over four years, had the highest survival rates with nearly 70 percent of these businesses still operating six years after a four-year triage period. Slow growth firms, which Industry Canada defines as firms with positive growth in employment of less than 50 percent over four years, had a survival rate of 67 percent after the same period, while hyper-growth firms, which Industry Canada defines as firms with at least 150 percent in employment over four years, had a survival rate of 64 percent (Industry Canada, 2008). One possible explanation as to why hyper-growth firms had a lower survival rate than strong growth firms is that there seems to be a risk trade-off between growth and survival. Thus, some hyper-growth firms were most likely growing beyond their means and were simply unable to manage this rapid growth.

This research differs from the work that Harhoff and Stahl have undertaken on German firms in the manufacturing, construction, trade, finance and services industries. Harhoff and Stahl (1995) find evidence that the likelihood of survival is positively related to firm size and that firm growth is negatively related to firm size. Audretsch, Santarelli and Vivarelli (1999) report similar results in that growth rates are negatively related to firm size and that the likelihood of survival is greater in the

start-up year than in the second year, but subsequently increases over time. Thus, as firms get older they have a greater chance of survival, however, the larger the firm is, the less likely it is to grow as rapidly as smaller firms.

**Research Using KFS**

As indicated in the previous review, researchers have a keen interest on how enterprise age and size affects their growth and survival. Although the findings are at times conflicting, it still is important to study this relationship in order to better understand how size affects survival. What literature already exists on the topics of growth and survival that uses the KFS data? Furthermore, what literature exists that focuses on innovation that may provide insight into the business activities that could be a predictor to survival?

The KFS has been widely used for research with regards to firm growth and survival, Cole and Sokolyk (2014) focus their research on debt financing, survival and growth of start-up firms and how different forms of debt financing (personal and business) at firms' start-up affect their survival and growth. In order to examine these issues, they use the KFS data to analyze the amounts of financial credit used by start-ups and compare that to their variables of interest (revenue, assets, ownership, etc). They find that firms using debt financing at start-up are significantly more likely to survive and achieve higher growth than other firms that do not.

Nasserddine (2012) also examines at survival but from three additional perspectives. His first approach looks at the founding and current conditions on survival. In doing so, he investigates owners' relevant experience as well as firms' debt leverage. He finds that relevant experience is a positive predictor of survival but higher debt levels have a negative effect on survival when they have not been justified by acquiring assets. The second way in which he examines survival

is to determine if any differences exist between product and service start-ups and their likelihood of survival. He reports that service providers have a greater probability of survival in comparison to product-based firms.

His third approach to survival attempts to identify differences in the survival of start-up firms based on the gender of the lead entrepreneur. With this last analysis, Nasserddine finds that female-owned firms are more likely to fail than male-owned firms and that over time, female-owned firms are more likely to be operated from home, compared to those of their male counterparts.

Coleman and Robb (2014) also use the KFS to research growth firms but focus their research on access to capital by high-growth female-owned businesses. They investigate the differences between male and female business owners for firm growth, amount and sources of financial capital, and the relationships between these factors. In order to do this, they use KFS data but with a threshold of a minimum of five employees, rather than the OECD industry standard of a minimum of 10 employees. Further, they investigate both growth expectations as well as actual growth during a three-year period for both revenues as well as employees. They find that female-owned firms usually have lower employment growth compared to male-owned firms. Moreover, they report that on average, men start firms with about double the amount of capital as women.

Doms, Lewis and Robb (2010) investigate the relationship between education and the establishment, performance and survival of new businesses. They use employment growth, revenue growth, profit and assets from a three-year period of the KFS and attempt to relate the performance of firms within these categories to the owner(s)' education level. They observe that the level of education of entrepreneurs is strongly related to positive business growth. They also find that more highly educated entrepreneurs tended to be located in metropolitan areas and employ relatively higher-educated workforces. Finally, highly-

educated areas are observed to experience above average rates of entrepreneurship.

Pergelova and Angulo-Ruiz (2014) also use the KFS data to research firm performance but they focus on how government financial support influences the performance of new firms. In order to do this, they examine the impact of government financial support measures on firms' competitive advantage and more specifically, their innovation, licensing-in, marketing and human capital and ultimately, how these variables affect their financial performance. Using the KFS, they find that revenues and profits should not be the first outcomes on which public policies should be based, but rather competitive advantages might be a better indicator of firm performance.

**Innovation**

Several other different determinants of growth and survival exist for businesses today. These determinants vary from country to country, and even region to region, as each country is unique in terms of the advantages and disadvantages which exist for businesses that operate within its boundaries. These determinants to growth and survival include a business's growth orientation, access to resources, human capital, social capital, financial capital, innovation activities and intellectual property (Barro, 1996). All of these variables are available on the KFS dataset which allows for the investigation of any relationship that may exist between those variables and survival.

Specifically, with regards to this thesis, innovation and intellectual property are two areas that are examined to evaluate if either are relevant to growth and survival. With regards to innovation, Christensen (1997) states that innovation is important for survival, not only for new firms introducing new products or creating new markets, but also for incumbent firms that need to continuously innovate to face the threat of disruption from new technologies. Cefis and Marsili (2006) build on this previous work and find that a positive and significant effect of innovation on the probability of survival in Dutch

manufacturing firms increases over time and is conditional on firm age and size.

When one thinks of innovation, it is often associated with R&D as the R&D process is so closely linked to innovation activities. Looking specifically at R&D, Hall (1987) reports that the intensity of R&D expenditure increases the survival probability, and that this effect is stronger for firms that do not patent than for firms that do. Fontana and Nesta (2009) report similar results, in that the effect of R&D intensity is positive on firm survival. Pérez, Llopis and Llopis (2004) find that firms that invest in R&D activities experience a 57 per cent lower exit risk than firms that do not.

Intellectual property can be seen as an extension of innovation and as such, it is important to understand any potential relationships between IP and survival as well. Helmert and Rogers (2008) analyse the survival of approximately 162,000 British firms in 2001 over a five-year period. Their results indicate that IP activity is associated with a higher probability of survival, specifically national patents and trademarks are significant in improving survival. Buddelmeyer, Jensen and Webster (2010) look at 300,000 Australian firms and find that past successful radical innovations, as proxied by the stock of patents, and incremental innovation investment (new-to-company), measured by trademark applications, are associated with higher company survival rates.

Given this discussion of existing work in the field, the variables of interest become clear. Survival is the dependent variable to be used in the following analysis.

In terms of the independent variables, there are numerous variables that could be used to investigate whether or not a relationship exists with the dependent variable of survival. Our primary interest in this study is to investigate the relationship, if any, between innovation and firm survival. As such, our independent variables consist of a number of known proxies of innovation. They are summarized in Table 1, along

with the relationship to firm survival that exists in the literature.

Looking at survival from an innovation perspective, it should not be surprising that innovation and survival are related. Firms that innovate are able to offer a good or service to the market that is new or different, allowing firms to differentiate themselves from their competitors. When firms have this competitive advantage, it gives them an opportunity to obtain new customers or retain the customers that they already have. Looking at start-ups, it is even more evident that they need to distinguish themselves from their competitors in order to survive. They are entering the marketplace with no market share and must offer some sort of value proposition to attract customers. Audretsch (1991) exemplifies this point in his research where he finds that although entrepreneurs may be unsure about their ability to innovate upon establishing a new firm, the need to innovate becomes clearer as time passes. Those firms that successfully innovate can expect future sales growth, while those that are less likely to innovate are more likely to exit from the industry. Audretsch goes even further by stating this "innovate or exit" strategy is even more accurate in capital-intensive industries as an even greater likelihood exists of new firms which are forced to exit because they do not have the scale and are less efficient as established firms. Cefis and Marsili (2004) find similar results by looking at manufacturing firms in the Netherlands and find that in general, the expected survival time of an innovative firm is about 11 per cent higher than that of a non-innovative firm.

Table 1

Summary of Independent Variables

| **Variable** | **Expected Impact on Survival** | **Supporting Literature** |
|---|---|---|
| Size (employment and revenue) | Positive | Audretsch and Mahmood (1994)<br>Mata and Portugal (1994)<br>Mitchell (1994)<br>Dunne, Roberts and Samuelson (1989)<br>Harhoff and Stahl (1995)<br>Geroski (1995)<br>Haverman (1995)<br>Sharma and Kesner (1996) |
| Investing in research and development (R&D) | Positive | Hall (1987)<br>Pérez, Llopis and Llopis (2004)<br>Fontana and Nesta (2009) |
| Investing in machinery and equipment | Positive | |
| Holding a copyright | Neutral | |
| Holding a patent | Positive | Helmert and Rogers (2008)<br>Buddelmeyer, Jensen and Webster (2010) |
| Holding a trademark | Positive | Helmert and Rogers (2008)<br>Buddelmeyer, Jensen and Webster (2010) |
| Female Ownership | Negative | Bitler et al., (2001)<br>Fairlie & Robb, (2009)<br>Coleman & Robb, (2009) |
| Operating in the Services Industries | Neutral | |

Paired with a concise list of independent variables, this brings forth a number of research questions that will hopefully shed some light on the relationships that may or may not exist among the listed variables.

## 3. Hypotheses

The Kauffman Firm Survey captures data on consecutive years of business characteristics, strategy, innovation, finances and demographics. What factors, known to be related to survival, are observed to be associated with survival for this sample of start up's?

Given these discussions of the key issues and variables identified in previous research, four different hypothesises are tested. They are as follows:

1) Revenue and employment in the founding (year one) are positively related to survival through year seven.

2) Investing in R&D or machinery and equipment in any one year is positively related to survival through year seven.

3) Investing in R&D and machinery and equipment persistently is positively related to survival through year seven.

4) Holding intellectual property is positively related to survival through year seven.

## 4. Data

As mentioned above, The Kauffman Firm Survey (KFS) is a panel study of 4,928 businesses founded in 2004 and tracked over their early years of operation. The survey focuses on the nature of new business formation activity; characteristics of the strategy, offerings, and employment patterns of new businesses; the nature of the financial and organizational arrangements of these businesses; and the characteristics of their founders

(Kauffman Foundation, 2012). The complete database to be used in this thesis is available for download through the Kauffman Foundation website (provided individual and institutional information is provided and the intended use of the data – i.e. for academic investigation – complies with the terms and conditions of use as set out by the individual organizations).

The panel of businesses was created by using a random sample from Dun & Bradstreet's (D&B) database list of new businesses started in the United States in 2004, which totaled roughly two hundred and fifty-thousand (250,000) such businesses. The KFS oversamples businesses based-on research intensity and the employment development of the businesses' primary industries. The KFS seeks to create a panel that includes new businesses founded by a person or team of people, purchases of existing businesses by a new ownership team, and purchases of franchises. To this end, the KFS excludes D&B records for businesses that were wholly owned subsidiaries of existing businesses, businesses inherited from someone else, and not-for-profit organizations. In response to the Kauffman Foundation's interest in understanding the dynamics of high-technology, medium-technology, and woman-owned businesses, the KFS is a stratified sample based on industrial technology level (High-Tech, Medium-Tech, and Non-Tech) and gender, which also oversamples businesses in high- and medium-tech industries (Kauffman Foundation, 2012).

The distribution of firms by industry can be seen in Table 2. This distribution is based on the identification of the firms' NAICS' classification during their first interview. It can be observed that the KFS has a relatively higher representation of firms in professional management (54), manufacturing (31-33), retail trade (44-45) and other services (81). The KFS appears to be underrepresented by organizations in the public administration (91), mining (21), utilities (22) and management (55) industries. One explanation for the lack of start-ups in these NAICS is that both mining and utilities require a lot of capital to enter their respective markets which could be a deterrent for many entrepreneurs who are looking at starting a

business. The relative under-representation in public administration is self-evident in a survey of primarily private-sector firms. Lastly, firms in the management NAICS are usually, in some shape or form, a holding company that do not produce any goods or services, they simply are the ultimate parent of other companies in a company group.

For a detailed explanation of the components of these NAICS codes please consult Statistics Canada website: http://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=118464

Table 2

KFS Firm Distribution by Industry

| **Two Digit NAICS** | **Firms** | **Percent** |
|---|---|---|
| 11 - Agriculture | 40 | 0.81 |
| 21 - Mining | 5 | 0.1 |
| 22 - Utilities | 6 | 0.12 |
| 23 - Construction | 390 | 7.91 |
| 31 - Manufacturing | 51 | 1.03 |
| 32 - Manufacturing | 151 | 3.06 |
| 33 - Manufacturing | 518 | 10.51 |
| 42 - Wholesale | 219 | 4.44 |
| 44 - Retail | 283 | 5.74 |
| 45 - Retail | 243 | 4.93 |
| 48 - Transportation | 102 | 2.07 |
| 49 - Transportation | 10 | 0.2 |
| 51 - Information | 164 | 3.33 |
| 52 - Finance | 186 | 3.77 |
| 53 - Real Estate | 177 | 3.59 |
| 54 - Professional | 1203 | 24.41 |
| 55 - Management | 10 | 0.2 |
| 56 - Administrative | 360 | 7.31 |
| 61 - Educational | 29 | 0.59 |
| 62 - Health Care | 121 | 2.46 |
| 71 - Arts | 105 | 2.13 |
| 72 - Accommodation | 98 | 1.99 |
| 81 - Other | 454 | 9.21 |
| 92 - Public Administration | 3 | 0.06 |

Looking at the KFS in terms of size (both employment and revenue), it is easy to see that these start-ups are, by all intents and purposes, small enterprises, which is to be expected of most new firms. Table 3 shows that in the first year of the panel, the mean employee count is 1.68, with the largest of the

start-ups still only having 25 employees. This shows that all start-ups in the KFS came into existence as small enterprises (0-49 employees) and only after 2009 did some of those start-ups finally grow to become medium-sized enterprises (50-250 employees). It is interesting to see that even by the end of the panel the mean employee count has only grown to 3.72 employees.

Table 3

KFS Employee Count Descriptive Statistics

| Year | Mean | Std Dev | Minimum | Maximum | Number of Firms |
|---|---|---|---|---|---|
| 2004 | 1.682977 | 3.827043 | 0 | 25 | 4823 |
| 2005 | 2.782895 | 4.967363 | 0 | 25 | 3952 |
| 2006 | 3.141898 | 5.367049 | 0 | 25 | 3425 |
| 2007 | 3.1875 | 6.010482 | 0 | 30 | 2944 |
| 2008 | 3.126654 | 5.710574 | 0 | 26 | 2645 |
| 2009 | 3.063804 | 5.718436 | 0 | 26 | 2445 |
| 2010 | 3.506259 | 7.950425 | 0 | 61 | 2157 |
| 2011 | 3.725221 | 8.262689 | 0 | 61 | 2038 |

Table 4 provides a similar view of firm size by revenue. One thing to note about the revenue figures on the public KFS dataset, they are not exact dollar figures they are revenue ranges. Due to this, for all of the analysis with respect to revenue, the revenue ranges are used rather than an exact dollar figure. The revenue ranges for the KFS can be seen in Table 4.

Table 4

KFS Revenue Ranges

| Size Category | Revenue Range |
|---|---|
| 1 | $500 or less |
| 2 | $501 to $1,000 |
| 3 | $1,001 to $3,000 |
| 4 | $3,001 to $5,000 |
| 5 | $5,001 to $10,000 |
| 6 | $10,001 to $25,000 |
| 7 | $25,001 to $100,000 |
| 8 | $100,001 to $1,000,000 |
| 9 | $1,000,001 or more |

In terms of revenue, start-ups on the KFS are distributed all along the revenue scale. The mean from the start of the panel to the end of the panel stays between six ($10,001 to $25,000) and seven ($25,001 to $100,000). Although this change may not seem significant from one category to the other, there could be instances where a firm's revenue increases or decreases by a substantial amount by simple going from one category to the next. For example, if a firm is in category six in one year with $12,000 in revenue, and the next year is in category seven with $90,000 in revenue, it is a substantial increase in revenue. However, it is almost impossible to identify the magnitude of any such increases or decreases in revenue with the revenue ranges. This point is identified later as one of the limitations to the KFS dataset.

Table 5

KFS Revenue Descriptive Statistics

| Year | Mean | Mode | Std Dev | Minimum | Maximum |
|---|---|---|---|---|---|
| 2004 | 6.133 | 7 | 2.0091 | 1 | 9 |
| 2005 | 6.7492 | 8 | 1.7899 | 1 | 9 |
| 2006 | 7.0059 | 8 | 1.7055 | 1 | 9 |
| 2007 | 7.0697 | 8 | 1.695 | 1 | 9 |
| 2008 | 7.0459 | 8 | 1.772 | 1 | 9 |
| 2009 | 6.9619 | 8 | 1.8257 | 1 | 9 |
| 2010 | 6.9636 | 8 | 1.8454 | 1 | 9 |
| 2011 | 7.0578 | 8 | 1.8035 | 1 | 9 |

The baseline questionnaire was sent in 2004 and follow-up questionnaires were sent every year until the final year, 2011. Due to the nature of this longitudinal dataset and the demand for this type of valuable data, the dataset has been widely used by researchers and academics alike to publish peer-reviewed journal articles, dissertations and theses, research reports and working papers, as well as conference presentations on several different topics. The literature review identified a number of the ways in which the KFS database has been used extensively by researchers over the years. The dataset is not perfect, as basically none are, but it does show how in demand this type of data is by researchers and academics and the relative dearth of alternatives available.

The survival variable used is a variable that is created when respondents are asked during every consecutive follow-up interview, after the initial baseline interview in 2004, if the business is still in operation. The specific question that the respondents are asked is, “We’d like to confirm that the name of the business is [NAME BUSINESS] and that [NAME BUSINESS] is still operating” and the follow-up question “What is the main reason [NAME BUSINESS] is out of business?”. Using these

responses, a survival variable is created for each follow-up year, in which a business that is still in operation receives a value of one, and businesses that are not still in operation receive a value of zero.

Table 6

KFS Firm Survival in Percentages

| Year | Survived (%) | Closures - Overall (%) | Closures – Yearly (%) |
|---|---|---|---|
| 2005 | 93.85 | 6.15 | 6.15 |
| 2006 | 86.99 | 13.01 | 6.86 |
| 2007 | 81.29 | 18.71 | 5.7 |
| 2008 | 73.86 | 26.14 | 7.43 |
| 2009 | 68.47 | 31.53 | 5.39 |
| 2010 | 63.31 | 36.69 | 5.16 |
| 2011 | 58.12 | 41.88 | 5.19 |

Looking at Table 6, it is clear that the number of firms that survive from one year to the next steadily decreases from one follow-up interview to the next. Of those firms that have ceased operations, they are composed of firms that have closed operations entirely, have been sold or merged with another business or have temporarily ceased operations. The majority of the firms that have ceased operations are composed of firms that have closed their operations entirely, with very few being sold or merged with another business, and as such, all three have been grouped together as a "non-survivor". It is quite interesting to see that after four years over 25% of start-up firms have already ceased operation and that number grows to 40% after just seven years. These results are more encouraging than those of Mata and Portugal (1994). In their research of Portuguese manufacturing firms, one fifth died during the first year of operation and only 50% survived for four years.

It is obvious that not every start-up will succeed. Yet this type of research is important in that it seeks to identify some general characteristics that will provide start-ups with the best possible chance of surviving. Although it is evident that these characteristics are not of the one-size-fits-all variety, the results will be beneficial and increase the number of start-ups that are able to survive but also thrive.

## 5. Methods

This thesis involves the analysis of quantitative data that have been collected and prepared by an independent research organization (the Kauffman Foundation). Although there are over 4,000 unique variables in the dataset, the focus is variables that relate to innovation, and if and how they affect firm survival rates. This approach require a number of standard tests to ensure data reliability and significance. The data are analysed using a regression technique, namely, the probit model technique. The probit model was the quantitative technique selected because the dependent survival variable is a dichotomous variable with only two possible values, "1" being alive and "0" being dead. As a result, this binary-response model is the most appropriate technique to use with these data. Other quantitative techniques could have been used, such as logit and proportional hazard models. However, these techniques are more complex than a probit model and provide similar results no matter what regression technique is used (Mata and Portugal, 1994). Furthermore, because all of the firms in the KFS started operations in the same year (2004), there is no need to control for the age of the firm, which would be necessary in a hazard model. Thus, the probit model is the optimal and straightforward technique to use with these data.

The dependent variables used in these analyses are related to firm survival. To construct the survival variables, the variable

that provided data on if the business was still in operation or not is used. For the dependent survival variables, every respondent is included in the population. If the business was still in operation during the first follow-up interview, it's coded "1" and is considered a survivor for year one. If the firm responded that it was not in operation during the first follow-up interview, it is coded as "0" and are considered dead. This same process was also done for firm survival in follow-up years three, five and seven as well. This procedure was followed in order to compare if the results from the independent variables changes as time progresses throughout the panel.

With the dependent variables set and created, the independent variables need to be identified. Although research on survival has been done previously using the KFS, none of it has focused on innovation characteristics of start-ups. The innovation independent variables of interest are research and development (R&D), machinery and equipment, as well as three intellectual property variables, trademarks, patents and copyrights. Furthermore, included also are two independent variables that are associated with survival which are gender (female ownership) as well as industry that the business operates in (service industries). Lastly, all of the previous independent variables are accompanied by revenue and employment, as a proxy for size and used as control variables.

With the necessary dependent variable and independent variables identified, four different dependent variables were used for the probit model that was run. In the probit model, the four different dependent variables were used with the exact same independent variables to allow for a comparison over time. A more thorough explanation of how each variable was constructed follows.

In order to create the probit model for analysis, the probit was run four different times, one for each dependent survival year. The results were then amalgamated into one table for ease of analysis. All of the four probits that were ran included revenue

and employment size in the founding year (2004). This was done to see how founding firm size affects survival in any of the survival years of interest (one, three, five and seven). The next set of variables that were included were the innovation variables. These included R&D and machinery and equipment. For each of the probits, the variables for R&D and machinery and equipment were created by coding respondent's answers for all the surveys into one categorical variable for each, R&D and machinery and equipment. If a respondent did not invest in R&D at any point during the panel, it was coded as "0". If a respondent only invested in R&D one time during the panel, it was coded as "1". If a respondent invested in R&D persistently (more than one time over the panel), it was coded as "2". The exact same categorical variable was created in the same way for machinery and equipment. In doing so, it allowed for a reference to be selected out of the three possible values and for the probit to produce the difference between the reference and the other two values for the respective variable. This step makes the comparison of the difference between the reference and two other values straightforward. With regards to the four probits in this thesis, the reference are those that are coded as "0" (did not invest in R&D or those that did not invest in machinery and equipment) which will be compared to those that invested in one year and those that invested persistently.

For the three intellectual property variables (copyrights, trademarks and patents), they vary slightly in each of the probits and are based on the four dependent survival variables. They are constructed in order to determine if the respondent held the type of intellectual property in question the year before the survival period. As such, if the probit was for survival in year five, the independent variable for copyrights would be coded as "1" for those that held a copyright in year four and "0" for those that did not hold a copyright in year four. This step was undertaken in order to see if holding IP in the year immediately preceding the survival year in question will have any effect on survival.

The last two independent variables of interest are gender (female ownership) and industry (services industries). For the gender variable, if the business was owned by a female during its founding year, it was coded as "1" and if it was owned by a male, it was coded as "0". This coding was done to see if there was any difference in survival between those businesses owned by females and those owned by males in this dataset. With regards to the industry variable, those that were in NAICS 31, 32 or 33 during the founding year were coded as "0" and were considered a part of a manufacturing industry; all others were coded as a "1" and were considered a part of a services industry. This coding was done in order to see if any difference exists between those firms that are in a manufacturing industry versus those in a service industry.

With both the dependent and independent variables identified and a definition provided for how they were constructed, the next section examines the results from the probits and provides an analysis of those results.

## 6. Analysis

This section analyses the data using the models as described in the Methods section. The analysis tests the hypotheses proposed earlier. The analysis starts by looking at the results from the four different probit models and amalgamates them into one clear and concise model for easier analysis.

The results for the probit model are presented in Table 7. The first variables analysed are the employee and revenue variables. The model shows that both employee count and revenues at founding are not significant with regards to firm survival in year one. However, after year one, employee count becomes positively significant for years three, five and seven, while revenues remains insignificant in years three and five, but also becomes positively significant in year seven. This result is noteworthy as it suggests that the greater number of employees a business has at founding has a positive effect on survival for all years except for year one. As such, as long as a firm can

survive the first year without closing, it increases its chance of survival with the more employees that it has at founding. With regards to revenues, and quite interestingly, the greater the revenues a firm has at founding only increases its chance of survival in year seven.

Looking now at the innovation variables, those that only invest in R&D for one year actually have a negative effect on survival in every of the survival years of interest when compared to those firms that did not invest in R&D throughout the panel. Furthermore, this negative effect on survival becomes significant in year three. This finding is interesting as it indicates that firms that do not invest in R&D have a better chance of survival compared to those firms that only invest in R&D for one year. However, looking now at those that invest in R&D persistently, one can see there is a positive and significant effect on survival when compared to those that do not invest in R&D. Once again, this result is interesting as it shows that merely investing in R&D one time has a negative effect but the persistent investment in R&D has a positive effect for years one, three, five and seven.

Similar results are seen by looking at machinery and equipment. For those that invest in machinery and equipment for just one year of the panel, there is a positive but insignificant effect on survival in years one and five when compared to those firms that did not invest in machinery and equipment throughout the entire panel. However, looking at years three and seven, there is actually a negative but insignificant effect on survival in those years when compared to those firms that did not invest in machinery and equipment throughout the entire panel. Once again, looking at the persistent investment in machinery and equipment shows a vastly different picture. Those firms that invest in machinery and equipment persistently have a positive and significant effect on survival in years one, three, five and seven compared to those that did not invest in machinery and equipment, similar to R&D. Once again, this finding is noteworthy as it shows that merely investing in machinery and equipment persistently has a positive effect for years one,

three, five and seven, while only investing in machinery and equipment once has mixed results.

Looking next at the three intellectual property variables, the first analysis is on the copyright variable. Holding a copyright in the founding year actually had a negative but insignificant effect on firm survival in year one. However, for years three, five and seven, this effect changes. Holding a copyright in year two actually has a positive and significant effect on survival in year three. This result is the same for those that hold a copyright in year four, as there is a positive and significant effect on survival in year five and those that held a copyright in year six, as there is also a positive and significant effect on survival in year seven.

With regards to firms that hold trademarks, similar results can be seen as to those for copyrights. Holding a trademark in the founding year or in year two does not show any effect for survival in year one and year three, respectively. However, holding a trademark in year four shows a positive and significant effect on survival in year five. This positive and significant effect on survival remains in year seven for those that hold a trademark in year six.

Looking next at the patent variable, the results are similar to those that held trademarks and copyrights in the later years of the panel. Firms that held a patent in their founding year has a positive and significant effect on survival. This significance is removed for those that held a patent in year two for survival in year three. However, those that held a patent in year four and year six has a positive and significant effect on survival in years five and seven, respectively.

With regards to those business that have a female owner at founding and those that are in service industries, the results show that both factors have a negative effect on survival in all years which is insignificant until year seven.

Table 7

Probit Model 1

| | Survival Year 1 | Survival Year 3 | Survival Year 5 | Survival Year 7 |
|---|---|---|---|---|
| **Employees** | 0.0224<br>(0.0124) | 0.0149 **<br>(0.00689) | 0.0107 *<br>(0.00564) | 0.00883 *<br>(0.0052) |
| **Revenues** | 0.00502<br>(0.0108) | 0.00446<br>(0.00695) | 0.0069<br>(0.00607) | 0.014 **<br>(0.00576) |
| **Investing in Research and Development for One Year** | -0.0979<br>(0.0903) | -0.1177 **<br>(0.0589) | -0.0859<br>(0.0528) | -0.0901 *<br>(0.051) |
| **Persistent Investment in Research and Development** | 1.0613 ***<br>(0.2584) | 0.3539 ***<br>(0.0759) | 0.2381 ***<br>(0.0588) | 0.1598 ***<br>(0.0535) |
| **Investing in Machinery and Equipment for One Year** | 0.00692<br>(0.0741) | -0.00737<br>(0.061) | 0.0132<br>(0.0593) | -0.0387<br>(0.0594) |
| **Persistent Investment in Machinery and Equipment** | 1.8133 ***<br>(0.1541) | 0.9363 ***<br>(0.0613) | 0.727 ***<br>(0.0558) | 0.5788 ***<br>(0.0547) |
| **Holding Copyrights** | -0.2107<br>(0.1871) | 0.3003 *<br>(0.1594) | 0.7955 ***<br>(0.189) | 0.511 ***<br>(0.1579) |
| **Holding Trademarks** | 0.3052<br>(0.3851) | 0.1377<br>(0.2453) | 1.3152 ***<br>(0.4656) | 0.5493 **<br>(0.252) |
| **Holding Patents** | 0.6905 **<br>(0.2873) | 0.2176<br>(0.1734) | 0.6283 ***<br>(0.2265) | 0.611 ***<br>(0.185) |
| **Female Ownership** | -0.0315<br>(0.0749) | -0.0443<br>(0.0503) | -0.0138<br>(0.0447) | -0.0709 *<br>(-.0428) |
| **Service Industry** | -0.0576<br>(0.5934) | -0.0862<br>(0.0691) | -0.0731<br>(0.059) | -0.108 *<br>(0.0556) |
| **Observations** | 4518 | 3911 | 3295 | 2795 |

Standard error in parentheses

* Significant at 10%, ** Significant at 5%, *** Significant at 1%

The results from this model indicate that the greater the number of employees when a firm is founded, the greater are its chances of survival in years three, five and seven. However, the larger are a business's founding revenues are only increases the chances of survival in year seven. Persistent investment in either innovative business activity, like research and development and machinery and equipment, improves a business's chances of survival in years one, three, five and seven. Holding any intellectual property (copyrights, trademarks or patents) will improve a business's chance of survival in years five and seven. Finally, both female ownership and those business's that operate in a service industry have a lesser chance of survival through year seven compared to those that are owned by males and those that operate in manufacturing industries.

## 7. Discussion

This section provides an understanding of the findings shown in the analysis section by examining linkages between the findings and the previous literature. Table 8 summarizes the proposed hypotheses that were proposed earlier in the thesis and their corresponding findings based on the previous analysis.

Table 8

Research Hypothesis and Findings

| Hypothesis | Findings |
|---|---|
| 1) Revenue and employment in the founding (year one) are positively related to survival through year seven. | **Supported.** The relationship between employment and survival is positive and significant. The relationship between revenue and survival is also positive and significant. |
| 2) Investing in R&D or machinery and equipment in one year is positively related to survival through year seven. | **Not Supported** The relationship between investing in R&D and machinery and equipment in one year and survival is negative and significant (for R&D) to firm survival. |
| 3) Investing in R&D and machinery and equipment persistently is positively related to survival through year seven. | **Supported** The relationship between investing in R&D and machinery and equipment persistently and survival is positive and significant to firm survival. |
| 4) Holding intellectual property is positively related to survival through year seven. | **Supported** The relationship between holding intellectual property (copyrights, trademarks or patents) in the year before the survival year is positive and significant to firm survival. |

Beginning with size (employment and revenue) and its relationship with survival, the results presented in this thesis are similar to the results by other researchers (Harhoff and Stahl, 1995; Audretsch, Santarelli and Vivarelli, 1999; Nassereddine, 2012). There is evidence to suggest that the larger the size (both by employees and by revenue) of the firm in its founding year, the greater probability of that firm's

survival through year seven. This result supports hypothesis 1 that a positive relationship exists between size (employment and revenue) and firm survival. These results confirm the commonly-held view that these larger start-ups seemingly have greater advantages and options available to them. For example, start-ups with large revenues have an advantage over start-ups with smaller revenues because they are not only showing that they are able to sell their good or service, but they are also more likely to be able to secure debt financing (business loan, mortgage, line of credit, credit card) from lenders (Nassereddine, 2012) due to their ability to generate revenues. This access to debt financing affords them options that might not be available to smaller start-ups, such as purchasing more inventory to fulfill purchase orders or investing in innovation activities.

Furthermore, start-ups that are larger in size (in terms of employment) are more diversified than smaller firms, and this diversification may improve their survival prospects by reducing risk and keeping alive options in one market should activities go sour in another (Geroski, Mata and Portugal, 2009). Also, downsizing options available to larger firms, once again, may not be available to smaller start-ups. This argument suggests that when a larger start-up is faced with financial pressures, it is able to downsize and lay people off to reduce expenses in hopes of surviving and staying in business. Since it is known that growth is episodic (Garnsey, 2006), if the start-up is able to survive its business contraction, it is possible that it could eventually return to another growth phase.

Consistent with Christensen (1997) and Cefis and Marsili (2006), this study finds that there is a positive relationship between persistent investment in innovation activities and survival. Model 1 clearly shows that a positive relationship exists between the persistent investment in innovation activities (R&D and machinery and equipment) and firm survival when compared to those firms that do not invest in R&D or machinery and equipment. Furthermore, investing persistently in R&D returns similar results to investing in machinery and equipment.

However, investing in R&D and machinery and equipment for only one year decreases a firm's chance of survival compared to those that do not invest in R&D or machinery and equipment. This finding is intriguing and logical as investing in these types of innovative business activities cannot be seen as a "one and done" approach in which a firm invests in, R&D for example, one year and then never invests again. In order to stay competitive in their respective industries and markets, these firms needs to continuously innovate and invest in these types of business activities in order to offer new and exciting products or create new processes that will allow them to gain a competitive advantage over their competitors. However, firms must also balance continuous investment in these innovative business activities with bringing these ideas to market in order to see returns on their investment that will enable them to continue to operate.

Nonetheless, the results show that persistent investment in research and development or machinery and equipment can be seen as a positive predictor of survival.

Intellectual property can be seen as an output of innovation and as such, it is important to understand any potential relationships between intellectual property and survival as well. Helmert and Rogers (2008) analyse the survival of approximately 162,000 British firms in 2001 over a five-year period. Their results indicate that intellectual property activity is associated with a higher probability of survival, specifically national patents and trademarks are significant in improving survival. Buddelmeyer, Jensen and Webster (2010) look at 300,000 Australian firms and find that past successful radical innovations, as proxied by the stock of patents, and incremental innovation investment (new-to-company), measured by trademark applications, are associated with higher company survival rates.

The results for the three different types of intellectual property (copyrights, trademarks and patents) in Model 1 indicate that all three have a positive effect on survival, for

survival through year five and seven. The results for all of the other intellectual property variables for survival through year one and three are not as clear-cut as they are for survival through years five seven. However, these results do mirror the results found in previous research. Helmert and Rogers (2008) and Buddelmeyer, Jensen and Webster (2010) find that both patents and trademarks are associated with higher company survival rates, a relationship which this study also finds. As a result, this result supports hypothesis 4 in that a positive relationship exists between holding intellectual property and firm survival. With regards to female ownership, the results are consistent with previous research on the subject (Bitler et al., 2001, Fairlie & Robb, 2009 and Coleman & Robb, 2009). For Model 1, the results indicate that female ownership has a negative effect on survival and this becomes significant for survival through year seven. It is evident that female-owned firms are not surviving comparable to these of their male counterparts. This result is most likely due to the lack of initial start-up capital, inability to obtain debt financing and inability to obtain human capital as Coleman and Robb (2009) previously have found. Although this topic has been studied before, it would be interesting to see if Canadian women are at the same disadvantages as American women are with regards to firm survival. This type of Canadian perspective on an important gender issue would be an excellent area for future research. The results for businesses in service industries are quite similar to those of female owners. The results indicate that operating in service industries have a negative effect on the survival of a business and this becomes significant for survival through year seven. This finding is interesting as there is often keen interest in the manufacturing industries as they are thought to be the ones that are struggling in the economy. However, these results seem to suggest the opposite. Once again, this topic would be an excellent area for future research to investigate what is really happening to start-ups in service industries and why does it appear that they have less chance of survival than those in manufacturing industries.

## 8. Conclusion

This topic of research, specifically innovation and firm survival, is extremely useful for policy makers, in Canada and abroad, as well as researchers and academics. As mentioned time and time again, the growth and survival of enterprises have become a key focus for public policy in Canada and across many OECD countries in recent years. Government policy originated from a focus on merely promoting new business start-ups that the government anticipated would churn out as many "winners" as possible. Those enterprises that "won" survived and grew and those that "lost" ceased operations. However, we are beginning to see that playing the "numbers game" is not necessarily the best way to create, support and grow enterprises. We may need to rethink this strategy and transform our current policies into more effective ones.

Growth is highly episodic in nature, which means that the number of growth enterprises is constantly changing. As Garnsey (2006) suggests, growth spurts are often interjected with periods of stability or decline, followed by a subsequent upward growth "jump". Moreover, growth is not a characteristic of a sub-set of enterprises, but rather a state that some enterprises undergo and temporarily exit (Brown, Mason & Mawson, 2014). This argument suggests that policies may need to be tailored towards these more dynamic enterprises rather than on SME policies that try not to pick winners. It can and will be hard for governments to craft these types of policies as there is no such thing as a "typical" growth enterprise. Further research is required to provide us with as much information as possible when we try to create these type of complex policies using an evidence-based approach.

For researchers and academics, although there has been strong interest in this type of research, minimal research has been undertaken on these topics due to the lack of and availability of quality data. One of the largest obstacles for researchers and academics currently is the uphill battle to obtain these high quality data that national statistical agencies have.

Greater collaboration between researchers, academics and policy makers would be beneficial to all parties involved. Researchers and academics would be able to gain access to high quality data and policy makers would gain access to individuals who could study the topic and provide a plethora of knowledge and input that could help craft evidence-based policies.

**Limitations**

The KFS is a useful dataset with which to work in that it provides an abundance of data that can be studied but there are some limitations that were identified while using the KFS. For example, it would have been extremely beneficial to have exact dollar figures for each firm's revenue instead of their respective revenue in a range. Having this valuable information would have allowed for a more precise investigation using the revenue variable in terms of survival and growth. For example, instead of simply investigating how a firm's revenue growth affects survival, with actual revenue figures one could determine each firm's respective growth rate and see if there are any links to the level of growth and survival. Furthermore, it would have been beneficial to not only know if a firm is investing in research and development or machinery and equipment but the actual amount that it invested in each. This detail would have allowed for investigation into whether the investment level (low, moderate or high) in these innovation activities also has any effect on the survival of the firm.

The last limitation is the lack of a dataset that is more up-to-date than the KFS. The KFS is for 2004-2011, which is positive in terms of length of coverage, but it would obviously be ideal, and a preference for any researcher, to have data that are as current as possible. This dataset contains data from the financial crisis in 2008 but it would be interesting to see a dataset that takes into account the massive downturn in the price of oil and the ripple effects that might be felt across a country's entire economy.

**Future Research**

Further research on survival and growth is crucial as these start-ups are part of what drives the economy. First and foremost, it would be interesting to mimic the research done in this thesis but from a Canadian perspective to see if the results are similar because the composition of the Canadian business environment is so heavily skewed due to the volume of SMEs. One dataset with which it would nice to work is Statistics Canada's Survey of Financing and Growth of Small and Medium Enterprises. This survey is conducted approximately every three years (it is unfortunate that it is not longitudinal or at least conducted every year) and would be a useful dataset for this type of research because of its high data quality, (Statistics Canada is Canada's national statistical agency) due to its being mandatory for respondents to complete, and due to the sample size (20,000+ SME's that are located all throughout Canada and across almost all NAICS).

Furthermore, it would be interesting to investigate how different variables affect survival. Within this study, the variables used for innovation are proxy measures and can be seen as inputs to innovation. It would be useful to look at outputs of innovation to determine if the results are consist with the findings of this thesis.

One last area for future research would be to include an industry variable to both models, as innovation activities may be crucial in some industries and irrelevant in others. This analysis could be accompanied by the inclusion of additional variables, such as debt and education, that have been used in previous research.

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