IMPACT OF R&D EXPENDITURE ON FINANCIAL PERFORMANCE: A STUDY OF CANADIAN IT FIRMS

This paper empirically investigates the impact of R&D expenditure on three key financial performance variables - revenue growth, profitability, and market value - in Canadian IT firms. The t test results do not support that the performance of firms with R&D is significantly superior to non-R&D firms. However, the results of the regression analyses partially support that the R&D intensity is positively influences the firm’s market value, as measured by Tobin’s Q. The results extend the understanding of the role of firm size in the R&D intensity, and on the firm’s financial performance.

Introduction

Innovation is one of the major engines of growth and the most important way of gaining competitive advantage over competitors in today’s new economic environment. Research and Development (R&D) is a key factor of innovation and has become an integral part of many companies, especially those in the high-tech industries. Research is generally defined as the primary search for scientific and technical improvement. Development is defined as the translation of such improvements into product/service or process innovation. R&D-intensive companies compete on the basis of a new innovation that allows them to retain their existing customers and capture new markets with a substantial amount of growth in sales and earnings. However, given the strategic significance of R&D, how does R&D spending relate to a firm’s financial performance? Although many studies found that there is a link between R&D expenditure and firm value, this relationship changes over time and differs greatly from industry to industry and from firm to firm. In most cases, however, financial benefits become apparent only when the specific R&D activities lead to patent issuance (Lau, 1998).

There have been numerous empirical studies on the key determinants of R&D spending. Many variables have been considered important, but a firm’s financial and market performances are considered the most important variables. The firm’s market value in the last year, sales, and capital expenditure are significant determinants of the current year's R&D spending (Harmanitzis and Tanguturi, 2005). R&D spending is more valuable for firms with larger market shares and a higher percentage of technical employees, and also for those that have diversified into different
product categories (Chiang and Mensah, 2004). Evidence also shows that a federal tax credit has significant influence on R&D activity. Firms that are eligible for the tax credit spend more on R&D than non-eligible firms, as the user cost of in-house R&D increased (Billings et al., 2001). The entire R&D environment is changing due to the rapidly evolving technology and market globalization; this is especially true in the high-technology industry. R&D is becoming a major strategic weapon in the global marketplace to survive in the time-based competition. Therefore, it is predicted that the level of a firm’s R&D spending positively affects the firm’s financial performance. Once a firm spends money on R&D to develop a new process or product/service, it receives a higher return if the innovation can be marketed on a larger scale. R&D capabilities are considered to be important, particularly in high technology industries such as the information technology (IT) industry (Dutta et al., 1999).

IT plays a critical role in today’s global knowledge-based economy. The emergence of information technologies, especially internet technology, has changed everything in the world of business; it has, especially, affected how products are developed, marketed, and distributed. So, gaining a competitive advantage over competitors is the necessary precondition to survive in today’s competitive global market. Firms that invest significantly in R&D are more likely to thrive. They are better able to compete in global markets by offering their customers new or significantly improved products and services. Many firms see innovation as the way to keep up with competitors, meet changing client demands, grow profit margins, and increase productivity. The Canadian IT industry comprises both Canadian-controlled and foreign-controlled firms. Studies show that Canadian-controlled firms spend more on R&D than do foreign-controlled firms (Tang and Rao, 2001). But, on average, the foreign-controlled firms are more productive than Canadian-controlled firms because of their imported capabilities and knowledge from their parent companies. However, many private sector firms across Canada engage in R&D and receive the most generous tax credit in the world from Canada. The service sector, especially the information and communications equipment industry, is one of the strongest R&D performers in Canada (Innovation in Canada, 2005). Another factor that influences firms to invest in R&D is the firm size. Mohnen and Therrien (2002) found that firm size has a positive impact on the probability that a firm will engage in innovative activities. Several other studies also found that firm size has a direct link to the firm’s short-term and long-term financial performance (Lin et al., 2006; Ho et al., 2005; Quo et al., 2004; Kotabe et al., 2002).

This paper aims to identify statistical evidence of the positive effects of R&D spending on a firm’s financial performance. It also examines the effect of firm size on R&D spending and on the firm’s financial performance. R&D activities may influence a firm’s revenue growth, short-term profitability, and long-term economic performance. Researchers have been using Return on Asset (ROA) and Return on Equity (ROE) extensively as measures of short-term profitability and Tobin’s Q for long-term economic measure. The three performance measures employed in this paper are: 1) Growth in Revenue (GR), a measure of business growth; 2) ROA and ROE, measures of profitability; and 3) Tobin’s Q, a measure of a firm’s long-term economic performance (the firm’s market value).
Literature Review

According to the resource-based view of Dutta and Rao (1999), marketing, R&D, and operations capabilities, along with the interactions among these capabilities, are important determinants of financial performance in the high technology sector. Chan et al. (1990) argued that R&D investment is crucial for firms to stay competitive, especially among the high-tech industries. In practice, R&D is a part of a firm’s innovation activities. Firms decide on the amount of R&D investment considering their resource constraints. The decision of the intensity of R&D investment is based upon the expected future returns. Investment in R&D is considered to be an investment in intangible assets that contribute to the long-term growth of the firm. However, the accounting treatment of R&D expenditure has a direct impact on a firm’s financial performance. If R&D costs are expensed in the period they were incurred, it decreases the net income as well as the profitability ratios (ROA and ROE) for that period. However, if R&D costs are deferred to future periods as intangible assets, it would not decrease the current period’s net income and profitability ratio – ROE – but it might decrease another profitability ratio – ROA. Since total assets will be increased by capitalization of the R&D expenditure as an intangible asset. A successful investment in R&D results in an innovative product or service, which enables a firm to be differentiated from other firms. This means that financial benefits will become apparent only when the specific R&D activities lead to patent issuance.

However, the Generally Accepted Accounting Principles of Canada (Canadian GAAP) is very strict about the way R&D expenditure is treated. According to the Chartered Accountants of Canada (CICA) handbook, research costs should be charged as an expense of the period in which they are incurred\(^1\). Development costs should be deferred to future periods if all the following criteria are satisfied, otherwise they should be charged as an expense of the period in which they are incurred\(^2\). The criteria to be satisfied are:

\(a\) the product or process is clearly defined and the cost attributable hereto can be identified;
\(b\) the technical feasibility of the product or process has been established;
\(c\) the management of the enterprise has indicated its intention to produce and market, or use, the product or process;
\(d\) the future market for the product or process is clearly defined or, if it is to be used internally rather than sold, its usefulness to the enterprise has been established; and
\(e\) adequate resources exist, or are expected to be available, to complete the project.

This is not an accounting policy choice for Canadian firms with regards to the capitalization of development costs. If a development project meets all of these five criteria, then the costs must be capitalized\(^2\). However, since these criteria are largely based on management judgment, capitalization of R&D expenditure sometimes becomes an accounting choice that can be used for income manipulation. A study of Canadian high-tech and biopharmaceutical firms show that the probability of capitalizing R&D spending increases for firms in the software industry (Landry and Callimaci, 2003). The probability of capitalizing R&D spending also

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\(^1\) CICA Handbook, 3450.16
\(^2\) CICA Handbook, 3450.19, 3450.21
increases for firms that are more leveraged, more mature, and have a higher level of cash flows from operations. However, Landry and Callimaci (2003) also found that the probability of capitalizing R&D spending decreases for larger corporations, firms with more concentrated ownership, and highly profitable firms. The study suggests that firms use the decision to capitalize or expense R&D spending as an earning management tool to either meet debt covenants or to smooth income. In contrast, US GAAP adopts an immediate expensing rule for all R&D spending, except for software development costs for which technological feasibility has been established.

**R&D Expenditure and a Firm’s Value**

A firm’s long-term economic performance (firm’s market value) is measured by Tobin’s Q, proposed by James Tobin (Tobin, 1969). It is defined as the ratio of the market value of a firm to the replacement cost of its assets and commonly used to measure a firm’s value, management performance, and the mispricing of stocks. It is a good measure of firm performance, which may include a variety of subjective characteristics. Tobin’s Q represents a long-run equilibrium measure capturing both risk and return dimensions (Petri and Elgar, 2004). It reflects the market expectations of less quantifiable dimensions of performance, which reflects the portion of the firm’s intangible assets besides its total tangible assets (Jose and Lancaster, 1996). According to its creator, if the market value reflected solely the recorded assets of a company, Tobin’s Q would be 1.0. If Tobin’s Q is greater than 1.0, then the market value is greater than the value of the company's recorded assets. This suggests that the market value reflects some unmeasured or unrecorded assets of the company. On the other hand, if Tobin's Q is less than 1.0, the market value is less than the recorded value of the assets of the company. This suggests that the market may be undervaluing the company (Andriessen, 2004; Nathalie, 1998).

Many studies have attempted to analyze the nature of the relationship between R&D expenditure and a firm’s value. Many of those studies found a positive linkage between R&D expenditure and a firm’s value (Ho et al, 2005; Agrawal and Knoeber, 1996; Lloyd and Jahera, 1994). Ho et al. (2005) have studied 15,039 US firms to examine the relationship between a firm’s market performance and the intensity of their investment in R&D and advertising. They found that the firms in the manufacturing sector had a positive relationship between R&D intensity and market value. In a sample of 134 companies in Canada, Dutta et al. (2004) found that price-to-book value is positively correlated to R&D intensity. Lloyd and Jahera (1994), who studied 115 US firms from the Fortune 500 to examine the effect of firm diversification on performance measured by Tobin’s Q, also found similar results for manufacturing firms. However, Lin et al. (2006) studied 258 US-based technology public firms and did not find any significant relationship between R&D intensity and Tobin’s Q. Similarly, Dutta et al. (1999) argued that technology firms might not be able to enhance competitive advantage solely by increasing their R&D expenditure; they should also consider that marketing capability has its greatest impact on the output of innovations. Firms with a strong R&D base are the ones with the most to gain from a strong marketing capability. On the other hand, Lantz and Sahut (2005) found a weak negative correlation between R&D intensity and stock returns.

Giammarino (1998) argued that high R&D spending is significantly related to high share prices. He suggested that stock market value does reflect long-term strategic decisions, especially
a firm’s R&D investment. The investors greet the R&D announcement positively, even when a
firm reports operating losses in the period in which the R&D announcement was made. But the
positive response might be restricted to firms in the high-tech sector. The study shows that
shareholders are not short-term focused; instead, they like long-term investments. They believe
that a firm gains intrinsic value by investing in R&D, which extends the opportunity for future
growth potential.

R&D Expenditure and Firm Performance

Beyond the impact of R&D expenditure on a firm’s market value, it has a significant
influence on the firm’s financial performance. The impact on performance variables sometimes
varies with the accounting policy choices, business strategy, degree of success of R&D
investment, and speed of product commercialization or process implementation. The following
factors significantly influence a firm’s financial performance variables: 1) accounting policy
choices to capitalize or expense the R&D expenditure; 2) strategy to gain market share or profit; 3)
frequency of R&D activities leading to patent issuance; and 4) speed and ability to commercialize
these innovations into the products that capture consumer needs and preferences. We will review
the impact of R&D expenditure on a firm’s revenue and profitability.

Impact on revenue. Innovations are believed to have unique economic characteristics. A
successful innovation should lead to increases in revenue if the innovation can be marketed on a
larger scale. Many studies find a positive relationship between R&D expenditure and growth in
revenue. Chen et al. (2005) have studied 4,254 firms listed in the Taiwan Stock Exchange during
1992-2002 to investigate the relationship between value creation efficiency and a firm’s market
value and financial performance. The results show a strong significant positive relationship
between R&D intensity and growth in revenue. Lau (1998) also found a strong positive
relationship between R&D intensity and revenue growth in the Standard and Poor’s (S&P) 500
companies in the chemical and allied products industry.

Impact on profitability. R&D expenditure has a direct impact on profitability based on
various circumstances. The impact may come from either the accounting choices to capitalize or
expense the R&D expenditure, a firm’s strategy to gain market share or profit, the frequency of
R&D activities leading to patent issuance, or the speed and ability to commercialize the
innovations into the products that capture consumer needs and preferences. However, studies
show both a positive and negative relationship between R&D intensity and profitability measures.
Chen et al. (2005) found a significant positive relationship among R&D intensity and both of the
profitability measures – ROA and ROE. The results suggest that R&D investment is important for
the firm’s future profitability and revenue growth. Lau (1998) found evidence that the difference
of ROA between high and low R&D intensity firms is marginally significant, though not as strong
as growth in revenue. Based on his observation, he concludes that high R&D intensity firms do
not produce a significantly higher ROA than their counterparts. Kotabe et al. (2002) found a
non-significant negative relationship between ROA and R&D intensity. Quo et al. (2004) found
that R&D intensity has a significant negative impact on profitability.

R&D Expenditure and Firm Size
Firm size has a significant influence on R&D expenditure and a firm’s performance. Many studies have found both a positive and negative relationship among R&D intensity, firm size, and performance measures. Ho et al. (2005) found a strong positive and significant relationship between firm size and market-to-book value ratio. They also found a significant negative relationship between a firm size and R&D intensity. This result suggests that bigger firms have a relatively higher market value than do smaller firms, but smaller firms are more innovative if their R&D intensity is higher than that of bigger firms. Kotabe et al. (2002) found a strong positive significant relationship between firm size and ROA. This finding indicates that bigger firms are more profitable and able to manage their assets to earn profit. However, Lin et al. (2006) found a negative and significant relationship between firm size and Tobin’s Q. This result suggests that bigger firms have lower growth potential than that of smaller, innovative firms. Quo et al. (2004) found that firm size has a consistent positive impact on productivity, but no significant influence on profitability. The positive influence of firm size on productivity is due to the fact that large firms achieved economies of scale in specialization and more input into the adoption of management tools.

**R&D Performance of Canadian Firms**

Canada’s innovation is primarily attributed to three main R&D performers: the private sector, universities, and government itself. The private sector performs about 57 percent, universities about 31 percent, and government about 11 percent of Canada’s R&D (OECD, 2001). The Government of Canada attracts R&D investment by providing firms the most favorable R&D tax incentives. Many of the private sector firms across Canada engage in R&D and receive the most generous tax credit in the world. The service sector, especially the information and communications equipment industry, is among the strong R&D performers in Canada. However, Canada’s private sector R&D still lags behind the major Organization for Economic Co-operation and Development (OECD) countries. To some extent, this reflects the large presence of foreign-controlled firms in Canada, who tend to spend more on R&D in their home countries. However, Tang and Rao (2001) found that even though foreign-controlled firms spend less on R&D, they are, on average, more productive than Canadian-controlled firms because of their superior technological and managerial capabilities, imported from their parent companies.

Innovation is both risky and costly, since some uncertainties associated with the success of R&D activities carry over into product or process innovation. In order to mitigate the risk of uncertainties, private sector firms often get expertise and share risk with outsiders in the form of strategic alliances. Such collaborations with others would increase the likelihood of innovation success and draw a higher share of revenue from the sale of new products. Canadian firms have a strong international track record in forming strategic alliances for joint marketing and sales activities, compared to the competitors. However, Canadian firms form fewer of the alliances that are important to the development of new technologies (Megun, 1996). Canadian firms also rely on universities as a source of important research-based innovation. Universities play an important role in stimulating innovation; their ties to the private sector make them a particularly important player in Canada. Universities collaborate with Canadian firms to develop new technologies. On average, Canadian firms contract out more than six percent of their R&D to universities (OECD,
The Canadian government also plays an important role in national innovations by both direct and indirect contributions. Canada has approximately 200 Government of Canada R&D laboratories with a $1.7-billion research budget and 14,000 research scientists and engineers (Statistics Canada, 2001). The government has focused its efforts in the area of public interest, especially in the areas of health and safety, environment, and stewardship of natural resources. Several other sectors of the Canadian economy have depended heavily on the government for R&D, notably the agriculture and fisheries sectors. Governments also have key roles to play as builders, holders, and facilitators of a research infrastructure that supports Canada's innovation system (Innovation in Canada, 2005).

Mohnen and Therrien, (2002) have compared the innovation performance of Canadian firms to some European firms and found that about 80 percent of Canadian manufacturing firms successfully introduced a new or significantly improved product or process. About 26 percent of Canadian manufacturing firms are "first innovators" in Canada as well as in the world. The study suggests that Canada's manufacturing firms appear to be more innovative than their counterparts in selected European countries. But firms in Germany, Spain, and Ireland enjoy substantially more sales from their innovations. The author concludes that Canada has a better performance than Europe when comparing the percentage of innovators, but that advantage does not seem to hold when comparing the intensity of innovation as measured by the share in sales of innovative products. Tang and Rao (2001) noted that, although the R&D propensity of the Canadian firms has increased during the 1985-1994 period, they do not find any evidence to conclude that Canada has received benefit from the globalization of R&D. However, Gu and Tang (2003) have introduced a new way to measure innovation performance of Canadian firms that captures both technology generation and technology adoption. They find a strong and positive relationship between innovation and productivity. Their study suggests that the length of time that it takes for innovation to have a positive and significant impact on productivity differs across industries. For some industries, it takes only one year; for others, it takes two to three years.

**Hypotheses**

R&D capabilities are considered to be the most important source of competitive advantage for firms in high-technology industries, especially the IT industry. These capabilities create value for the customers by introducing new products developed through R&D. In this industry, being first to the market is often a necessary condition to become economically successful and to enjoy superior financial performance relative to the competition in this rapidly changing marketplace. Considering this phenomenon in the IT industry, we would expect that firms having R&D capabilities would have a distinct advantage. In light of this understanding, we propose the following hypothesis.

**H1.** The performance of R&D firms is superior to non-R&D firms.

The R&D intensity of a firm indicates the strategic importance of innovation to the firm. So, deciding upon R&D expenditure is a critical business decision that might affect the firm’s performance. However, a high level of R&D intensity doesn’t necessarily guarantee successful
innovation. Firms that are trying to compete on the basis of innovativeness invest heavily in R&D (O’Brien, 2003). Many studies report the relationship between R&D intensity and a firm’s performance. Lau (1998) studied the chemical industry and found a strong positive co-relation between R&D intensity and GR, but he found a weak positive co-relation with ROA. Lantz and Sahut (2005) found a negative correlation with the return in technology firms. In contrast, Lin et al. (2006) found no relationship with a firm’s long-term economic performance (Tobin’s Q). Considering the mixed findings regarding R&D intensity and a firm’s performance, we propose the following hypothesis:

**H2.** The R&D intensity of a firm positively influences the firm’s financial performance.

Literature shows that firm size has significant influence on both R&D expenditure and its financial performance. In order to identify the effect of firm size on R&D intensity and financial performance of Canadian listed IT firms, we propose the following hypothesis:

**H3.** The size of a firm positively influences the firm’s financial performance.

**Research Methodology**

**Variable Definitions - Performance (Dependent) Variables**

**Growth in Revenue (GR).** A firm’s growth is measured by GR over the time-period by taking average of the changes observed on a year-to-year basis. Increases in revenue usually signal a firm’s growth opportunities. GR is calculated by using the following formula:

\[ GR = \frac{\text{(current year's revenue} - \text{last year’s revenue})}{\text{last year’s revenue}} \times 100 \]

**Return on Assets (ROA):** A firm’s profitability is measured by ROA, which measures a firm’s success in using its assets to earn a profit. ROA is calculated by using the following formula:

\[ \text{ROA} = \frac{\text{net income}}{\text{average total assets}} \times 100 \]

**Return on Equity (ROE):** ROE is a popular measure of a firm’s profitability. It measures how much income is earned for every $1 invested by the common shareholders. ROE is calculated by using the following formula:

\[ \text{ROE} = \frac{\text{net income}}{\text{average shareholder’s equity}} \times 100 \]

**Tobin’s Q:** Many researchers have used Tobin’s Q as a measure of a firm’s long-term economic performance. However, because data is not available, the calculation of Tobin’s Q is often not an easy task. Several researchers formulated their own operational measures of Tobin’s Q as an attempt to deal with lack of data. Nathalie (1998) calculated and compared the various estimators of Tobin’s Q for a sample of Canadian firms. Our study uses a simple Tobin’s Q estimator, which principally uses book value data. The simple Tobin’s Q ratio, Qs, is given by:

\[ Qs = \frac{\text{MVCE} + \text{PREFBK} + \text{STDEBT} + \text{DS}}{\text{RCS}} \]

Where, \text{MVCE} = \text{Year-end market value of the firm's common stock}
PREFBK = Year-end book value of the firm's preferred stock
STDEBT = Year-end book value of the firm's short-term debt
DS = Year-end book value of the firm's long-term debt
RCS = Year-end book value of the firm's total assets

Variable Definitions - Independent Variables

To account for effect on performance of firm size and R&D intensity, we use them as independent variables. Since the total assets are relatively more stable than the sales revenue for the IT industry, we adopt a proxy measure of R&D intensity as the R&D expenditure divided by the total net assets.

Firm Size: Firm size is defined as the natural logarithm of a firm’s net total assets at fiscal year end and is denoted here as SIZE.

R&D Intensity: R&D intensity is the ratio of R&D expenditure and net total assets at fiscal year end and is denoted here by R&D INT.

Variable Definitions - Other Variables

Since the Canadian IT industry has suffered from negative returns for consecutive years, we have analyzed how they are surviving by investigating their capital structure (debt ratio). Debt ratio is defined as the ratio of total liabilities to total assets, which states the proportion of a firm’s assets that is financed with debt (Harrison et al., 2004). We have also analyzed how R&D expenditure is changing over time (R&D growth). R&D growth is measured by growth in R&D expenditure over the time-period by taking the average of the changes observed on a year to year basis. R&D growth is calculated in the following formula:

\[ \text{R&D growth} = \left( \frac{\text{current year’s R&D expenditure} - \text{last year’s R&D expenditure}}{\text{last year’s R&D expenditure}} \right) \times 100 \]

Sample Selection and Data Source

In this study, both the performance and R&D spending data is obtained from the COMPUSTAT database, which contains Canadian listed firm data on different IT industries for the period of 2001 to 2005. The industry is classified based on a four-digit Standard Industrial Classification (SIC) Code. We have chosen SICs in the IT industry based upon the following two criteria: 1) data should be available for at least three companies in each SIC, and 2) data should be available for each company for at least five years. After screening out non-qualified firms from our pooled dataset, based on the previously mentioned criteria, we ended up with a total of 79 sample firms for our study; of these 79 firms, 63 firms have engaged in continuous R&D activities for the last five years (2001 to 2005). Out of the remaining 16 non-R&D firms, only two firms engaged in R&D activities for a particular year. Table 1 shows the Canadian IT firms included in this study.
Table 1

Canadian Listed IT Firms Included in this Study

<table>
<thead>
<tr>
<th>SIC</th>
<th>Industry</th>
<th>Abbreviation</th>
<th>R&amp;D Firms</th>
<th>Non-R&amp;D Firms</th>
<th>Total Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>3661</td>
<td>Telephone and Telegraph Apparatus</td>
<td>T&amp;T Apparatus</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>3663</td>
<td>Radio, TV broadcast, Communication Equipment</td>
<td>Telecom</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>3670</td>
<td>Electronic Computing, Accessories</td>
<td>Computing</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3674</td>
<td>Semiconductor, Related Devices</td>
<td>Semiconductor</td>
<td>8</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>3825</td>
<td>Electrical Measurement and Test Instruments</td>
<td>Test Instrument</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>7370</td>
<td>Computer Programming, Data Process</td>
<td>Data Process</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>7372</td>
<td>Prepackaged Software</td>
<td>Software</td>
<td>20</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>7373</td>
<td>Computer Integrated System Design</td>
<td>System Design</td>
<td>7</td>
<td>4</td>
<td>11</td>
</tr>
</tbody>
</table>

|       |                                   |             | 62        | 16            | 79          |

Hypotheses Testing

In order to test the first hypothesis (H1), two-sample t-tests were applied to test the significance of the difference in GR, ROA, ROE, and Tobin’s Q between two groups: R&D firms and non-R&D firms.

For testing hypotheses H2 and H3, we investigated the effect of firm size and R&D intensity on a firm’s R&D performance and also the effect of firm size on the non-R&D firm performance. We have conducted a number of regression analyses by taking firm size and R&D intensity as independent variables and a firm’s performance (GR, ROA, ROE, and Tobin’s Q) as dependent variables. We also used regression analysis with firm size as an independent variable and R&D intensity as a dependent variable for analyzing the relationship between firm size and R&D intensity.

Result Analysis and Discussion

Test of Hypothesis H1

Hypothesis H1 is based on the assumption that R&D-intensive firms gain a competitive advantage over non-R&D firms through the innovation of new product and process, which add value to their firms and contribute financial incentives in the long run. The means of the performance variables of R&D firms seems superior to non-R&D firms, although both categories of firms have suffered from negative average returns for the last five years. To test the significance of this observation, we have used a one-tail t test to see if there is enough evidence to infer that hypothesis H1 is supported. Table 2 summarizes the results of the t-tests in terms of the t-statistic and the associated significance, along with the means and standard deviations of
financial performance variables (GR, ROA, ROE, and Tobin’s Q) for R&D firms and non-R&D firms.

Table 1

<table>
<thead>
<tr>
<th>Performance Variables</th>
<th>R&amp;D firms’ score Group A (N_A = 63)</th>
<th>Non-R&amp;D firms’ score Group A (N_B = 16)</th>
<th>t-value</th>
<th>Sig. (1 tailed)</th>
<th>H1</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR (%)</td>
<td>10.29 ± 31.95</td>
<td>9.67 ± 30.73</td>
<td>0.070</td>
<td>0.944</td>
<td>Not supported</td>
</tr>
<tr>
<td>ROA (%)</td>
<td>(27.75) ± 39.74</td>
<td>(38.03) ± 89.84</td>
<td>0.689</td>
<td>0.493</td>
<td>Not supported</td>
</tr>
<tr>
<td>ROE (%)</td>
<td>(76.22) ± 135.53</td>
<td>(242.48) ± 745.69</td>
<td>1.681</td>
<td>0.097</td>
<td>Not supported</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>6.26 ± 9.44</td>
<td>4.45 ± 5.28</td>
<td>0.734</td>
<td>0.465</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

The test results shown above suggest that none of the performance variables are significantly different for the two groups, which indicates that hypothesis H1 is not supported. Therefore, the performance of Canadian R&D IT firms is not significantly superior to that of non-R&D firms. This finding suggests that Canadian IT firms might not be able to enhance their competitive advantage solely by investing on R&D activities.

Test of Hypotheses H2

Evidence in the earlier section suggested that the Canadian R&D firms in the IT industry do not outperform non-R&D firms. For testing hypotheses H2, we have used simple linear regression models to see if there is any significant relationship between performance variables and R&D intensity in R&D firms. We have also extended this analysis to major industrial sectors within the IT industry. In the regression models, R&D intensity is taken as independent variable and financial performance variables (GR, ROA, ROE, and Tobin’s Q) are taken as dependent variables. Table 3 shows the regression results for all sectors and individual industry sectors within the IT industry.

The results show that among the four financial performance variables (GR, ROA, ROE, and Tobin’s Q) only ROA and Tobin’s Q have a statistically significant relationship with R&D intensity for companies in all industrial sectors. About 18 percent of the variation in ROA and 31 percent of the variation in Tobin’s Q can be explained by R&D intensity. However, the coefficients (b value and Beta) of ROA are negative, which indicates that ROA decreases with the increase of R&D expenditure. This result is consistent with the recent finding of Chen et al. (2005) and Kotabe et al. (2002). These results may be due to the fact that, according to the CICA handbook, R&D expenditures are expensed in the period in which they are incurred and thus reduce the current period’s net income; this results in a contemporaneous inferior financial performance.
Table 3

Relationship between Performance Variables and R&D Intensity in R&D firms

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Industry sectors</th>
<th>( b )</th>
<th>Beta</th>
<th>( R^2 )</th>
<th>( F )</th>
<th>Sig. ( F )</th>
<th>t</th>
<th>Sig. t</th>
<th>H2</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR</td>
<td>All industry sectors</td>
<td>0.152</td>
<td>0.058</td>
<td>0.003</td>
<td>0.209</td>
<td>0.649</td>
<td>0.458</td>
<td>0.649</td>
<td>Not supported</td>
</tr>
<tr>
<td>ROA</td>
<td>All industry sectors</td>
<td>-1.355</td>
<td>-0.419</td>
<td>0.176</td>
<td>12.988</td>
<td>0.001</td>
<td>-3.604</td>
<td>0.001</td>
<td>Not supported</td>
</tr>
<tr>
<td>ROE</td>
<td>All industry sectors</td>
<td>-1.241</td>
<td>-0.101</td>
<td>0.010</td>
<td>0.618</td>
<td>0.435</td>
<td>-0.786</td>
<td>0.435</td>
<td>Not supported</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>Telecom</td>
<td>0.427</td>
<td>0.557</td>
<td>0.310</td>
<td>27.367</td>
<td>0.000</td>
<td>5.231</td>
<td>0.000</td>
<td>supported</td>
</tr>
<tr>
<td>ROA</td>
<td>Telecom</td>
<td>-2.944</td>
<td>-0.917</td>
<td>0.840</td>
<td>42.005</td>
<td>0.000</td>
<td>-6.481</td>
<td>0.000</td>
<td>Not supported</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>Telecom</td>
<td>0.570</td>
<td>0.794</td>
<td>0.631</td>
<td>13.684</td>
<td>0.006</td>
<td>3.699</td>
<td>0.006</td>
<td>Not supported</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>Semiconductor</td>
<td>0.112</td>
<td>0.816</td>
<td>0.666</td>
<td>11.940</td>
<td>0.014</td>
<td>8.110</td>
<td>0.004</td>
<td>Not supported</td>
</tr>
<tr>
<td>GR</td>
<td>Test Instrument</td>
<td>7.070</td>
<td>0.978</td>
<td>0.957</td>
<td>65.780</td>
<td>0.004</td>
<td>6.352</td>
<td>0.008</td>
<td>Not supported</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>Test Instrument</td>
<td>1.148</td>
<td>0.965</td>
<td>0.931</td>
<td>40.346</td>
<td>0.008</td>
<td>4.044</td>
<td>0.001</td>
<td>Not supported</td>
</tr>
<tr>
<td>ROA</td>
<td>System Design</td>
<td>-1.722</td>
<td>-0.527</td>
<td>0.278</td>
<td>7.325</td>
<td>0.014</td>
<td>-2.706</td>
<td>0.014</td>
<td>Not supported</td>
</tr>
<tr>
<td>ROE</td>
<td>System Design</td>
<td>-5.487</td>
<td>-0.599</td>
<td>0.359</td>
<td>10.096</td>
<td>0.005</td>
<td>-3.177</td>
<td>0.005</td>
<td>Not supported</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>System Design</td>
<td>0.649</td>
<td>0.680</td>
<td>0.463</td>
<td>16.350</td>
<td>0.001</td>
<td>4.044</td>
<td>0.001</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

Independent Variable: R&D intensity

The relationship between Tobin’s Q and R&D intensity is positive and significant. This result differs from the findings of Lin et al. (2006). They found no significant relationship between Tobin’s Q and R&D intensity. However, our result is consistent with the findings of Agrawal and Knoeber (1996) and Lloyd and Jahera (1994). The results are consistent with the suggestion that IT firms might be able to enhance their long-term economic performance and market value by increasing their R&D expenditure. This result partially supports hypothesis H2, which postulates that the R&D intensity of an IT firm positively influences the firm’s financial performance. Thus, based on this test result, the corrected hypothesis would be that the R&D intensity of an IT firm positively influences the firm’s long-term economic performance.

Further analyses for all individual industry sectors have provided mixed results. The telecom industry has shown similar results to all industry sectors. About 84 percent of the variation in ROA and 63 percent of the variation in Tobin’s Q can be explained by R&D intensity. Similarly to all industry sectors, the coefficients (\( b \) value and Beta) of ROA are negative, and GR and ROE are also not significantly related to R&D intensity in this industry. In the Semiconductor industry, Tobin’s Q shows a significant and strong positive relationship with R&D intensity. About 67 percent of the variation in Tobin’s Q can be explained by R&D intensity. GR, ROA, and ROE are not significantly related to R&D intensity in this industry. In the Test Instrument industry, GR and Tobin’s Q have a very strong positive and significant relationship with R&D intensity. About 96 percent of the variation in GR and 93 percent of the variation in Tobin’s Q can be explained by R&D intensity. ROA and ROE are not significantly related to R&D intensity in
this industry. In the System Design industry, ROA, ROE, and Tobin’s Q are significantly related to the R&D intensity. About 28 percent of ROA, 36 percent of ROE, and 46 percent of Tobin’s Q can be explained by R&D intensity. GR is not significantly related to R&D intensity, and the coefficients (\(b\) value and \(\beta\)) of ROA and ROE are negative in this industry. The regression results do not show any significant relationship between financial performance (GR, ROA, ROE, and Tobin’s Q) and R&D intensity in the T&T Apparatus, Data Process, and the Software industries.

To provide more information about the financial performance of all industry sectors, data about five performance variables and R&D intensity is provided for seven industries in Table 4. The data shows that the Test Instrument industry has the highest growth in revenues for the last five years but the Semiconductor and Telecom industries have almost zero revenue growth. The most alarming indication is that all the industry sectors within the IT industry are suffering from negative returns (ROA and ROE). The T&T Apparatus industry has the highest debt ratio, and it also has the second lowest negative return. The semiconductor industry’s Tobin’s Q is the lowest among the IT industries. Semiconductor and Software are still the most R&D intensive industries, and the Data Process industry is the lowest R&D intensive industry in the IT sector.

### Table 4

**Individual Industry Sector Performances in IT Industry (R&D Firms)**

<table>
<thead>
<tr>
<th>Industry Sector</th>
<th>GR</th>
<th>ROA</th>
<th>ROE</th>
<th>Tobin's Q</th>
<th>Debt Ratio</th>
<th>R&amp;D INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&amp;T Apparatus</td>
<td>9.83</td>
<td>(38.47)</td>
<td>(67.93)</td>
<td>1.57</td>
<td>65.25</td>
<td>13.90</td>
</tr>
<tr>
<td>Telecom</td>
<td>(1.90)</td>
<td>(31.75)</td>
<td>(84.28)</td>
<td>6.88</td>
<td>46.24</td>
<td>13.48</td>
</tr>
<tr>
<td>Semiconductor</td>
<td>0.34</td>
<td>(26.67)</td>
<td>(35.87)</td>
<td>1.38</td>
<td>26.17</td>
<td>19.21</td>
</tr>
<tr>
<td>Test Instrument</td>
<td>36.74</td>
<td>(43.55)</td>
<td>(48.68)</td>
<td>8.99</td>
<td>20.12</td>
<td>13.05</td>
</tr>
<tr>
<td>Data Process</td>
<td>6.04</td>
<td>(3.37)</td>
<td>(112.77)</td>
<td>2.48</td>
<td>38.98</td>
<td>6.97</td>
</tr>
<tr>
<td>Software</td>
<td>13.03</td>
<td>(23.29)</td>
<td>(48.81)</td>
<td>8.83</td>
<td>43.36</td>
<td>18.10</td>
</tr>
<tr>
<td>System Design</td>
<td>16.79</td>
<td>(31.47)</td>
<td>(181.37)</td>
<td>6.35</td>
<td>47.62</td>
<td>15.63</td>
</tr>
<tr>
<td><strong>Industry Average</strong></td>
<td>11.56</td>
<td>(28.37)</td>
<td>(82.82)</td>
<td>5.21</td>
<td>41.11</td>
<td>14.33</td>
</tr>
</tbody>
</table>

Table 5 provides data on growth in performance variables and growth in assets against seven industry sectors. The data shows that none of the industries is experiencing any significant growth in assets; this indicates that firms in the Canadian IT industry are in the end-of-growth stage of the industry life cycle. However, the IT industry – especially the Data Process, Software, and System Design sectors – is a knowledge-based industry. It has much fewer tangible assets as compared to other high-tech industries. Only two industries (T&T Apparatus and Test Instrument) are experiencing significant growth in return (ROA) for the last five years, but they still have a negative return. The Test Instrument industry has a maximum growth in Tobin’s Q, which indicates that investors consider this industry to have future growth potential. The Telecom, Software, and System Design industries also have significant growth in Tobin’s Q. Although the Test Instrument and T&T Apparatus industries have significant positive growth in ROA, both of them still have a maximum growth in debt ratio, which indicates that they are trying to increase their return by using more borrowed money. Since the whole industry has had a negative return
for several consecutive years, they are perhaps surviving with an increased amount of borrowed money. As for R&D growth, only three industries – Test Instruments, System Design, and Data Process – have had significant growth in R&D expenditure.

Table 5
Growth Rate (%) of Performance Variables for Individual Industry (R&D Firms)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Asset</th>
<th>ROA</th>
<th>Tobin's Q</th>
<th>Debt Ratio</th>
<th>R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td>T&amp;T Apparatus</td>
<td>0.21</td>
<td>194.12</td>
<td>31.71</td>
<td>21.61</td>
<td>13.13</td>
</tr>
<tr>
<td>Telecom</td>
<td>(10.25)</td>
<td>(36.43)</td>
<td>80.85</td>
<td>10.35</td>
<td>(1.88)</td>
</tr>
<tr>
<td>Semiconductor</td>
<td>(2.44)</td>
<td>(22.49)</td>
<td>22.28</td>
<td>9.88</td>
<td>(5.14)</td>
</tr>
<tr>
<td>Test Instrument</td>
<td>11.36</td>
<td>213.48</td>
<td>537.71</td>
<td>29.60</td>
<td>111.38</td>
</tr>
<tr>
<td>Data Process</td>
<td>5.76</td>
<td>47.72</td>
<td>17.45</td>
<td>8.42</td>
<td>66.17</td>
</tr>
<tr>
<td>Software</td>
<td>10.62</td>
<td>45.11</td>
<td>55.63</td>
<td>22.58</td>
<td>10.02</td>
</tr>
<tr>
<td>System Design</td>
<td>14.18</td>
<td>(9.16)</td>
<td>86.25</td>
<td>18.62</td>
<td>143.36</td>
</tr>
<tr>
<td>Industry average</td>
<td>4.20</td>
<td>61.76</td>
<td>118.84</td>
<td>17.29</td>
<td>48.15</td>
</tr>
</tbody>
</table>

Test of Hypotheses H3

Hypothesis H3 postulates that the size of an IT firm positively influences the firm’s financial performance. We first tested this hypothesis for non-R&D firms. We have used simple linear regression models to see if there is any significant relationship between performance variables (GR, ROA, ROE, and Tobin’s Q) and firm size. The test results shown in Table 6 indicate that ROA and ROE have a significant positive relationship with firm size in non-R&D IT firms. However, the strength of relationship ($R^2$) is not strong, as only 42 percent of variability in ROA, and 38 percent of variability in ROE is explained by firm size. The GR and Tobin’s Q are not significantly related to firm size. This finding suggests that bigger firms in the IT sector earn more returns than smaller firms, which means that bigger IT firms are more capable of utilizing their assets to earn a higher return. This finding partially proves that hypothesis H3 is true for non-R&D firms.

Table 6
Relationship between Performance Variables and Firm Size in Non-R&D Firms

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>b</th>
<th>Beta</th>
<th>$R^2$</th>
<th>F</th>
<th>Sig. F</th>
<th>t</th>
<th>Sig. t</th>
<th>H3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR</td>
<td>Firm Size</td>
<td>-0.898</td>
<td>-0.063</td>
<td>0.004</td>
<td>0.056</td>
<td>0.816</td>
<td>-0.237</td>
<td>0.816</td>
<td>Not supported</td>
</tr>
<tr>
<td>ROA</td>
<td>Firm Size</td>
<td>26.909</td>
<td>0.647</td>
<td>0.419</td>
<td>10.103</td>
<td>0.007</td>
<td>3.178</td>
<td>0.007</td>
<td>supported</td>
</tr>
<tr>
<td>ROE</td>
<td>Firm Size</td>
<td>211.417</td>
<td>0.613</td>
<td>0.376</td>
<td>8.420</td>
<td>0.012</td>
<td>2.902</td>
<td>0.012</td>
<td>supported</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td></td>
<td>-0.775</td>
<td>-0.317</td>
<td>0.101</td>
<td>1.567</td>
<td>0.231</td>
<td>-1.252</td>
<td>0.231</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

For analyzing the relationship among performance variables (GR, ROA, ROE, and
Tobin’s Q) and firm size in R&D firms we have also used simple linear regression models, and the test results are shown in Table 7. The regression models show that only ROA and Tobin’s Q have a significant relationship with the size of R&D IT firms. GR and RE do not have any significant relationship with firm size. However, the strength of the relationships ($R^2$) is not strong, as only 7 percent of variability in ROA and 18 percent of variability in Tobin’s Q are explained by firm size. The relationship between Tobin’s Q and firm size is negative, which indicates that Tobin’s Q decreases with the increase of firm size. This result is consistent with the recent finding of Lin et al. (2006). The result indicates that bigger firms have lower growth potentials, and their Tobin’s Q values tend to be lower than those of small, innovative firms.

**Table 7**

**Relationship between Performance Variables and Firm Size in R&D Firms**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>$b$</th>
<th>Beta</th>
<th>$R^2$</th>
<th>$F$</th>
<th>Sig. $F$</th>
<th>$t$</th>
<th>Sig. $t$</th>
<th>H3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR</td>
<td>Firm size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROA</td>
<td>Firm size</td>
<td>4.873</td>
<td>0.257</td>
<td>0.066</td>
<td>4.298</td>
<td>0.042</td>
<td>2.073</td>
<td>0.042</td>
<td>supported</td>
</tr>
<tr>
<td>ROE</td>
<td>Firm size</td>
<td>8.319</td>
<td>0.195</td>
<td>0.038</td>
<td>2.363</td>
<td>0.130</td>
<td>1.537</td>
<td>0.130</td>
<td>Not supported</td>
</tr>
<tr>
<td>Tobin’s Q</td>
<td>Firm size</td>
<td>-1.911</td>
<td>-0.424</td>
<td>0.179</td>
<td>13.343</td>
<td>0.001</td>
<td>-3.653</td>
<td>0.001</td>
<td>Not supported</td>
</tr>
</tbody>
</table>

We have also analyzed the relationship between R&D intensity and firm size. The test of the linear regression model with R&D intensity as a dependent variable and firm size as an independent variable shows that they have a statistically significant relationship. The result in Table 8 shows that firm size has a negative relationship and explains only about 11 percent of the variation in R&D intensity. This result indicates that smaller innovative firms in the IT industry spend more on R&D expenditure than larger firms. This result is consistent with the findings of Tang and Rao (2001). They examined the R&D propensity of Canadian-controlled and foreign-controlled firms in Canada. Their results suggest that the R&D propensity is higher in high-technology and export-oriented firms, and lower in large- and medium-sized firms. This result is also consistent with the earlier result we found in this study, which indicates that smaller firms have more growth potential and are more capable of gaining long-term economic benefits through R&D investment.

**Table 8**

**Relationship between R&D intensity and Firm Size in R&D Firms**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>$b$</th>
<th>Beta</th>
<th>$R^2$</th>
<th>$F$</th>
<th>Sig. $F$</th>
<th>$t$</th>
<th>Sig. $t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D intensity</td>
<td>Firm size</td>
<td>-1.901</td>
<td>-0.324</td>
<td>0.105</td>
<td>7.142</td>
<td>0.010</td>
<td>-2.673</td>
<td>0.010</td>
</tr>
</tbody>
</table>

Our result shows that smaller firms gain a competitive advantage and enhance their long-term economic performance by investing more on R&D. This conclusion is consistent with
the findings of Albert (1990) and Zenger (1994); they compared the relationships between small and large firms as an explanation for the difference in innovative activity across firm sizes. They concluded that there are diseconomies of scale in producing innovations in large firms due to the inherent bureaucratization process that inhibits both innovative activity as well as the speed with which new inventions move through the corporate system towards the market. On the other hand, small firms are able to avoid these bureaucratic inefficiencies and gain a competitive advantage over large firms.

**Conclusion**

It is a common belief that R&D investment carries some intrinsic value. Our empirical analysis shows that there is no significant difference in performance variables between R&D firms and non-R&D firms in the IT sector. However, the result might be biased because of the small sample of non-R&D Canadian firms. Besides, further consideration should include the key activities of non-R&D firms and their sources of input. As a previous study (Tang and Rao, 2001) shows, even though foreign-controlled firms in Canada spend less or do not spend on R&D, they are, on average, more productive than Canadian-controlled firms because of their superior technological and managerial capabilities, imported from their parents. So, our test results for hypothesis H1 would be misleading if some of the non-R&D firms are controlled by foreign companies.

As for the R&D firms, we found no relation between a firm’s growth (GR) and its R&D intensity. This result confirms the low innovation performance of Canadian firms in the IT sector who fail to convert their innovations into sales. This finding suggests that firms with a strong R&D base should improve their marketing capability in order to gain the most from their innovations.

We investigated both the short-term and long-term effects of R&D investment on performance variables. Our study confirms that R&D expenditure has significant negative effects on short-term profitability measures (ROA and ROE), but its effect on a long-term economic performance measure (Tobin’s Q) is positive and significant. This finding proves the strategic significance of R&D investment on a firm’s value.

Our result extends the understanding of the role of firm size in R&D intensity and a firm’s financial performance. We found that smaller firms invest more on R&D and are more productive in innovation than large firms. Smaller, innovative firms have higher growth potentials and their market value is relatively higher. One reason might be the Canadian government’s significant tax benefit for small firms. An extension of this study could be to investigate the underlying reasons why small firms are more innovative.
References


