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CANADIAN HIGH-GROWTH SMEs AND THEIR PROPENSITY TO INVEST IN R&D AND EXPORT

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ABSTRACT

Growth, research and development (R&D) and exporting are known to be strongly linked. The literature shows that investments in R&D and exporting lead to increased growth but there is less evidence on other directions of these links, particularly with respect to high-growth firms. This research uses a unique set of survey data on Canadian small and medium-sized enterprises (SMEs), linked with administrative tax data, to explore 1) whether the R&D propensity of SMEs increases with exporting and high-growth, and 2) whether the export propensity of SMEs increases with R&D and high-growth. Results indicate that R&D propensity is significantly predicted by exporting but is not significantly predicted by high growth. Likewise, export propensity is significantly predicted by R&D, while there is mixed evidence on whether export propensity is significantly predicted by high growth.

1. INTRODUCTION

High-growth firms (HGFs) are defined as firms that disproportionately drive growth in employment or sales.[1] Rapid growth is naturally of great interest to policy-makers and researchers alike, with the latter group producing an extensive body of literature showing that HGFs, of which a majority are small and medium-sized enterprises (SMEs), play a vital role in job creation.[2]

Given the well-established links between firm performance, research and development (R&D) and exporting,[3] it may be tempting to presume that rapid growth generally leads to increased R&D spending and exports.

Such a presumption, however, lacks empirical support, with evidence limited to descriptive statistics showing that high growth correlates positively with innovation and exports. In particular, HGF research has left the links between high growth, exports and R&D largely unexplored. Exports and R&D are known to drive growth, but their links to high growth are less clear, while there is no evidence on the other direction of the relationship, whether high growth leads to exports and R&D.

This paper aims to fill one part of this research gap by addressing the following question: are HGFs more likely than non-HGFs to undertake R&D or to export?[4]

The results, based upon a unique set of survey data on Canadian SMEs, Statistics Canada's *Survey on Financing and Growth of Small and Medium Enterprises*, 2011, linked with administrative tax data for the years 2007 to 2011, indicate that high-growth firms, controlling for other factors influencing R&D propensity, are no more likely to undertake R&D than their slower growth counterparts. Although

1 This study uses the U.S. Bureau of Labor Statistics definition of high growth, which is based upon employment. See Section 2 for details.

2 See, for example, Nightingale and Coad (2014).

3 See, for example, Unterlass (2013).

4 The other direction of the relationship — does R&D spending or exporting drive high growth? — is also worthy of study, but the data used here are not suitable for such an analysis.

the results for exporting propensity are less categorical, there is no clear evidence indicating that in general high-growth SMEs are more likely to export.

One implication of these results is that while R&D, exporting and high growth are correlated, caution should be applied when assuming that any one activity leads to the others.

Following a review of the literature below, the remainder of this paper is structured as follows: Section 2 describes the data, Section 3 discusses descriptive statistics, Section 4 describes the econometric analysis and Section 5 presents conclusions.

The respective bodies of literature on high-growth firms, innovation and exports are vast, and a full review of each body of work is well beyond the scope of this paper. Instead, the focus here is on studies dealing with the overlap between high-growth firms, innovation and exports.[5] In particular, two areas of research are relevant to the present study — studies linking HGFs with innovation and exports, and studies linking more general firm performance with innovation and exports.

1.1 HIGH-GROWTH FIRMS, INNOVATION AND EXPORTS

Research into HGFs is overwhelmingly focused on the relationship between firm size and rapid growth. Studies on HGFs began following the publication of Birch (1979), who found that small firms are responsible for the majority of job growth in the United States. A large body of literature followed, exploring the apparent rapid growth of small firms. Subsequently, a more nuanced conclusion was reached — growth is driven by young firms, which tend to be small, rather than by small firms per se, that is, conditioning on firm age, firm size does appear to significantly impact growth.[6] In fact, the majority of small firms do not grow or grow very slowly. It is also the case, however, that a small number of small firms are HGFs, and it is these firms that play a critical role in overall job creation.[7]

Within the HGF literature, however, only a limited number of studies specifically examine the relationship between high growth, innovation and exports. Coad and Rao (2008) use quantile regressions on a large U.S. firm database, finding that patents and R&D increase firm sales growth across the sales growth distribution. In particular, the effect for firms in the 90th percentile is considerably higher.

Other studies link the three activities using descriptive statistics to show that high growth, innovation and exports are positively correlated, although descriptive analyses do not explore the direction of the relationships.

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5 Note that reference in this section is to the broader topic of "innovation" rather than only to "R&D" (as in the rest of this study). This follows the convention, in the literature reviewed here, of treating R&D as a proxy of innovation.

6 See, for example, Neumark et al. (2011) and Haltiwanger et al. (2013).

7 See, for example, Acs and Mueller (2008), Halabisky (2006) and Davidsson and Henrekson (2002). Decker et al. (2016), however, suggest that the importance of HGFs in the United States may be decreasing, with the percentage of young HGFs on the decline. Coad et al. (2014) provide a useful summary of HGF literature.

In a wide-ranging survey of literature linking innovation and growth, Baldwin and Gellatly (2006) present Canadian survey data showing that, broadly speaking, high-growth entrants are twice as likely to innovate as their slower growth counterparts.

Halabisky (2006) and Parsley and Halabisky (2008) analyze linked administrative data for the universe of Canadian firms from 1993 to 2002. They found that exporters are more likely to be hyper- or strong-growing[8] firms than non-exporters; firms that exported in 2002 account for nearly half of the job growth in continuing firms from 1993 to 2002, while comprising only 6 percent of this subpopulation; fast-growing exporters are responsible for a disproportionately large share of job growth by all fast-growing firms; and wage growth over this period is 20 percent higher in exporting firms than non-exporting firms.

Evidence from the United Kingdom also links high growth, innovation and exports. The Department for Business Enterprise & Regulatory Reform (2008) shows that innovative firms are more likely to be HGFs, while a wide-ranging survey by the U.K. Department for Business, Innovation & Skills (2010) on the internationalization of innovative and high-growth SMEs notes that HGFs are both more likely to export and more likely to innovate.

To summarize, limited evidence shows that high growth, innovation and exports are positively related. The direction of the relationships, however, is unclear with one exception: innovation positively increases growth in HGFs (Coad and Rao 2008).

This study contributes to research on high growth, R&D and exports by evaluating two relationships: whether high-growth firms are more likely to undertake R&D, and whether high-growth firms are more likely to export. Though the estimates presented in this study should not be interpreted as structural, they do go further than the descriptive analyses described above, offering correlations conditional on other factors important to R&D and export propensities, while controlling at least partially for simultaneity.

1.2 FIRM PERFORMANCE, INNOVATION AND EXPORTS

Outside of HGF research, numerous studies link innovation and exports to a range of other firm performance metrics (including employment growth, although not high-growth employment growth). This broader body of literature can be categorized according to the following themes: self-selection hypothesis, impact of innovation on exports, learning-by-exporting hypothesis, exports and economic performance, and innovation and economic performance. As this literature is reviewed comprehensively elsewhere, only a brief summary is given here.[9]

A company exporting for the first time faces sunk costs, such as establishing contacts and distribution channels and adjusting its products to export-destination market tastes. To the extent that these costs are non-trivial, more productive firms will be more likely to self-select into export markets.

8 Halabisky (2006) and Parsley and Halabisky (2008) define hyper- and strong-growth as over 150 percent growth in employment and 50 to 150 percent growth in employment, respectively, from 1993 to 1996.

9 The following themes: self-selection hypothesis, impact of innovation on exports, learning-by-exporting hypothesis, exports and economic performance, and innovation and economic performance are borrowed from Unterlass (2013).

A number of studies, such as Aw et al. (2011) and Bernard and Jensen (1999), provide evidence indicating that productive firms are, indeed, more likely to begin exporting than less-productive firms.

Innovation often increases productivity or leads to other competitive advantages that may, in turn, positively impact exports. Becker and Egger (2013) and Lefebvre and Lefebvre (2000) are among the many studies pointing to the positive effects of innovation and R&D on exports.[10]

Conversely, Criscuolo et al. (2010) and Crespi et al. (2008) found that exporting positively impacts innovation by exposing firms to innovative products and, more generally, a greater pool of knowledge — these ideas and innovations, in turn, increase productivity.

Exporting may also increase firm performance along dimensions other than productivity, such as employment growth. For example, Bernard and Jensen (1999) found that U.S. manufacturers that export experienced greater employment growth, while survey results from the European Commission (2010) showed employment growth of exporters to be much higher than that of non-exporters.

Likewise, innovation can positively impact economic performance. For example, employment growth among manufacturing firms in Japan and Taiwan that invest in R&D is greater than among those that do not, while sales growth among innovative Italian industries exceeds that among non-innovative industries.[11] Innovation resulting in more efficient production processes may reduce the need for labour, however, so innovation is not always associated with increased employment.[12]

This paper contributes to the broader study of firm performance, innovation and exports using high-growth status as a performance metric.

2. DATA

The data used for this analysis come from Statistics Canada and the Canada Revenue Agency. In particular, the data link the 2011 *Survey on Financing and Growth of Small and Medium Enterprises* with *General Index of Financial Information*, payroll deduction and *Annual Survey of Research and Development in Canadian Industry* data for the years 2007 to 2011.

The *Survey on Financing and Growth of Small and Medium Enterprises* is a cross-sectional survey on small and medium-sized businesses and their financing activities that provides detailed information on firm and owner characteristics, including export activity.[13] The linkage with *General Index of Financial Information* and payroll deduction data is important for regression analysis, which requires the use of lagged (2010) financial and high-growth variables to avoid bias due to simultaneity.

10 In particular, Becker and Egger (2013) show that product innovation impacts the propensity to export. Process innovation, on the other hand, does not appear to impact export decisions.

11 Yasuda (2005), Yang and Huang (2005) and Del Monte and Papagni (2003).

12 Klette and Forre (1998).

13 The *Survey on Financing and Growth of Small and Medium Enterprises* defines SMEs as firms with between 1 and 499 employees, and excludes from its population non-profit organizations, joint ventures, government agencies and the following North American Industry Classification System (NAICS) industries: 22, 52, 55, 61, 91, 5321, 5324, 6214, 6215, 6219, 6221, 6222, 6223 and 6242.

The *Annual Survey of Research and Development in Canadian Industry* provides information on R&D expenditures. In particular, the annual survey was, until 2011, a census of firms claiming the Scientific Research and Experimental Development (SR&ED) Tax Credit. To the extent that firms may spend on R&D without claiming the SR&ED tax credit, the number of firms spending on R&D is likely higher than that identified by the *Annual Survey of Research and Development in Canadian Industry*.

Firms are defined as high growth in 2010 according to the U.S. Bureau of Labor Statistics (Clayton et al. 2013) definition, that is, a firm with 10 or more employees in 2007 is considered to be high growth in 2010 if its average annual employment growth was 20 percent or more over the previous three years. A firm with fewer than 10 employees in 2007 is considered to be high growth in 2010 if it increased in size by eight or more employees since 2007.

The Bureau of Labor Statistics definition is an extension of the Organisation of Economic Co-operation and Development (OECD) definition, which excludes small firms, treating as high growth only firms that have grown from 10 employees or more at an average annual rate of 20 percent or more over the previous three years. The Bureau of Labor Statistics definition has important advantages: simplicity, international comparability and inclusion of small firms. In particular, as firms with fewer than 10 employees comprise the majority of the SME population, the OECD definition limits analysis somewhat compared with the broader Bureau of Labor Statistics definition.

The complete 2011 *Survey on Financing and Growth of Small and Medium Enterprises* sample contains roughly 8,500 firms that have operated four or more years and are incorporated.[14] Roughly 2,000 additional firms were removed due to missing values for the required administrative variables (e.g., financial, employment and R&D data), for a final sample of just over 6,500 firms. The statistics calculated throughout this analysis are weighted using survey weights, with an adjustment to account for these sample exclusions.[15]

Table 1 presents the means (which give proportions for binary variables) and standard deviations for the variables used in the econometric analysis.[16] For the regressions of R&D and exporting decisions, the dependent variables are binary indicators for R&D and exporting, created from the *Annual Survey of Research and Development in Canadian Industry* and *Survey on Financing and Growth of Small and Medium Enterprises*, indicating if firms spent on R&D or exported in 2011.[17]

14 More precisely, firms are considered to be incorporated when they have T2 income tax data. Firms that have operated less than 4 years cannot be high growth in the years up to 2010 and are, therefore, not included in this study. In addition, the small number of SMEs within the territories have been removed.

15 See Appendix A for details on survey weight adjustment.

16 Industries are divided following the NAICS. Note that the "all other" category is comprised primarily of the construction, accommodation and food services, and other service sectors, which rarely export or spend on R&D. See Appendix B for further details.

17 Exports include both exports of goods and services.

Table 1: Summary statistics

	Mean	Standard deviation
Dependent variables		
R&D	0.04	0.19
Export	0.11	0.31
Independent variables		
High growth (2010)	0.02	0.12
R&D (2010)	0.04	0.20
Firm characteristics		
Size (number of employees, 2010)	11	20
Total assets ($ 2010)	1,053,893	4,708,168
Labour productivity ($ sales / number of employees, 2010)	151,937	259,457
Working capital ($ 2010)	41.75	xxx
Industry Grouping		
Natural Resources and Mining	0.06	0.23
Manufacturing	0.07	0.26
Retail, Wholesale and Transportation	0.25	0.43
Information, Cultural and Professional Services	0.11	0.32
Information and Communications Technology	0.04	0.20
All Other	0.47	0.50
Province or region		
Atlantic	0.07	0.26
Quebec	0.21	0.41
Ontario	0.34	0.47
Prairie	0.06	0.24
Alberta	0.14	0.34
British Columbia	0.17	0.38
Owner characteristics		
Immigrant	0.23	0.42
Education		
No bachelor's degree	0.65	0.48
Bachelor's degree	0.22	0.42
Master's degree or above	0.13	0.34
Observations	6,534	

Note: "xxx" indicates confidential data.
Sources: Statistics Canada, *Survey on Financing and Growth of Small and Medium Enterprises*, 2011; and author's calculations.

The primary independent variable of interest is a dummy variable for HGF status. As high growth is likely determined in part by R&D and exports, HGF status for 2010 is used to avoid simultaneity. The variable is calculated from payroll deduction data from 2007 to 2010, where a firm is given a value of one if it was a high-growth firm in 2010 and is otherwise given a value of zero. A positive and significant coefficient estimate of high growth, controlling for firm size, would indicate something beyond scale economies implicit to high growth generating a positive impact on R&D or exporting probability.

The literature clearly indicates that export and R&D status are important for R&D and export decisions respectively. In the regression of 2011 R&D, a binary indicator for 2011 exports is included. To the extent that returns to R&D spending are unlikely to accrue in the same year, the 2011 export control is not simultaneously determined. In the regression of 2011 exports, a binary indicator for 2010 R&D is included. Research and development in 2010 is the appropriate control in this case because R&D yields returns with a lag.[18]

Size can impact R&D or exporting. As R&D expenditure below a certain threshold is unlikely to yield any return at all, small firms may lack the resources required to spend adequately on R&D. Likewise, establishing a distribution network, for example, may be too costly for small firms. To control size effects, firm size in 2010 is calculated using payroll deduction data for average annual employment. From this, size threshold indicators for small (1 to 19 employees), medium (20 to 99 employees) and large (100 to 499 employees) enterprises are calculated.

The financial health of a firm also plays a role in R&D and export decisions. For both regressions, labour productivity in 2010 is calculated, using the *General Index of Financial Information* and payroll deduction linkage, as sales divided by employment plus one.[19] The regression of R&D also includes a control for 2010 assets, while the regression of exports controls for 2010 working capital, calculated as current assets divided by current liabilities. These variables are calculated from the *General Index of Financial Information*.[20]

Research and development and exports also vary by industry and owner education. To control for this, dummy variables are created for the six broad North American Industry Classification System (NAICS) sectors industry grouping listed in Table 1 and for owners with post-secondary education or higher.

Finally, an indicator for immigrant status is created from the *Survey on Financing and Growth of Small and Medium Enterprises* for inclusion in the export regression. Research suggests that

18 As noted in Hall et al. (2009), R&D yields returns when R&D turns to innovation and innovation becomes commercialized — all of which takes time.

19 In particular with small firms, the owner is likely to be directly involved in the production of the goods and services sold.

20 In the regression analysis, the inclusion of a variety of financial controls was tested, such as leverage (total liabilities divided by total assets), return on assets (sales divided by total assets), (after-tax) net income and sales. Labour productivity and working capital were, in the end, selected for superior fit, but control of other financial indicators does not qualitatively impact results.

immigrant-owned exporting firms may tend to export more often as they have more established networks and greater knowledge of the culture and language in their countries of origin.[21]

Other variables, such as firm age, owner experience, female ownership and province, were explored but were ultimately excluded as they are not statistically significant or do not qualitatively change the regression results.

3. DESCRIPTIVE STATISTICS

Propensities of high-growth status, exporting and R&D are cross-tabulated below as a preliminary to econometric analysis. The estimates are calculated using adjusted survey weights. Note that the differences discussed are statistically significant at the 5 percent level, unless otherwise indicated.

Table 2 shows clearly that R&D and exporting activities are linked with HGFs: 14 percent and 27 percent of HGFs undertake R&D and exporting, respectively, compared with 3 percent and 11 percent of slower growth firms.

Table 2: HGFs are more likely to undertake R&D and exporting

	HGFs (%)	Non-HGFs (%)	All firms (%)
Exporting	27	11	11
R&D	14	3	4
All firms	2	98	

Sources: Statistics Canada, *Survey on Financing and Growth of Small and Medium Enterprises*, 2011; and author's calculations.

Furthermore, high-growth SMEs have a greater propensity to spend on R&D and exporting across most age, size, province and industry categories.

Table 3: R&D spenders are more likely to export and exporters are more likely to undertake R&D

	Percentage exporting		Percentage undertaking R&D	
	R&D	No R&D	Exports	No exports
HGFs	40	25	20	11
Non-HGFs	52	9	17	2
All firms	51	10	17	2

Sources: Statistics Canada, *Survey on Financing and Growth of Small and Medium Enterprises*, 2011; and author's calculations.

21 Sui et al. (2015) found that owner language is also important. An alternative dummy control for immigrants whose mother tongue was not English or French was also included, but this variable was highly correlated with immigrant status. Immigrant status was ultimately used, but it was found that including the language control does not qualitatively impact results.

Interestingly, descriptive statistics in Table 3 show a stronger link between R&D and exporting than between high growth and either of the two activities. In particular, comparing the first and second columns in Table 3, it is clear that more SMEs that undertake R&D also export, regardless of high-growth status. Similarly, comparing the third and fourth columns shows that more exporting firms spend on R&D than non-exporting firms across both HGFs and non-HGFs. Thus, exporting and R&D propensities are associated with R&D and exporting, respectively, regardless of high-growth status.

It is less clear, however, whether HGFs export more than non-HGFs, controlling for R&D. For SMEs that do not spend on R&D, 25 percent of HGFs export compared with 9 percent of non-HGFs. However, for SMEs that spend on R&D, 40 percent of HGFs export compared with 52 percent of non-HGFs, a difference that is not statistically significant (and negative).

Whether HGFs undertake R&D more often than non-HGFs, controlling for exporting, is similarly unclear. For non-exporting SMEs, 11 percent of HGFs spend on R&D compared with 2 percent of non-HGFs. Among exporting SMEs, however, the difference between the 20 percent of HGFs and 17 percent of non-HGFs spending on R&D is not statistically significant.

Broadly speaking, descriptive statistics show a strong relationship between exporting propensity and R&D activity, and between R&D propensity and exporting activity. The relationship between high growth and exporting propensity or R&D propensity, however, is less clear. Overall, high-growth SMEs export more often than non-high-growth SMEs, although for firms that spend on R&D the export propensity of HGFs is not significantly different from that of non-HGFs. Similarly, high-growth SMEs spend on R&D more often than non-high-growth SMEs overall, but for firms that export the R&D propensity of HGFs is not significantly higher than that of non-HGFs.

4. ECONOMETRIC ANALYSIS

4.1 METHODOLOGY

For a deeper understanding of the factors influencing a firm's decision to undertake R&D or to export, probit models for each decision are estimated econometrically.

Specifically, a firm's unobserved decision of whether to undertake R&D in 2011 is modelled as

$$RD_i^* = \beta HGF_i + \boldsymbol{x}_i'\boldsymbol{\delta} + u_i,$$

where HGF_i indicates high-growth status in 2010. The vector $\boldsymbol{x}_i$ includes variables that influence R&D decisions: a dummy variable for whether the firm exported in 2011; the natural logarithm of labour productivity and working capital in 2010[22]; dummy variables for whether the firm had 20 to 99 or 100 to 499 employees in 2010; a dummy variable for export status; and dummy variables for the natural

22 The natural logarithm of these variables is used because their distributions are highly skewed.

resources and mining; manufacturing; retail, wholesale and transportation; information, cultural and professional services; and information and communications technology sectors.[23]

The firm's decision is observed in the data based upon the value of the latent variable RD_i^* as

$$RD_i = \begin{cases} 1 \; if \; RD_i^* > 0. \\ 0 \; otherwise \end{cases}$$

Similarly, a firm decides whether to export in 2011 as follows:

$$export_i^* = \gamma HGF_i + \mathbf{z}_i'\boldsymbol{\theta} + e_i,$$

where HGF_i indicates whether the firm was high growth in 2010. The vector $\mathbf{z}_i$ contains a control for whether the firm spent on R&D in 2010; the natural logarithm of 2010 labour productivity and working capital; dummy variables for 2010 size thresholds of 20 to 99 employees and 100 to 499 employees; indicators for owner education of less than a bachelor's degree and a master's degree or above; an indicator for immigrant status; and dummy variables for the natural resources and mining; manufacturing; retail, wholesale and transportation; information, cultural and professional services; and information and communications technology sectors.[24]

Firms decide to export according to the value of $export_i^*$:

$$export_i = \begin{cases} 1 \; if \; export_i^* > 0. \\ 0 \; otherwise \end{cases}$$

Assuming errors are (standard-) normally distributed, each model is estimated as a probit.[25]

As the estimated coefficients are difficult to interpret directly, the corresponding average marginal effects are also reported. Average marginal effects are calculated as the average of marginal effects evaluated for each firm at its observed levels of covariates.[26] In particular, average marginal effects are calculated for continuous variables as

$$N^{-1}\sum_i F'(\chi_i'\hat{\beta})\hat{\beta}_k,$$

and for binary variables as

$$N^{-1}\sum_i [F(\hat{\beta}_1 + \hat{\beta}_2\chi_{i,2} + \cdots + \hat{\beta}_{k-1}\chi_{i,k-1} + \hat{\beta}_k) - F(\hat{\beta}_1 + \hat{\beta}_2\chi_{i,2} + \cdots + \hat{\beta}_{k-1}\chi_{i,k-1})].$$

23 Owner controls for experience and education, as well as geographic controls, are excluded due to their insignificance when included.

24 Macroeconomic factors, such as the exchange rate or foreign demand for Canadian SMEs' goods and services, of course, play into firms' exporting decisions, but bias from the omission of macroeconomic factors may be limited to the extent that these factors have similar impacts on firms.

25 Estimating both equations simultaneously as a bivariate probit, which in this context seems a natural option, was explored but ultimately rejected. The primary reason is that doing so endogenizes, by construction, the export dummy variable in the R&D equation and the data offered no suitable exclusion restriction with which to identify it. On a similar note, estimating R&D and exporting separately does not preclude the possibility that exports are simultaneous with R&D in the former equation, but the removal of exports from the equation yields estimates that are qualitatively similar, suggesting any bias due to simultaneity is fairly limited.

26 Readers should note that average marginal effects are different from marginal effects at the mean, which evaluate marginal effects with the covariates set to their (sample) mean values. Marginal effects at the mean are an alternative measure of the non-linear impact of a covariate commonly found in the literature.

4.2 ECONOMETRIC RESULTS

The above models are estimated by maximum likelihood using a variety of specifications. Regressions are weighted using adjusted *Survey on Financing and Growth of Small and Medium Enterprises* survey weights. As the probit and logit results do not differ qualitatively, only estimates for probit specifications are reported. Overall, these results are robust to specifications with fewer or alternative restrictions, and estimates of average marginal effects are similar to estimates of average partial effects from analogous linear probability models.[27]

4.2.1 RESEARCH AND DEVELOPMENT PROPENSITY

Table 4 presents estimates of the average marginal effects corresponding with the probit estimation of the model described above.[28] Results yield no evidence to suggest that HGFs are significantly more likely to spend on R&D than non-HGFs.

Although a regression analysis of R&D using only high growth suggests a (significant) positive relationship between high growth and R&D, this relationship disappears when controlling for firm size. One interpretation of this result is that rapid growth impacts R&D decisions only insofar as it confers upon firms the scale required for R&D (as HGFs tend to be larger than other firms),[29] that is, R&D is either important for an SME or not. If it is important, a certain level of resources may be necessary for R&D to be practicable. While high growth can provide the scale required for R&D, however, it does not change whether R&D would yield benefits.

Regression results suggest that other factors are much more important to R&D decisions. Exporting, for example, is a significant predictor of R&D, with the probability of undertaking R&D increasing by 6 percentage points when firms export. This result, consistent with previous research, confirms the relationship between R&D and exports suggested by descriptive statistics above.

The strongest predictor of R&D spending is industry, with goods-producing SMEs spending more often on R&D than service-providing firms. In particular, compared with SMEs in service industries in the "all other" category (where only 1 percent of firms undertake R&D), firms in the information and communications technology; manufacturing; information, cultural and professional services; and natural resources and mining sectors are 17, 14, 7 and 4 percentage points more likely to spend on R&D. There is no significant difference in the probability to undertake R&D for firms in the retail, wholesale and transportation sector compared with firms in other service ("all other") industries.

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27 For example, inclusion of alternative financial ratios or indicators and provincial dummy variables for both models, or of firm age in the R&D model, does not qualitatively change the results. The models used to generate the results shown below are selected based upon measures of fit, such as information criteria and pseudo-R-squared.

28 The results presented are average marginal effects and their corresponding standard errors calculated from weighted regressions and their robust standard errors.

29 Descriptive statistics point to a low yet important size threshold for undertaking R&D — only 1 percent of firms with 1 to 3 employees undertake R&D compared with 4 percent of firms with 4 to 9 employees. This latter figure is close to the propensity of undertaking R&D for all SMEs, 4.4 percent.

Table 4: Probit estimates of R&D

Variable	Coefficient	Average marginal effect
High growth (2010)	0.207	0.014
	0.211	0.016
Export	0.743***	0.062***
	0.092	0.01
Working capital (natural logarithm; 2010)	−0.029	−0.002
	0.035	0.002
Labour productivity (natural logarithm; 2010)	0.147**	0.008*
	0.075	0.004
Firm age (natural logarithm)	−0.113	−0.006
	0.077	0.005
Firm size: 20 to 99 employees	0.709***	0.060***
	0.108	0.012
Firm size: 100 to 499 employees	1.017***	0.114***
	0.176	0.031
Natural Resources and Mining	0.514**	0.040**
	0.202	0.02
Manufacturing	1.212***	0.138***
	0.156	0.026
Retail, Wholesale and Transportation	−0.078	−0.004
	0.178	0.010
Information, Cultural and Professional Services	0.776***	0.065***
	0.150	0.016
Information and Communications Technology	1.331***	0.169***
	0.179	0.036
Post-secondary education	0.087	0.005
	0.086	0.005
Observations	6,534	
Pseudo R-squared	0.298	

Note: * indicates 10 percent level of significance.
** indicates 5 percent level of significance.
***indicates 1 percent level of significance.

Sources: Statistics Canada, *Survey on Financing and Growth of Small and Medium Enterprises*, 2011; and author's calculations.

Another important R&D predictor is firm size, with larger firms being more likely to spend on R&D: firms with 20 to 99 employees and 100 to 499 employees are 6 and 11 percentage points, respectively, more likely to spend on R&D than firms with 1 to 19 employees.

Other firm characteristics are less important to R&D decisions. Working capital and firm age are insignificantly associated with R&D, while labour productivity significantly, but modestly, predicts R&D spending.

Owner characteristics, such as experience, age and education (the latter two of which are ultimately excluded from the model as their inclusion does not impact other coefficient estimates), are not significantly related to R&D. This result further reinforces that differences in R&D propensity are largely driven by exports, industry and firm size.

4.2.2 EXPORT PROPENSITY

Table 5 presents estimates for SMEs' export decisions.[30] High-growth firms do not appear to export significantly more often, although the evidence is less categorical than that for R&D decisions. In particular, the coefficient estimate for high-growth status is significant at the 10 percent level (which points to a role for high growth in exporting), but the corresponding estimate of the average marginal effect is insignificant.[31] Taken together, it is difficult to conclude that high growth significantly impacts exporting propensity based upon these results.

The other estimates parallel the R&D regression results, with strong evidence suggesting that export activity is significantly predicted by R&D, industry and firm size.

Research and development is a statistically and economically significant predictor of exporting: SMEs that undertake R&D are 21 percentage points more likely to export. This result is in line with past studies showing a positive impact of innovation on exporting.

Exporting varies by industry as well. Compared with SMEs in service industries in the "all other" category (where less than 5 percent of firms export), firms in the manufacturing; information and communications technology; information, cultural and professional services; retail, wholesale and transportation; and natural resources and mining sectors are 23, 19, 14, 11 and 9 percentage points more likely to export. These results indicate that service sector firms outside the information and communications technology and information, cultural and professional services sectors, and industries distributing and selling goods, are significantly less likely to export than SMEs in those sectors or than SMEs in natural resources and mining and manufacturing industries.

30 As for Table 4, the results presented are average marginal effects and their corresponding standard errors calculated from weighted regressions and their robust standard errors.

31 The corresponding linear probability model estimate for high growth, which is analogous to the estimated average marginal effect, is also insignificant.

Firm size also plays an important role in exporting, with larger firms exporting more often than smaller firms. Specifically, firms with 20 to 99 employees and 100 to 499 employees are 4 and 10 percentage points, respectively, more likely to export than firms with 1 to 19 employees.

Table 5: Probit estimates of exporting

Variable	Probit	Average marginal effect
High growth (2010)	0.400*	0.082
	0.232	0.056
R&D (2010)	0.836***	0.205***
	0.117	0.038
Working capital (natural logarithm; 2010)	0.038	0.006
	0.033	0.005
Labour productivity (natural logarithm; 2010)	0.06	0.01
	0.051	0.008
Firm age (natural logarithm)	−0.024	−0.004
	0.046	0.008
Firm size: 20 to 99 employees	0.195**	0.035**
	0.089	0.017
Firm size: 100 to 499 employees	0.465***	0.098***
	0.131	0.033
Natural Resources and Mining	0.454**	0.093**
	0.187	0.045
Manufacturing	0.866***	0.229***
	0.116	0.03
Retail, Wholesale and Transportation	0.561***	0.107***
	0.095	0.018
Information, Cultural and Professional Services	0.636***	0.135***
	0.126	0.032
Information and Communications Technology	0.789***	0.187***
	0.168	0.05
Post-secondary education	0.217***	0.037***
	0.071	0.013
Immigrant	0.061	0.017
	0.096	0.015
Immigrant and Manufacturing	0.283	
	0.191	
Observations	6,534	
Pseudo R-squared	0.124	

Note: * indicates 10 percent level of significance.
** indicates 5 percent level of significance.
*** indicates 1 percent level of significance.
Sources: Statistics Canada, *Survey on Financing and Growth of Small and Medium Enterprises*, 2011; and author's calculations.

Estimated coefficients for working capital, labour productivity and firm age are insignificant, which perhaps, surprisingly, suggests neither financial indicators nor firm age are predictors of exporting.

In contrast with R&D propensity, exporting propensity increases modestly with owner education — SME owners with post-secondary education are 4 percentage points more likely to export than their counterparts with high school education or less.

Other owner characteristics, such as experience, mother tongue and immigrant status, are not significantly related to exporting, although the analogous linear probability model (not reported) yields a significant coefficient for the interaction between immigrant status and manufacturing industry, which hints at the possibility of immigrant effects on exporting for specific sectors.

Overall, these results mirror closely those from the R&D regression, indicating that high growth is not significantly related to exporting and that the most significant predictors of exporting propensity are R&D, industry and firm size.

5. CONCLUSIONS

High growth, research and development, and exports are, in themselves, important policy goals. Descriptive statistics show that they are also positively correlated. The direction of high growth, R&D and export dynamics is unclear, however, with econometric research having previously been limited to showing a positive impact of R&D on high growth.

This study evaluates econometrically two other dynamics: whether HGFs are more likely to undertake R&D and whether HGFs are more likely to export. Results indicate that, controlling for factors important to R&D decisions, HGFs are no more likely to undertake R&D than other firms. Similarly, the impact of high growth on export propensity is insignificant, although the evidence against a relationship is less categorical.

Rather than high growth, R&D and exports are strong predictors of each other, while industry and firm size are also important factors in these decisions.

The result that R&D and exports strongly predict each other is consistent with the literature. On the R&D side, expenditures on research and development are often an investment in productivity. Insofar as such investments yield increased productivity, exporting should increase correspondingly. Exporting, on the other hand, exposes firms to a greater pool of innovations and ideas, which may spur SMEs to spend on R&D to expand their own knowledge pool.

That export and R&D propensities vary significantly by industry is not surprising given that firms operating in different industries face substantially different market conditions. Consider, for example, the local nature of SMEs in accommodation and food services compared with SMEs

in the manufacturing sector, the latter of which is more likely to both face competition from abroad and to seek markets outside of Canada.

The significance of size is, likewise, not unexpected. Exporting involves added costs related to administration, distribution and customs charges, which may be difficult for smaller firms to bear, while spending on R&D is the type of long-term investment that may not be practicable for a smaller firm.

On a related note, the significance of the size control coupled with the insignificance of the high-growth status indicator may point to an explanation for the insignificance of high growth. Empirically, a high-growth firm is characterized by two things: rapid growth and greater size than a non-HGF. This result may, therefore, suggest that it is size alone, rather than the speed at which size is attained, that is important to export and R&D propensities.

Overall, these findings suggest that rapid SME employment growth, in general, is unlikely to impact export and R&D propensities. In general, caution should be applied when assuming that one activity necessarily leads to others, particularly without further research into other aspects of SME high-growth, R&D and export dynamics.

Future research could take several directions as richer data become available. Panel data, including variables on exports, R&D and growth, to capture variation across time, may allow for something closer to a causal analysis of the impact of high growth on exporting and R&D. Another natural extension would be a Heckman-type regression of export and R&D propensities and intensities, which in this study would have required a robust exclusion restriction unavailable in the data used here. Similarly, richer data could be used for identification in bivariate probit analysis of exports and R&D, or multivariate probit analysis of exports, R&D and high growth. Finally, some of these econometric issues may be at least partially circumvented through estimation of a structural model.

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APPENDIX A: SURVEY WEIGHT ADJUSTMENT

The *Survey on Financing and Growth of Small and Medium Enterprises* is designed to be representative of all Canadian SMEs, but removal of firms due to missing values may limit its representativeness. In particular, weighting the restricted sample using survey weights no longer gives nationally representative estimates. This leaves two choices: use no weights or adjust the survey weights.

While the former option yields unbiased estimates for the sample, the sample is selected non-randomly. Specifically, the sample includes, by design, proportionately more large firms, more firms from smaller provinces and more firms in given industries than the population of Canadian employer SMEs. In a policy context, unweighted estimates may be inappropriately misinterpreted to be estimates of the population coefficients.

Adjusting survey weights is also not entirely satisfactory as it may introduce, rather than reduce, bias if poorly implemented. However, two diagnostics are useful for assessing the bias of adjusted weights.

First, the distributions of the dependent and (available) independent variables for the full *Survey on Financing and Growth of Small and Medium Enterprises* sample, weighted by survey weights, are nationally representative and provide benchmark distributions. Similarly, regressions of the propensity to export and to undertake R&D for the full sample weighted by survey weights, using available independent variables, yield nationally representative, benchmark regression estimates. A valid adjustment to the weights should, therefore, give adjusted-weighted, restricted sample distributions and regression estimates that are both (1) similar to the benchmarks and (2) closer to the benchmarks than the corresponding unweighted, restricted sample distributions and regression estimates.

Survey weights are adjusted using the following procedure. A logistic regression of an SME's probability to be included in the restricted sample is estimated as a function of firm size, province and NAICS. The inverse of the resulting predicted probability is multiplied by the original survey weight.

Both diagnostics point to the reduction of bias using adjusted weights, that is, the distributions of the dependent and independent variables from the adjusted-weighted, restricted sample are both similar to the benchmark distributions and closer to them than the unweighted, restricted sample distributions. Likewise, regression estimates for the adjusted-weighted, restricted sample align with the benchmark regression estimates and are substantially closer to them than regression estimates for the unweighted, restricted sample. Notably, the distributions and regression estimates for the unweighted, restricted sample correspond closely to those of the unweighted, full sample.

As the risk of introducing bias by weight adjustment appears to be limited, adjusted survey weights have been used throughout this analysis.

APPENDIX B: INDUSTRY GROUPINGS

Industry grouping	NAICS titles (codes)
Natural Resources and Mining	Agriculture, Forestry, Fishing and Hunting (11); Mining, Quarrying, and Oil and Gas Extraction (21)
Manufacturing	Manufacturing (31—33), excluding Computer and Electronic Product Manufacturing (334)
Retail, Wholesale and Transportation	Wholesale Trade (41), excluding Computer and Communications Equipment and Supplies Wholesaler-Distributor (4173); Retail Trade (44—45); Transportation and Warehousing (48—49)
Information, Cultural and Professional Services	Information and Cultural Industries (51), excluding Publishing Industries (except Internet) (511), Telecommunications (517) and Data Processing, Hosting, and Related Services (518); Professional, Scientific and Technical Services (54), excluding Computer Systems Design and Related Services (5415)
Information and Communications Technology	Computer and Electronic Product Manufacturing (334); Computer and Communications Equipment and Supplies Wholesaler-Distributor (4173); Publishing Industries (except Internet) (511); Telecommunications (517); Data Processing, Hosting, and Related Services (518); Computer Systems Design and Related Services (5415); Electronic and Precision Equipment Repair and Maintenance (8112)
All Other	Construction (23); Real Estate and Rental and Leasing (53); Administrative and Support, Waste Management and Remediation Services (56); Health Care and Social Assistance (62); Arts, Entertainment and Recreation (71); Accommodation and Food Services (72); Other Services (except Public Administration) (81), excluding Electronic and Precision Equipment Repair and Maintenance (8112)
NAICS exclusions from the *Survey on Financing and Growth of Small and Medium Enterprises* population	Utilities (22); Finance and Insurance (52); Automotive Equipment Rental and Leasing (5321); Commercial and Industrial Machinery and Equipment Rental and Leasing (5324); Management of Companies and Enterprises (55); Educational Services (61); Out-Patient Care Centres (6214); Medical and Diagnostic Laboratories (6215); Other Ambulatory Health Care Services (6219); General Medical and Surgical Hospitals (6221); Psychiatric and Substance Abuse Hospitals (6222); Specialty (except Psychiatric and Substance Abuse) Hospitals (6223); Community Food and Housing, and Emergency and Other Relief Services (6242); Public Administration (91)