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CANADIAN START-UPS: GROWTH AND SCALE-UP TRANSITIONS

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ABSTRACT

This study presents a statistical description of Canadian firm size transitions, in terms of numbers of employees, by examining five cohorts of firm entrants during the period 2002 to 2006.[1]

The study found that the vast majority of Canadian firms, around 87 percent, remained within their size category during the observation period without scaling up or scaling down to other size categories. Indubitably, this number might vary according to the chosen size category definition. Regardless of the size category definition, however, 80 percent of firms experienced either no change in their employment figures or variation of plus/minus one to two employees over the observation period.

As a result, we looked at various size category definitions without observing significantly different results as most scale ups and scale downs occur in the bottom of the distribution.

For example, using a finer size category definition, we observed that 91 percent of scale ups and scale downs occurred in firms with less than 20 employees and this number jumped to 99.9 percent for firms with less than 100 employees. Regrettably, 90 percent of small firms and 99 percent of micro firms that did scale up went on to scale back down during subsequent periods.

Furthermore, the study found that almost 75 percent of firms that scaled up did so within the first 5 years of being established, suggesting that firms are more likely to expand when they are younger.

The study also found that the federal government's Small Business Deduction (SBD) and Scientific Research and Experimental Development (SR&ED) Program were both positively correlated with the likelihood that a firm would scale up and with sustainable firm-level employment growth. In addition, both the SBD and SR&ED Program seem to be negatively correlated with the likelihood that a firm would scale down.

The probabilities of firms scaling up and scaling down were both positively related to profitability and both negatively related to the financial leverage ratio. These results suggest that a firm's financial position has a significant influence on its capacity to scale up.

[1] Note that results (i.e., values presented in this paper) have sometimes been rounded off, meaning that categories might not always sum to 100 percent.

01 INTRODUCTION

Firm growth has long been an area of interest for research into entrepreneurship and small and medium-sized enterprise (SME) policies. In the 1990s, technology-based start-ups were being established at accelerating rates, especially in the United States, with Silicon Valley at the epicentre of this activity. Over the past 20 years, Canada has been developing a successful ecosystem for start-ups.[2] However, unlike in the United States, there are doubts about the growth performance of Canadian SMEs. Following the relatively mild recession of 2008–09[3] in Canada, Canadian policy-makers began to pursue policy approaches that could more aggressively stimulate SMEs' growth.

Some policy-makers are still referring to a Canadian scale-up challenge, especially at the later stages of the entrepreneurial development process. With fewer firms scaling up, Canada may be missing opportunities to increase its population of large firms, which contribute disproportionately to the nation's economic activity, research and development (R&D) and export activity (Huang 2019). Recognizing this, a report from Canada's Economic Strategy Tables[4] recommended doubling the rate at which Canadian mid-sized companies become large companies. This is a key driver for the research presented in this paper, which can help provide a better understanding of the dynamics and factors affecting firm size transitions to inform policy development to support SME growth.

During the last decade, much research has been directed at studying high-growth firms (HGFs) and start-ups, while the study of firm scale ups has received much less attention. Research in Canada providing a comprehensive investigation of the dynamics and factors affecting SME growth is scarce. Baldwin (1998) shed some light on firm growth as a multi-dimensional phenomenon. He found substantial heterogeneity in factors related to firm growth, such as industry and demographic characteristics. At this point, it is useful to clarify the scale-up terminology and definitions that can be found in the literature and in popular media. The most generic definition of firm scale up would be "a firm that is in the process of expanding/growing." However, the definition must also be clear about whether that expansion is referring to growth in employment, sales/revenues or some other measure such as productivity, added value or profits. Most businesses and investors focus on revenue growth that can eventually translate into higher profits. In fact, business literature often reserves the term "scale ups" for companies that target rapid sales growth, possibly seeking to become so-called "gazelles." On the other hand, most policy-makers are more interested in measuring employment growth, which more directly leads to lower unemployment rates. The choice of the variable being measured in association with the scale-up terminology must be clearly understood and depends upon the context.

It is also important to define the level of growth that constitutes a scale up over time. According to the Eurostat–OECD Manual on Business Demography Statistics, "a scale-up company is a firm that has an average annualized growth rate greater than 20 percent over the past 3 years with at least 10 employees at the beginning of the period." However, this definition of "scale up" adds to the confusion, as it is also one of the most cited definitions for high-growth firms.

As it turns out, there is no universal definition of what should be considered a scale-up firm (Daunfeldt et al. 2010). Does a company going from three to four employees or from $10 million to $11 million in sales constitute a scale up? In most cases, not every growing firm should be considered a scale up. Here, too, every use of the terminology should be clear about what level of growth constitutes a scale up.

[2] According to the Global Entrepreneurship Monitor 2017–2018, Canada is a leader in early-stage entrepreneurial activity, scoring above many G7 nations, including the United States.
[3] The Canadian recession of 2008–09 was milder than the downturns of 1981–82 and 1990–92. The main Canadian business cycle indicators rebounded in the spring and early summer of 2009.
[4] Report from Canada's Economic Strategy Tables: Seizing opportunities for growth: September 25, 2018. Innovation, Science and Economic Development Canada.

This study looked at firm size transitions (scale ups and scale downs) of start-ups as defined by changes in employment. It also defines the concept of sustainable scale ups. While some firms scaled up and also scaled down during the observation period, for the purpose of this study, a firm is considered to have sustainably scaled up when, after the last scale-up transition to a higher size category, it remained within the higher firm size category for at least 3 years. To best isolate and identify some determinants of scale ups, this study focused on firms that could be observed from birth (as start-ups).[5] It traced the size category transitions of start-ups in five cohorts between 2002 and 2006 inclusive. The observation period was from 2002 to 2014, which allowed each cohort to be observed for at least 9 years from the time it was established through a formation period and, perhaps, a growth phase.

We also considered a cohort of firms that was at least 5 years old in 2002. Firms within this cohort are usually over their initial exploratory phase, have found their initial product/service offering and market segment, and are normally entering a growth phase where they seek significant market penetration. Results are not presented here, but we found no (significant) difference in behaviour between those firms and the start-up companies after 5 years, which suggests that scale ups happen mainly within the first few years of a company's existence. After that, Canadian firms are mostly not scaling up. This also suggests that economic policy should focus on the conditions for new firm formation and early growth of firms, rather than targeting particular types of firms, until we find what could trigger scale ups among more mature (i.e., at least 5 years old) Canadian firms. Section 2 of this report introduces the study's analysis framework, including a description of the datasets and methodology used. Section 3 presents empirical findings from the analysis, including descriptive statistics and results from binomial and trinomial logistic regression models, as well as a Cox proportional hazards regression model (Cox 1972). Section 4 presents our conclusions.

02 EMPIRICAL ANALYSIS FRAMEWORK

This section lays out the analysis framework, including the data used in the analysis, descriptive statistics framework and methodology of regression models, as well as the associated model variables.

Dataset

The dataset used in this study was constructed from the National Accounts Longitudinal Microdata File (NALMF), developed by the Economic Analysis Division and accessed through the Canadian Centre for Data Development and Economic Research at Statistics Canada. NALMF is an experimental database that is still evolving. Any absolute numbers reported in this paper should be considered indicative (i.e., not official numbers) and used only for research purposes.[6] The dataset consists of incorporated and unincorporated firm-level records containing robust data gathered from a number of sources, including administrative tax records such as a PD7A (Statement of account for current source deductions) and T4 (Statement of Remuneration Paid). The administrative data allow researchers to track the performance of each firm over time, including its age, business activities and employment level (firm size), and the sector and region in which it operates.

[5] We did not, however, impose any restrictions on the initial business size as, according to the Business Register in December 2018, almost 75 percent of businesses in Canada have less than 10 employees.
[6] Official numbers should only be calculated using Statistics Canada's Business Register. A longitudinal Business Register, which could also be used for the analysis performed in this research, is still under development at Statistics Canada.

With NALMF's longitudinal structure, five cohorts (2002 to 2006)[7] of start-ups were created and tracked over time (until 2014). The administrative data allowed computation of ratios to measure each firm's financial performance, such as profitability and debt leverage.[8] The data also allowed researchers to assess the role of federal tax incentives, such as the Small Business Deduction (SBD) and the Scientific Research and Experimental Development (SR&ED)[9] Program.

Once assembled, data cleaning and imputation techniques were applied to the dataset's longitudinal firm-level records.[10] After removing outliers and filling any data gaps, the number of start-ups at the beginning of each period and the number of observations for each cohort over the observation period are summarized in Table 1.

Table 1: Number of start-ups and observations for five cohorts between 2002 and 2006

	Cohort 2002	Cohort 2003	Cohort 2004	Cohort 2005	Cohort 2006
Start-ups	132,462	151,498	160,902	172,123	180,722
Observations	1,130,297	1,188,527	1,202,151	1,217,140	1,193,859

Source: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014.

Descriptive statistics framework

The study tracked individual firm size category transitions for five start-up cohorts (2002–2006) from birth to a more mature state over the period ending in 2014. Thus, the 2002 start-up cohort has 12 observable transition years, whereas the 2006 cohort has eight observable transition years. Descriptive statistics associated with this analysis are provided in Section 3.1.

A parallel analysis of firms that were at least 5 years old during the 2002–2006 period was also performed. Those results are not presented in this report, however, as they were very similar to the scale-up and scale-down results obtained for the start-up cohorts presented in this report. In other words, when start-ups reach 5 years of age, they pretty much behave all the same afterward (i.e., mostly not scaling up). Or, if you prefer, looking at cohort 2002 after 2006 is pretty much the same as looking at 5-year-old firms in 2002.

A firm size transition refers to when a firm moves from one size category to a different size category over time. Statistics Canada defines size categories as follows:

Micro firms
1 to 4 employees

Small firms
5 to 99 employees

Medium-sized firms
100 to 499 employees

Large firms
500+ employees

[7] For instance, a 2002 firm cohort included records of new firms established in 2002 and their history up to 2014.
[8] The proportion of a firm's assets financed through debt.
[9] Both the SBD and SR&ED Program are federal tax incentives designed to alleviate the corporate tax burden and encourage Canadian businesses to conduct research and development in Canada.
[10] Specification of data cleaning and imputation methods is available upon request.

In this report, a firm is considered a "scale up" when it transitions from one size category to a larger size category in a subsequent period. It follows that a "scale down" is defined as a firm transitioning from one size category to a smaller size category in a subsequent period. The range of possible scale-up and scale-down transitions is summarized in Table 2. "Churning" refers to when a firm transitions in one year and reverses the direction of transition in any subsequent year.

Table 2: Firm size transitions

Transition	Scale up	Scale down
1	Micro to small	Small to micro
2	Micro to medium	Medium to micro
3	Micro to large	Large to micro
4	Small to medium	Medium to small
5	Small to large	Large to small
6	Medium to large	Large to medium

To test whether the range of firm size within each category would have a significant impact on the results, an analysis was also conducted using finer firm size categories.[11] This analysis did not yield results that were significantly different from those presented in this report, the explanation being that around 1 percent of firms with more than 20 employees scaled up over the observation period. This result is not far from the proportion of HGFs reported in a study by Côté and Rosa (2017).

Moreover, looking at firms of all sizes, only 15.2 percent[12] of firms in the 2002 cohort scaled up or down, and most never exceeded 20 employees in size. In other words, the proportion of firms scaling up from the micro firm category (1–4 employees) to the small firm category (5–99 employees) is similar to that scaling up from the micro firm category to the 5–19 employees category. For example, in the 2002 cohort, and among firms that scaled up once, 66 percent went from the micro firm category (1–4 employees) to the small firm category (5–99 employees). When we used the "5–19 employees" category instead of the "5–99 employees" category for small firms, we found that 60.39 percent went from micro firms to small firms. For the same cohort, this time looking at firms that scaled down once, 33 percent went from the small firm category (5–99 employees) to the micro firm category (1–4 employees). Again, when we used the "5–19 employees" category instead of the "5–99 employees" category for small firms, we found that 30 percent went from the small firm category (5–19 employees) to the micro firm category (1–4 employees).[13] Moreover, without attributing any size category definition, the study found that in the 2002 cohort, 45 percent of firms reported the same number of employees 12 years later (i.e., zero change) and 80 percent experienced variation of plus/minus one to two employees during that period. The remaining 20 percent that moved were mainly in the bottom of the distribution (i.e., less than 20 employees).

[11] The firm size groups used were: 1–4, 5–19, 20–49, 50–99, 100–249, 250–499 employees.
[12] The average across cohorts is 13.1 percent. Results between cohorts were very similar (see Tables 4 and 5).
[13] We estimated that by using a larger category (5–99) for small firms, we were not reporting 4.7 percent of what could have been considered scale ups within this category. However, using the larger category for small firms, we found that 95 percent of small firms' scale ups scaled back. Using the alternate, more detailed categories, almost 99 percent of small firms scaled back! Regardless of the size category definition, the scale ups scaled back. Thus, the size category definition did not change the big picture results.

In addition to the start-up cohorts, the study also analyzed over the observation period the growth trajectory of a population of firms that were at least 5 years old during the 2002 to 2006 period. The econometric results of this more mature population of firms were not significantly different[14] from the results of the start-up cohorts presented in this report. However, we noted that more mature firms were not scaling up or down as much as start-ups, suggesting that when scale ups happen, they occur mainly within the first few years of a company's existence. Because of that, we decided to present results for start-ups only.

The descriptive statistics from this analysis are summarized in Section 3 under "Descriptive statistics analysis on size transition" and include the frequency of firm size transitions broken down by transition type: scale ups, scale downs and churning. It should be noted that mergers, acquisitions, divestitures and spinoffs were not considered as we did not have that information.

Regression specifications and variables

The study adopted two types of regression models (logistic and proportional hazards) to assess the association of key factors and evaluate scale-up sustainability of firm size transitions. The first regression method applied was a binomial logistic regression. The general form of the logistic regression is as follows:

$$\Pr(Y_i = 1) = \frac{e^{\beta_{Y_i} X_i}}{1 + \sum_{k=1}^{K-1} e^{\beta_k X_i}}$$

where $\Pr(Y_i = 1)$ represents the probability of being in state 1 relative to the reference case. K represents the number of alternatives to be modelled, X_i is a vector denoting the explanatory variables for the i^{th} firm and β is a vector of coefficients, which is constant across individual firms i.

For the binomial logistic regression, $K = 2$ and $\Pr(Y_i = 1)$ represents the probability of scaling up relative to the probability of scaling down or not scaling at all $(Y_i = 0)$.

For the trinomial logistic regression, we have three-transition status instead of two: scaled up (1), scaled down (0) and an unchanged (2) status as the reference state. Thus, $K = 3$ and the model calculates $\Pr(Y_i = 1)$, which now represents the probability of scaling up relative to firms that did not scale at all $(Y_i = 2)$, and $\Pr(Y_i = 0)$, which represents the probability of scaling down relative to firms that did not scale at all $(Y_i = 2)$.

Because the data are right censored (i.e., data stop in 2014), a proportional hazards regression (Cox 1972) was chosen to find which variables (Table 3) could explain sustainable firm size transitions. The proportional hazards regression also served as an alternative method to consolidate results from the logistic regressions. The instant "risk" of sustainably scaling up (the event) for each firm is assumed to follow its own hazard function and can be expressed as:

$$\lambda(t|X_i) = \lambda_0(t)\exp(X_i\beta)$$

This expression gives the hazard function at time t for firm i with covariate vector (explanatory variables) X_i, where $\lambda_0(t)$ is a baseline hazard and β is a vector of coefficients. The event (i.e., sustainably scaling up) occurred when a firm scaled up and stayed within (or above) the same firm size category for at least 3 years. The sustainable scale-up time can be uncensored (status = 1), in which case sustainable scale up happened before the study end date (or firm death); or censored (status = 0), in which case the firm reached the end of the study time frame (or died before 2014) without sustainably scaling up. The reasoning behind proportional hazards relates to the assumption that there is a constant relationship in time between dependent and explanatory variables, i.e., hazard functions for any two individual firms at any point in time are proportional. Unlike logistic regressions, this model depends upon time, which means that the hazard of an event, sustainably scaling up in this study, is associated with time. The explanatory/control variables used in all regressions are presented in Table 3.

[14] The econometric results gave the same direction for the considered "explanatory" variables.

Table 3: Definitions of explanatory variables

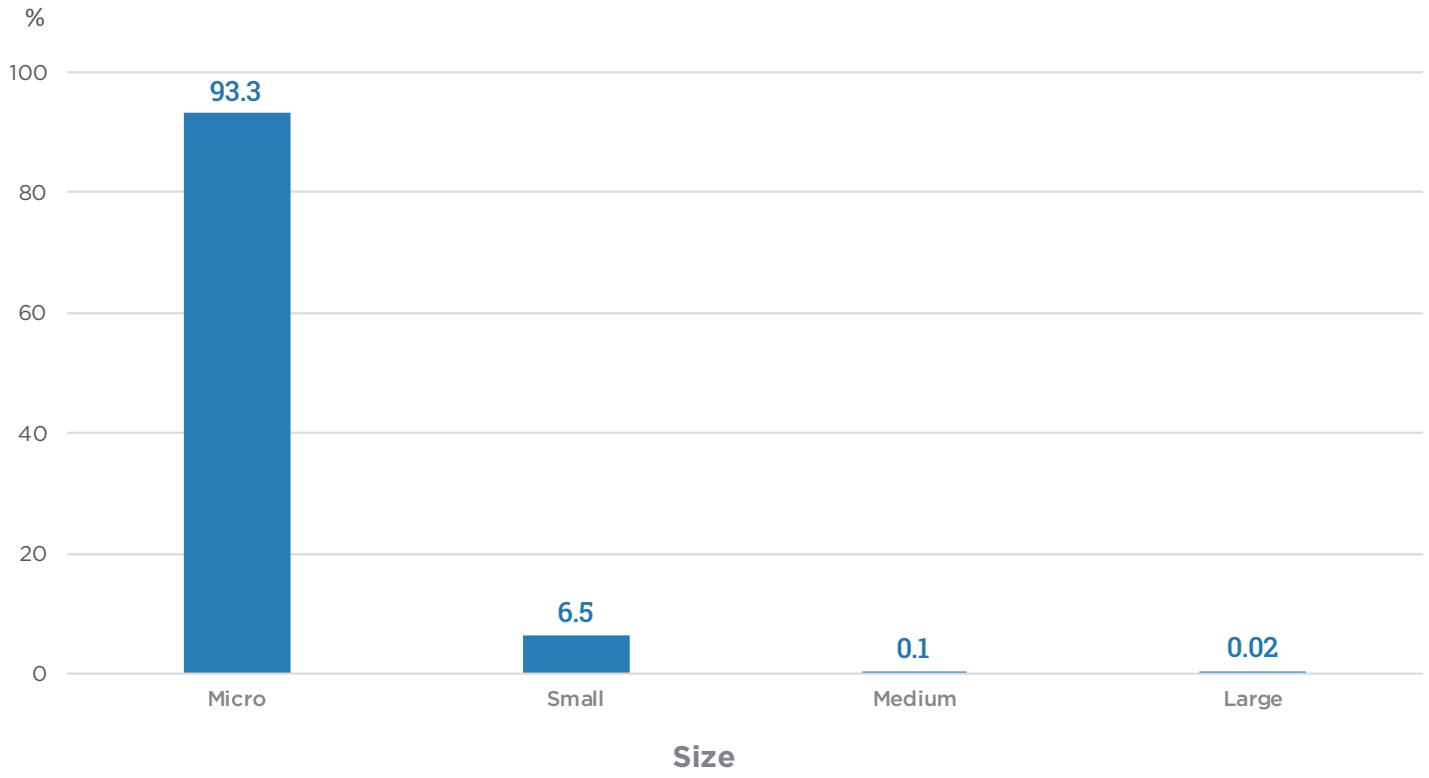
Variable	Definition
Firm age	Firm age is the year difference between the year of firm establishment and the year of firm size transition.
Firm size group	There are four size groups generated based upon the firm employment variable PD7A. PD7A employment is a measurement of employment based upon payroll account deductions. It is an annual average of the number of employees reported by firms every month. The four size groups are micro firms (1 to 4 employees), small firms (5 to 99 employees), medium-sized firms (100 to 499 employees) and large firms (500+ employees).
Profitability	An indicator of how profitable firms are relative to their total asset base the year before their scale up. Profitability provides a measure of how efficient a firm is at converting assets into earnings. Due to data limitations, profitability is calculated by dividing a firm's annual revenue by its total assets.
Leverage ratio	Leverage ratio measures the proportion of a firm's assets that are financed through debt. This provides an indication of a firm's existing financial risks. Due to data limitations, the leverage ratio is calculated by dividing a firm's liabilities by its total assets.
Small Business Deduction	The Small Business Deduction is a government-supported tax break for Canadian small businesses. As a continuous variable, a log-linearized value was adopted in the regression.
Scientific Research and Experimental Development	The Scientific Research and Experimental Development Program is a government tax incentive program designed to encourage Canadian businesses to conduct research and development in Canada. A log-linearized value was used in the regression to smooth out the data.
Region	Five regional categories are used in the regression to identify the geographic impact on firm size transition. The five regions are Atlantic, Quebec, Ontario, Western and the United States (less than 10 observations were coded U.S. in the database).
Industry	Modified Pavitt's Taxonomy (Pavitt 1984) was implemented in this study for the industrial classification. The main purpose is to sort industries according to innovation modes and the flow of knowledge. The categories of firms are labour-intensive, science-based, specialized suppliers, scale-intensive, resource-based, technological services, professional services and other services.

03 EMPIRICAL FINDINGS

Descriptive statistics analysis on size transition

Figure 1 shows the distribution of firms by entry size. Between 2002 and 2014, on average, 93.3 percent of entrant firms were micro firms (fewer than five employees), 6.5 percent were small firms (5 to 19 employees) and 0.1 percent were medium-sized or large firms (20 employees or above). Although the vast majority of new firms in Canada between 2002 and 2014 started with fewer than five employees, it is well known that firms survive and grow better when they enter with more employees (Audretsch and Mahmood 1991, 1995; Audretsch et al. 1999; Mata and Portugal 1994; Mata et al. 1995; Mahmood 2000; Song and Archambault 2018).

Figure 1: Distribution of firm entrants by entry size (cohort average 2002–2014)



Source: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014.

We have not considered every year in the following analysis because we wanted each cohort to have at least 9 years of observations from the time it was established. We created cohorts for the first 5 years only. The goal was to trace firms' size category transitions for those five cohorts between 2002 and 2006 inclusive.

In general, as illustrated in Table 4, over 84.8 percent of firms for any selected cohort, and an average of 86.9 percent across all five cohorts, remained within the same size category over the entire observation period. About 6.0 percent experienced a single size category transition, 5.3 percent experienced two size category transitions, and only 1.9 percent experienced three or more size category transitions.

Table 4: Number of transitions for selected cohorts over the 2002–2014 period

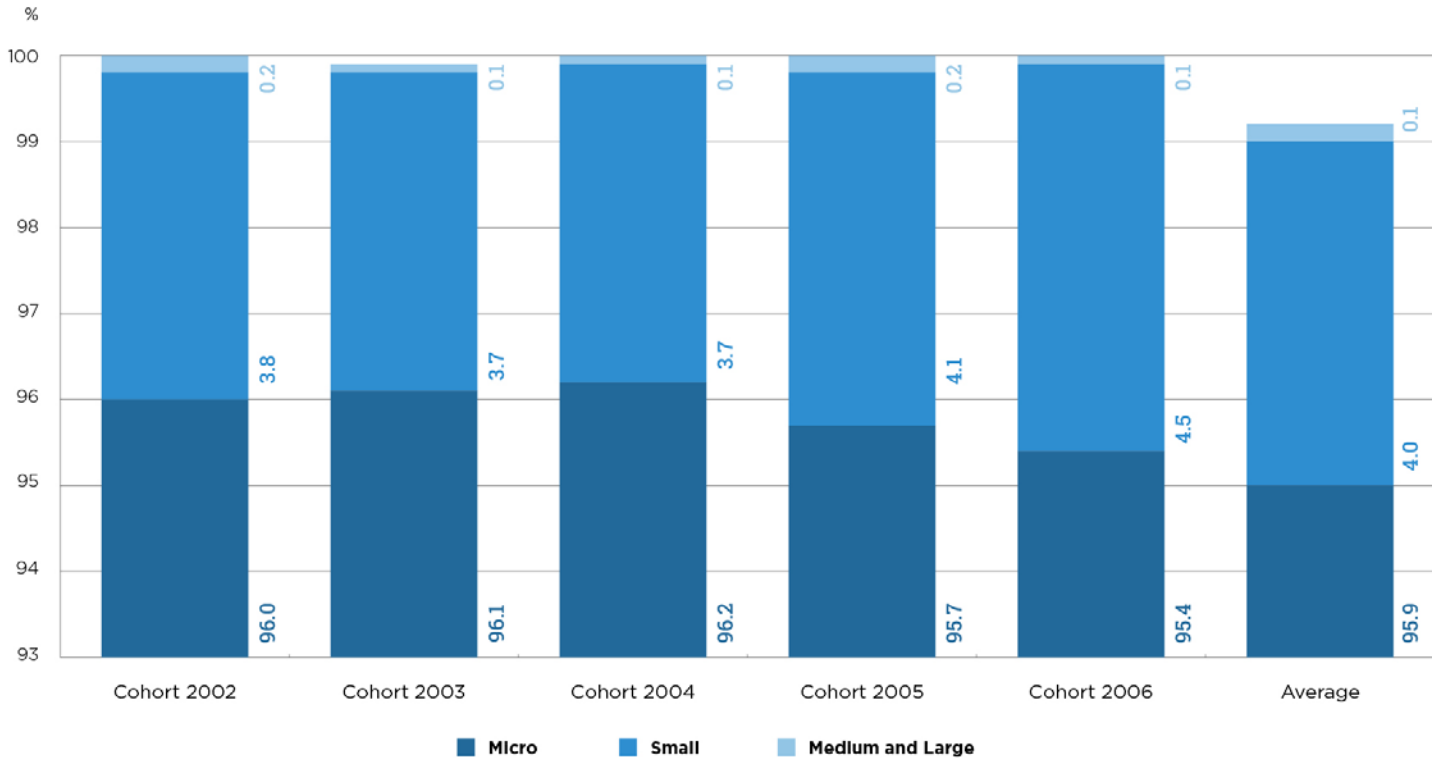
Number of transitions	Cohort 2002 (%)	Cohort 2003 (%)	Cohort 2004 (%)	Cohort 2005 (%)	Cohort 2006 (%)	Average (%)
0	84.8	86.0	86.8	88.0	88.8	86.9
1	6.5	6.0	5.9	5.8	5.8	6.0
2	6.4	5.9	5.5	4.7	4.2	5.3
3	1.1	1.1	0.9	0.9	0.8	1.0
4	0.9	0.8	0.7	0.5	0.4	0.7
5	0.2	0.2	0.1	0.1	0.1	0.1
6	0.1	0.1	0.1	0.0	-	-
7	0.0	0.0	-	-	-	-
8	0.0	-	-	-	-	-

"-" indicates no observation.
Source: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014.

Selected cohorts (2002–2006) with no transition over the 2002–2014 period

Among firms that did not undergo a size category transition during the observation period, 95.9 percent were micro firms, 4.0 percent were small firms, and 0.1 percent was medium-sized or large firms (Figure 2). This distribution by firm size group aligned with the distribution of total firm entrants (Figure 1), indicating that the bulk of firms of all size groups was similarly inclined to remain constant without expanding and/or contracting.

Figure 2: Distribution of firms by size group that did not undergo a size category transition, 2002–2014 (percentage of firms with no transition)



Source: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014.

Selected cohorts (2002–2006) with one transition over the 2002–2014 period

Table 5 shows firm size category transitions by firm size for firms that experienced only one transition. On average, almost 70 percent of firms experiencing a single firm size category transition over the observation period were micro firms scaling up, with most of the rest being small firms scaling down.

Table 5: Distribution of firm size category transitions

Size group (transition = 1)	Cohort 2002 (%)	Cohort 2003 (%)	Cohort 2004 (%)	Cohort 2005 (%)	Cohort 2006 (%)	Average (%)
Micro	**66.2**	**67.0**	**70.4**	**70.9**	**72.3**	**69.4**
Micro to small (scale up)	66.0	66.8	70.1	70.6	72.0	69.1
Micro to medium (scale up)	0.2	0.2	0.2	0.2	0.3	0.2
Small	**33.7**	**32.5**	**29.4**	**28.8**	**27.3**	**30.3**
Small to micro (scale down)	32.9	31.6	28.4	27.6	26.1	29.3
Small to medium (scale up)	0.8	0.9	1.0	1.3	1.2	1.0
Medium	**-**	**0.2**	**0.1**	**0.1**	**0.1**	**0.1**
Medium to small (scale down)	-	0.2	0.1	0.1	0.1	0.1
Medium to large (scale up)	-	-	-	-	-	<0.1

"-" indicates no observation.
Source: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014.

More specifically, of the firms experiencing a single firm size category transition during the observation period, 69.1 percent scaled up from micro firms to small firms,[15] 0.2 percent from micro firms to medium-sized firms and 1.0 percent from small firms to medium-sized firms. Less than 0.1 percent of these firms scaled up from medium-sized firms to large firms. On the scaling-down side, 29.3 percent scaled down from small firms to micro firms and 0.1 percent from medium-sized firms to small firms.

[15] This represents around 6,600 firms on average (or between 5,600 and 7,500, depending upon the cohorts).

Selected cohorts (2002–2006) with two transitions over the 2002–2014 period

Table 6 shows firm size category transitions by firm size for firms that experienced two transitions. On average, 96.2 percent began their two transitions as micro firms, whereas 3.5 percent started as small firms.

Table 6: Distribution of Size Transition Type

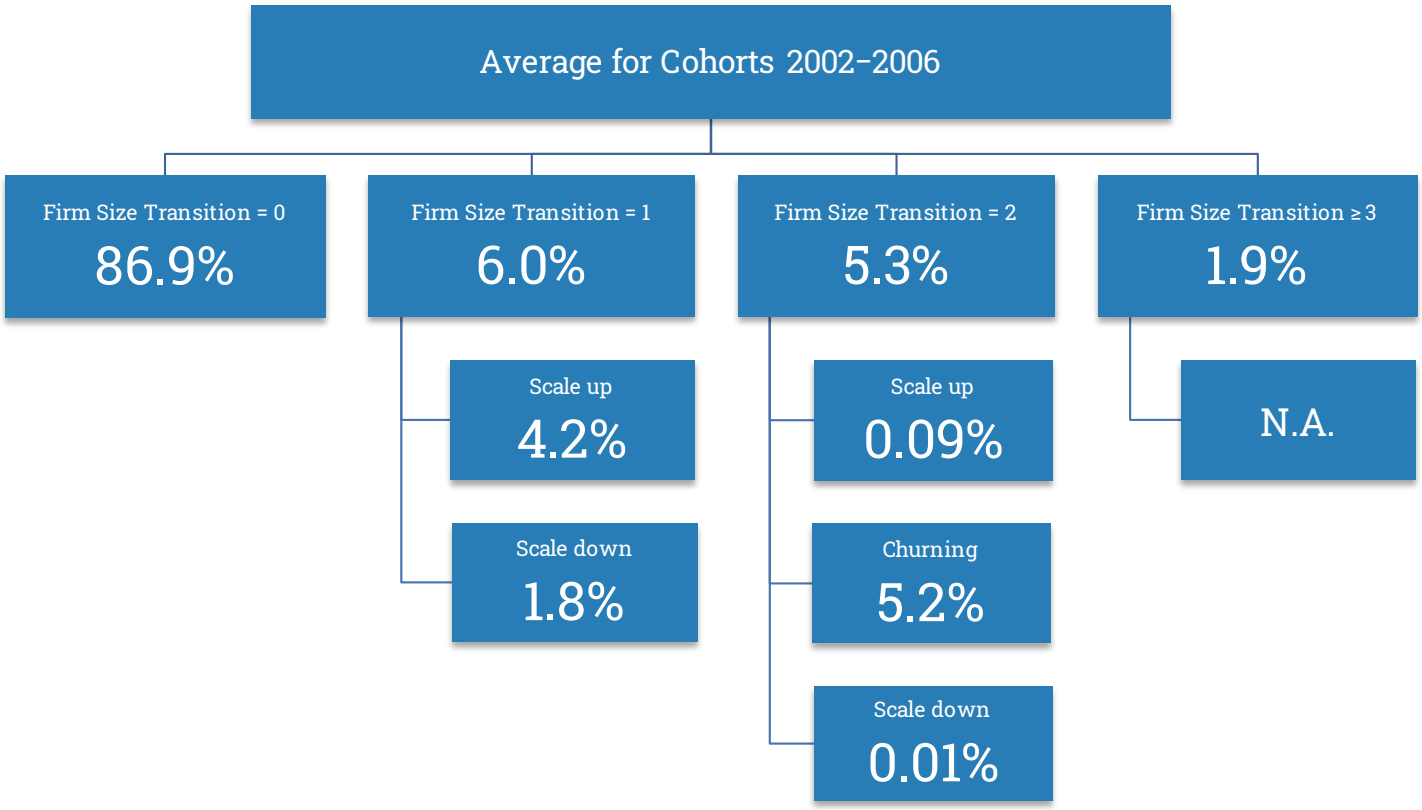
Size group (transition = 2)		Cohort 2002 (%)	Cohort 2003 (%)	Cohort 2004 (%)	Cohort 2005 (%)	Cohort 2006 (%)	Average (%)
	Micro	96.3	96.1	96.8	95.9	96.1	96.2
1st transition	Micro to small (scale up)	96.3	96.0	96.7	95.9	95.8	96.1
1st transition	Micro to medium (scale up)	-	0.2	0.2	-	0.2	-
2nd transition	Small to micro (scale down)	95.7	95.2	96.0	95.2	94.9	95.4
2nd transition	Small to medium (scale up)	0.7	0.8	0.7	0.8	1.2	0.8
2nd transition	Medium to micro (scale down)	-	0.1	0.1	0.2	0.1	0.1
	Small	3.5	3.6	3.0	3.7	3.7	3.5
1st transition	Small to micro (scale down)	2.5	2.7	2.1	2.7	2.9	2.6
1st transition	Small to medium (scale up)	0.9	0.9	0.9	1.0	0.9	0.9
2nd transition	Micro to small (scale up)	2.5	2.7	2.1	2.7	2.8	2.6
2nd transition	Medium to small (scale down)	0.8	0.8	0.8	0.8	0.8	0.8
2nd transition	Medium to large (scale up)	-	0.1	-	-	0.1	-

"-" indicates no observation.
Source: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014.

Interestingly, 96.1 percent, on average, of these two-transition firms scaled up from micro firms to small firms during the first transition, but 95.4 percent scaled back to micro firms during the second transition, leaving only about 0.7 to 0.8 percent of these two-transition firms actually scaling up from micro firms to medium-sized firms during the observation period. It is worth noting that the 2006 cohort had a higher percentage (1.2 percent) of firms scaling up from small firms to medium-sized firms than the other cohorts.

We observed a similar phenomenon for firms that started within the small firm size category. Almost all firms that scaled up from small firms to medium-sized firms (0.9 percent), scaled back during the second transition (0.8 percent). Only around 0.1 percent of small firms successfully scaled up to the medium-sized firm category during the first transition and then graduated to the large firm size category during the observation period.[16] However, the good news seems to be that the reverse is also true. On average, 2.6 percent of small firms scaled down during the first transition and the same percentage scaled up during the second transition, which means that there was a lot of churning at an aggregated level (i.e., not many firms scaled up or down permanently). Figure 3 sums up the findings from the descriptive analysis.

Figure 3: Summary of descriptive analysis



Note: Some values have been rounded off.

On average for the 2002–2006 cohorts, almost 87 percent of firms never changed their firm size category during the observation period. Six percent experienced a single firm size category transition, with 4.2 percent scaling up and 1.8 percent scaling down. As those firms experienced only one transition over the observation period, we can reasonably assume that those are sustainable scale ups (and downs). According to our definition, a sustainable scale up occurs when a firm scales up and stays within (or above) the higher category size for at least 3 years.

By looking at firms that experienced two transitions, we can observe not only sustainable scale ups but also churning (i.e., firms that reversed their firm size category during the second transition). On average, 5.3 percent of cohort firms experienced two firm size category transitions, with 5.2 percent experiencing churning rather than a sustainable scale up (i.e., the 0.09 percent). Overall, among the two transitions firm category, the vast majority of scale ups turned out to be churning rather than scaling up in a sustainable fashion.

[16] This represents around 700 firms.

Sustainable scale up of micro firms

The population of micro firms that successfully scaled up to small firms in a sustainable fashion and survived over the observation period was analyzed further. On average, 34.9 percent of these micro firms scaled up in the first year after being established (Table 7). Looking at the 2002 cohort, which has the longest observation period (i.e., 12 years), we can see that almost 75 percent of these firms scaled up within their first 5 years of operation. The likelihood of scaling up from micro firms to small firms decreased with firm age, which supports other evidence[17] that firms are more likely to grow, or grow sustainably, when they are younger.

Table 7: Duration of sustainable scale up

Duration (micro to small)	Cohort 2002 (%)	Cohort 2003 (%)	Cohort 2004 (%)	Cohort 2005 (%)	Cohort 2006 (%)	Average (%)
9 years (2011)	7.1	-	-	-	-	7.1
8 years (2010)	6.8	7.6	-	-	-	7.2
7 years (2009)	6.5	7.5	9.1	-	-	7.7
6 years (2008)	6.5	6.8	9.3	10.4	-	8.3
5 years (2007)	7.8	7.9	7.9	10.1	12.5	9.3
4 years (2006)	8.6	9.6	9.1	10.0	12.9	10.0
3 years (2005)	10.1	11.8	10.7	12.3	12.6	11.5
2 years (2004)	16.2	17.0	19.3	20.4	21.2	18.8
1 year (2003)	30.3	31.7	34.6	36.9	40.7	34.9
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014.

[17] Song and Archambault (2018).

Binomial and trinomial regression modelling results

Both binomial and trinomial logistic regressions were conducted for the five cohorts between 2002 and 2006. As regression results were very similar among the five cohorts, only results associated with the 2002 cohort are presented in this report.

Binomial logistic regression

For the binomial logistic regression, the dependent variable was defined as one when a firm scaled up and as zero when a firm scaled down or remained within the same size category. Table 8 presents the results of the binomial regression (intercept not shown).

Table 8: Binomial logistic regression

Cohort 2002 (0 = scaled down; 1 = scaled up)	Estimate	Pr > ChiSq	Odds Ratio
Firm age	-0.02	<0.0001	0.979
Firm size before size transition (reference: small)			
Micro	2.30	<0.0001	9.961
Medium	0.87	<0.0001	2.39
Large	-	-	-
Financial indicator			
Profitability	0.01	<0.0001	1.008
Leverage ratio	-0.03	<0.0001	0.966
Government programs			
Small Business Deduction (in Ln)	0.09	<0.0001	1.096
SR&ED expense (in Ln)	0.15	<0.0001	1.166
Region (reference: Ontario)			
Atlantic	0.23	<0.0001	1.262
Quebec	0.19	<0.0001	1.212
Western	0.10	<0.0001	1.105
USA	-0.89	<0.0001	0.412
Modified Pavitt industry (reference: labour-intensive)			
Science-based	-0.25	0.0286	0.78
Specialized supplier	-0.03	0.6739	0.969
Scale-intensive	0.02	0.8057	1.015
Resource-based	0.39	<0.0001	1.484
Tech-based services	-1.06	<0.0001	0.347
Profession-based services	-1.03	<0.0001	0.358
Other services	-0.32	<0.0001	0.729

Sources: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014; and authors' calculations.
Note: Some estimates and odds ratios have been rounded off.

As expected, firm age is negatively related to scaling up, suggesting that older firms are less likely to shift into a higher firm size category. All things being equal, the probability of scaling up is almost 10 times greater for micro firms than for small firms, the reference category for firm sizes. Medium-sized firms also appear to be more likely to scale up than small firms. Of course, large firms are already in the top firm size category and cannot scale up by definition. Small firms appear to have difficulties growing to over 100 employees.[18]

Results show that the probability of firms scaling up is positively associated with firm profitability and negatively related to the leverage ratio, i.e., given all the other controls. Thus, a higher profitability ratio would slightly increase the chance of scaling up. A higher leverage ratio, on the other hand, may indicate that a company is more dependent upon borrowing for its operations and, based upon the results (i.e., a negative parameter estimate), would have less chance to scale up.

The analysis shows that both the Small Business Deduction and the Scientific Research and Experimental Development incentive have a positive impact on the likelihood of scaling up. Because these variables have been transformed into natural logs (ln), a unit increase in the natural log of the SBD is associated with a 9.6 percent increase in the probability of scaling up (i.e., odds ratio = 1.096). In other words, raising the SBD 2.718 times,[19] holding all other variables constant, is associated with a 9.6 percent increase in the probability of scaling up. We can also express that in percentage change.[20] An 11.45 percent increase in the SBD would raise the odds of scaling up by 1 percent. If a firm doubles its SBD (i.e., increase of 100 percent), the odds of scaling up would rise by 6.57 percent.

The same calculations can be made with the SR&ED incentive. Raising the SR&ED incentive 2.718 times is associated with a 16.6 percent increase in the probability of scaling up. If a firm doubles its admissible R&D expenses, the odds of scaling up would rise by 11.2 percent. Similarly, to raise the odds of scaling up by 1 percent, a firm would have to raise its SR&ED expenses by 6.7 percent. We also added controls for geography and industry type. For the geographic control, the results should be interpreted relative to the province of Ontario.

For example, the binomial regression tells us that firms in the Atlantic Region, Quebec and Western part of the country were more likely to scale up than those in Ontario. In other words, firms in Ontario had proportionally fewer size group changes. Industrial sectors were combined based upon Pavitt's and Castellacci's taxonomies (Pavitt 1984; Castellacci 2008). Three industry sectors were not statistically significant compared with the labour-intensive industry. Only resource-based industries were more likely to scale up than labour-intensive industries (the reference).

[18] Using a smaller size category we found, for example, that only 0.5 percent of firms went from the 20–49 to 50–99 employee category. Canadian firms seem to have more difficulty growing to over 20 employees and then to over 50 employees than from 100–499 employees to 500+ employees, i.e., considering the other controls in the regression.
[19] A unit increase = exp(1) = 2.718 (rounded off at three digits).
[20] For example, an 11.45 percent increase in the SBD (i.e., ln(1.1145)) is given by the formula [(Exp (ln(1.1145)*0.0918)) – 1]*100 = 1 percent increase in the odds of scaling up.

Trinomial logistic regression

In conjunction with binomial modelling, trinomial modelling further differentiates between firms that scaled down (coded 0), scaled up (coded 1), or neither scaled up nor down (coded 2), which was the reference for the model. Table 9 presents the results of the trinomial regression (intercept not shown). The probability of scaling up or scaling down is relative to the probability of neither scaling up nor down. Results are consistent with the results of the binomial regression discussed previously.

Table 9: Trinomial logistic regression

Cohort 2002 (0 = scaled down; 1 = scaled up; 2 = unchanged [reference])		Estimate	Pr > ChiSq	Odds Ratio
Firm age	Scaled down	-0.0213	<0.0001	0.979
	Scaled up	-0.0214	<0.0001	0.979
Firm size before size transition (reference: small)				
Micro	Scaled down	-	-	-
	Scaled up	2.2053	<0.0001	9.073
Medium	Scaled down	0.4258	<0.0001	1.531
	Scaled up	0.9053	<0.0001	2.473
Large	Scaled down	-0.5801	<0.0001	0.56
	Scaled up	-	-	-
Financial indicator				
Profitability	Scaled down	0.0118	<0.0001	1.012
	Scaled up	0.00814	<0.0001	1.008
Leverage ratio	Scaled down	-0.0068	<0.0001	0.993
	Scaled up	-0.0341	<0.0001	0.966
Government programs				
Small Business Deduction (in Ln)	Scaled down	-0.074	<0.0001	0.929
	Scaled up	0.0914	<0.0001	1.096
SR&ED expense (in Ln)	Scaled down	-0.0415	<0.0001	0.959
	Scaled up	0.1519	<0.0001	1.164
Region (reference: Ontario)				
Atlantic	Scaled down	0.1539	<0.0001	1.166
	Scaled up	0.2336	<0.0001	1.263
Quebec	Scaled down	0.0401	0.0069	1.041
	Scaled up	0.193	<0.0001	1.213
Western	Scaled down	0.0907	<0.0001	1.095
	Scaled up	0.1009	<0.0001	1.106
USA	Scaled down	-0.0414	0.7489	0.959
	Scaled up	-0.8876	<0.0001	0.412
Modified Pavitt industry (reference: labour-intensive)				
Science-based	Scaled down	0.0927	0.3637	1.097
	Scaled up	-0.2461	0.0304	0.782
Specialized supplier	Scaled down	-0.0956	0.1797	0.909
	Scaled up	-0.0328	0.6605	0.968
Scale-intensive	Scaled down	-0.1265	0.0232	0.881
	Scaled up	0.014	0.8212	1.014
Resource-based	Scaled down	-0.1014	0.0514	0.904
	Scaled up	0.3941	<0.0001	1.483
Tech-based services	Scaled down	0.0159	0.7170	1.016
	Scaled up	-1.0576	<0.0001	0.347
Profession-based services	Scaled down	-0.0969	0.0176	0.908
	Scaled up	-1.0258	<0.0001	0.359
Other services	Scaled down	-0.15	<0.0001	0.861
	Scaled up	-0.3168	<0.0001	0.728

Sources: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014; and authors' calculations.
Note: Some estimates and odds ratios have been rounded off.

As expected, firm age is negatively related to scaling up, but also to scaling down. This, again, suggests that younger firms demonstrate a greater likelihood of changing group size categories, either up or down, than older firms, which tended to remain within their group size categories. Raising the age of a firm by 1 year is associated with a 2.1 percent decrease in the probability of scaling up or down. We concluded that employment levels in older companies are more stable.

The effects of firm size on scaling up are very similar to those observed in the binomial regression. For example, the probability of a micro firm scaling up is nine times higher than for a small firm, compared with 10 times in the binomial regression. Medium-sized firms display almost 2.5 times the likelihood of scaling up as small firms; however, they are also 1.5 times more likely to scale down than small firms. Unlike with the binomial model, the trinomial regression model could estimate the probability of a large firm scaling down. We found that the probability of large firms scaling down was almost half that of small firms (i.e., large firms have 44 percent less chance of scaling down than small firms). We noticed that large firms (500+ employees) do not scale down much once they reach this category size.

As for the binomial regression results, the trinomial regression also shows that a higher profitability ratio slightly increases the chance of scaling up. However, the results also indicate that a higher profitability ratio increases the chance of scaling down (even more than scaling up). We have no definitive explanation for this counterintuitive result apart from some endogenous effect. We advance the (non-tested) hypothesis that it might have to do with the risk a company is ready to take and its financial health in general. All things being equal, a firm can take more risks if it is profitable and take the chance to expand (i.e., scale up). However, it is common knowledge that firms in difficulty sometimes scale down (employment) to raise profitability. Those behaviours could explain the results of the trinomial regression.

For the leverage ratio, results showed that a higher ratio decreases the chance of scaling up. Again, as with the binomial regression, firms that potentially rely more on borrowing for their operations have less chance to scale up, but this time compared with not scaling. We were expecting that those same firms would be more likely to scale down than to not scale at all, but we found the reverse. Firms that potentially rely more on borrowing for their operations have less chance to scale down than to not scale at all, although the effect is smaller (than for scaling up). In other words, firms with high leverage ratios have more chance of not scaling at all than scaling up or down. Again, this result might have to do with the risk taken. One explanation could be that firms relying more on borrowing for their operations are less prone to take risk, so they have less chance to scale up or down.

Trinomial modelling results suggest that firms that leveraged either the SBD or the SR&ED Program were more likely to scale up and less likely to scale down. The odds ratios also suggest that the SR&ED Program provides higher odds for scaling up than the SBD and that the SBD provides higher odds for not scaling down. Overall, both the SBD and SR&ED Program tend to be positively associated with firm performance in terms of employment.

As for the binomial regression, these variables have been transformed into natural logs (ln). Also, as for the binomial regression, a unit increase in the natural log of the SBD is associated with a 9.6 percent increase in the probability of scaling up (i.e., odds ratio = 1.096), but this time compared with not scaling (instead of scaling down — reference for the binomial model). As the SBD parameter for the trinomial regression is very close to the SBD parameters for the binomial regression, an 11.45 percent increase in the SBD would also raise the odds of scaling up (but this time compared with not scaling) by 1 percent. For the SR&ED Program, a 6.8 percent increase in expenses would raise the chance of scaling up by 1 percent. These are almost exactly the same odds as for the binomial regression, indicating that the odds of scaling up associated with the SBD and SR&ED Program are almost the same whether you compare them with scaling down or not scaling.

With the trinomial regression, we can also look at the probability of scaling down. A unit increase in the natural log of the SBD is associated with a 7.1 percent decrease in the probability of scaling down (i.e., odds ratio = 0.929) relative to not scaling. A unit increase in the natural log of the SR&ED Program is associated with a 4.1 percent decrease in the probability of scaling down (i.e., odds ratio = 0.959) relative to not scaling. A 14.55 percent increase in the SBD or 27.4 percent increase in SR&ED expenses would decrease the odds of scaling down by 1 percent. Although both the SBD and SR&ED Program raise the chance of scaling up and diminish the chance of scaling down compared with not scaling, we noticed that the SBD is associated more with the chance of not scaling down and the SR&ED Program with the chance of scaling up.

Proportional hazards regression model

Size transition through a firm's life cycle is a multi-state process, and transition events are interrelated. As a greater focus should be placed on the factors contributing to a firm's sustainable growth, a Cox regression (Cox 1972) was conducted to estimate the magnitude of potential factors that contribute to the sustainability of scaling up.

Although the analysis was conducted on all of the cohorts and as there was consistency in the results across cohorts and with the logistic regressions, only results from the analysis of the 2003 cohort are presented in Table 10.

Interpretations (of parameters and odds ratios) from a proportional hazards regression are not very different from those from a logistic regression. However, we do not calculate the probability of scaling up relative to scaling down or the probability of scaling up (or down) relative to not scaling. Instead, the proportional hazards regression model measures the instant relative "risk" of sustainably scaling up relative to not sustainably scaling up.

Results indicate that micro firms and medium-sized firms demonstrate a greater potential to achieve sustainable scale up than small firms. However, the probability of scaling up in a sustainable manner for medium-sized firms (5.2 times), compared with small firms, is significantly higher than when we looked at scaling up only (i.e., 2.4 times for the binomial regression and 2.5 times for the trinomial regression). The differences for micro firms relative to small firms are much less when you compare the binomial (10 times), trinomial (9 times) and Cox regressions (11 times). The results support the argument that when Canadian firms scale up to the larger firm category, they generally do not scale down.

A firm's profitability is positively related to its probability to scale up in a sustainable manner, whereas its leverage ratio is negatively related to its probability to scale up sustainably, suggesting that higher leverage ratios do not favour sustainable scale up. Although profitability is statistically significant, the association between a higher profitability ratio and sustainably scaling up is very small, as were the associations in the binomial and trinomial regressions.

Both the SBD and the SR&ED Program are associated with a higher chance to sustainably scale up. We noticed that the association between the SBD and sustainably scaling up is not as high as the association between the SBD and scaling up that we calculated in the binomial and trinomial regressions. For the SR&ED Program, the association is slightly higher than in the binomial and trinomial regressions. For the SR&ED Program, a 5.9 percent increase in expenses would raise the chance of sustainably scaling up by 1 percent.

Table 10: Cox proportional hazards regression

Proportional hazards regression on sustainable growth (Cohort 2003)	Estimate	Pr > ChiSq	Odds Ratio
Firm size before size transition (reference: small)			
Micro	2.4314	<0.0001	11.375
Medium	1.64832	<0.0001	5.198
Large	-	-	-
Financial indicator			
Profitability	0.00606	<0.0001	1.006
Leverage ratio	-0.04316	<0.0001	0.958
Government programs			
Small Business Deduction (in Ln)	0.0715	<0.0001	1.074
SR&ED expense (in Ln)	0.17412	<0.0001	1.19
Region (reference: Ontario)			
Atlantic	0.11333	0.0084	1.12
Quebec	0.14286	<0.0001	1.154
Western	0.06453	0.003	1.067
USA	-0.45901	0.1125	0.632
Modified Pavitt industry (reference: labour-intensive)			
Science-based	-0.1022	0.583	0.903
Specialized supplier	-0.03082	0.8095	0.97
Scale-intensive	0.10853	0.346	1.115
Resource-based	0.63809	<0.0001	1.893
Tech-based services	-0.96111	<0.0001	0.382
Profession-based services	-1.09372	<0.0001	0.335
Other services	-0.31724	<0.0001	0.728

Sources: Statistics Canada, National Accounts Longitudinal Microdata File, 2002–2014; and authors' calculations.
Note: Some estimates and odds ratios have been rounded off.

04 CONCLUSIONS

This study has provided a statistical analysis of Canadian firm size category transitions by examining five cohorts of firm entrants over the period 2002 to 2006. In addition, the analysis used binomial and trinomial logistic regressions, as well as a Cox proportional hazards regression, to estimate the potential impact of selected firm characteristics on firm size category transitions. Those characteristics included firm age, firm size before transition, financial indicators and some government tax incentives. The analysis included controls such as region and industrial sectors.

Overall, the vast majority of firms (nearly 87 percent on average) appeared to stay within the same size category during the observation period without scaling up or scaling down. The analysis provided in this paper included every Canadian firm contained in the database. Scale-up proportions could have been higher if the authors had been able to identify lifestyle businesses that are less prone to growth by definition. In any case, the NALMF database should not be used to report official counts, as this is a constructed database for research purposes. That being said, proportions and relative numbers are still good indicators of what is going on.

On average, 6 percent of firms experienced either a single scale-up or scale-down transition. Of that 6 percent, 70 percent experienced a scale-up transition — mostly from a micro firm to a small firm — and 30 percent experienced a scale-down transition — mostly from a small firm to a micro firm. This means that 4.2 percent of all firms scaled up without scaling back over the period, which would correspond to sustainable scale up.

About 7 percent of firms experienced more than one transition over the observation period. Of that 7 percent, 5.3 percent experienced two transitions during the observation period. We looked at those firms that experienced two transitions: 96.1 percent scaled up from a micro firm to a small firm in their first transition. However, most of these firms were simply churning as 95.4 percent scaled back to the micro firm category. Similarly, while 0.9 percent transitioned from small to medium-sized firms, 0.8 percent transitioned back to the small firm category. Less than 1 percent that experienced two transitions scaled up from micro firms to small firms and then continued their growth trajectory to scale up to medium-sized firms in their second transition. There were not many sustainable scale ups among firms that experienced two transitions as most firms that scaled up eventually scaled back.

We noticed that most scaling activities occur in the bottom of the distribution. On average, 34.9 percent of micro firms scaled up in the first year after being established and almost 75 percent of firms that scaled up did so within their first 5 years of operation. The likelihood of scaling up decreased with firm age, which supports other evidence that firms are more likely to grow, or grow sustainably, when they are younger. While the observable firm characteristics contained in the study's dataset were limited, the logistic regressions, as well as the Cox proportional hazards regression, produced consistent results. Small firms were less likely to scale up or scale down compared with micro firms or medium-sized firms. Further research could be undertaken on the population of small firms to explore how homogeneous this group is in terms of growth and whether there are factors that promote the growth of small firms.

The probabilities associated with firms scaling up or scaling down were both positively related to profitability and both negatively related to the leverage ratio. This suggests that a firm's financial position has a significant influence on its capacity to scale up.

Two key government tax incentives, the Small Business Deduction and the Scientific Research and Experimental Development Program revealed themselves to have a significant positive influence on a firm's scaling up prospects and could improve the odds that a firm would not scale down. Both also showed a significant positive association with sustainable scale ups. While both programs showed a positive influence on the odds of a firm scaling up and not scaling down, odds ratios suggest that the SR&ED Program provides higher odds for firms scaling up, while the SBD provides higher odds for firms not scaling down.

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