The Determinants of Research and Development for Small Firms in Canada

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Major Paper presented to the

Department of Economics of the University of Ottawa

in partial fulfillment of the requirements of the M.A. Degree

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ECO 7997

Ottawa, Ontario

May 2005

Introduction

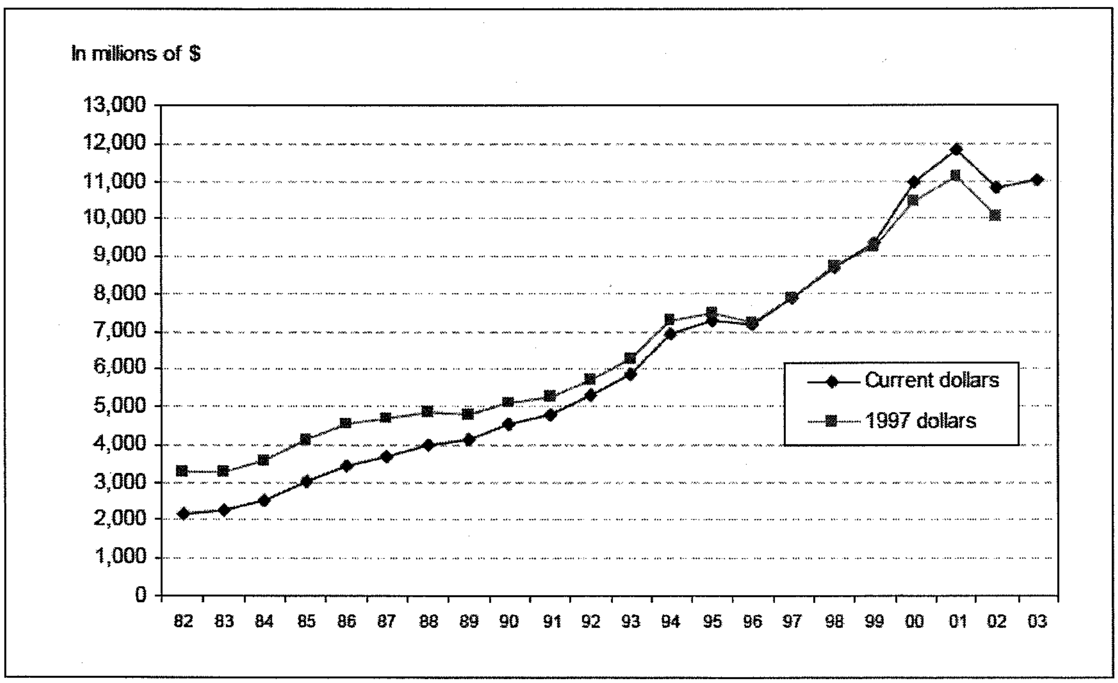
Research and development (R&D) is itself an important determinant of future productivity because it sparks innovation and technological change (Whewell 1999, 1). The goal of this paper is to examine what determines the R&D intensity of small sized firms in Canada. The potential determinants to be considered are financial, industrial, and locational.

Undertaking R&D is generally a major decision for firms, and is dependent on them being able to obtain financing for the project. A large number of firms that perform R&D haven't yet become successful and therefore rely on financing in order to fund their projects. To observe the financial effects I will look at the debt to assets ratio, the quick ratio, and the level of cash flow for the firm.

The industry that a company performs its business in has a large effect on the amount of R&D undertaken. In some industries R&D is viewed as critical to the success of the company and therefore will lead to more R&D intensive firms. Another aspect of the industry characteristics of a firm to be observed is the effect of their market share on their intensity.

Canada is a country that has very generous tax treatment for R&D, but this does not lead to the amount of expenditures that one would expect. An examination of business enterprise expenditures on R&D (BERD) for 2001 shows that in terms of BERD as a proportion of GDP Canada is in the middle of OECD member countries. For comparison purposes, over the period 1991-2001 Canada's BERD has been about 1.1% of GDP, while in the United States the share has been roughly 2.0% (Statistics Canada 2003, 14). Warda (1999) performs a comparison of countries based on the degree to which they promote R&D with tax incentives, in which he finds that Canada is the only country that can be considered a leading promoter. The federal tax treatment of R&D in Canada is detailed in Appendix 1. The data used in this study are for the time period of 2000-2003, which is a very interesting time period for R&D expenditures in Canada, which is shown in figure 1. During this period the tech bubble burst and the stock market crashed. As one can see, the level of expenditures had just come off a steep increase, and actually decreases in 2002 and then begins to recover in 2003.

Figure 1: R&D Expenditures, 1982 to 2003



Source: Industrial Research and Development, Catalogue No. 88-202-XIE, Statistics Canada, pg 16

To test the effects of these variables on the R&D intensity of companies I use both pooled and cross-section techniques. Cross-section regressions will be run for each year on both a balanced and unbalanced sample. Pooled regression techniques used include pooled ordinary least squares (OLS), fixed effects, and the random effects model.

Literature Review

The literature on R&D covers a variety of topics from countries all over the world. Predominantly the studies are performed on data for the United States, with a few performed on Canadian data. This paper looks at studies that focus on the determinants of R&D, studies that include tax policy, international topics, and briefly a study that employs a user cost model.

The determinants of research and development (R&D) have been on the minds of economists roughly the last thirty years, with Howe and McFetridge (1976) providing one of the earliest studies for Canada. They create a model for R&D expenditures that shows the effect of various shift parameters on the marginal rate of return and marginal cost. The shift parameters include sales, firm size, profits, government incentive grants, foreign ownership, and the effect of market concentration on R&D expenditures. The square and cube of sales are included in order to summarize a variety of other influences on R&D expenditures as the size of the firm increases. Some of these are that the optimal value of resources to be devoted to the development of cost-reducing process innovations increases with sales; the larger firm is more likely to find a profitable internal application for its R&D output; and if large size is associated with a large market share, then the larger firm will be able to receive a greater proportion of return from R&D (Howe and McFetridge 1976, 60). They used the electrical, chemical, and machinery industries, pooling the data to increase the degrees of freedom. Their findings include a positive effect on R&D expenditures for government grants and no effect for firm size or market concentration. The variables used to measure the financial environment are only relevant for domestic firms, which suggests that foreign firms will respond differently to changes from domestic authorities than domestic firms.

Moving to a more recent study, Cumming and Macintosh (2000) use a completely different technique: they use a survey of the biotechnology industry to test eight different hypotheses using an ordered multinomial discrete dependent variable model. The survey consists of 56 Biotechnology firms in Canada and required the firms to answer a set of questions on a scale of 1-10 of their importance in determining the level of R&D expenditures. They group the determinants of R&D into four categories: legal, market, strategic, and firm-specific factors. The legal factor they look at is whether the availability of patents has any effect on the R&D expenditures, which they find to be the case. They look at market factors such as competition, demand for products, and if potential consumer controversies are present and find that all of these increase the amount of R&D performed. They also find that firms that enter into strategic alliances or have a better cash flow will spend more on R&D. A couple of other findings from their study are that the higher the debt-equity ratio of the firm the less R&D they do, and that firms in the early stages of development spend a large proportion of their total expenditures on R&D.

The availability of internal financing is a very important aspect of the determination of R&D expenditures. Bloch (2004) writes a paper investigating the effect of financial constraints on R&D for firms in Denmark. He focuses on cash flow because if firm borrowing is constrained then R&D expenditures will be dependent on the firms' cash flow. Therefore, cash flow's ability to explain R&D investments will provide evidence of financial constraints. Cash flow can also show future profitability, since it forecasts future earnings, which suggests that cash flow may help explain R&D investments because it forecasts future earnings (Bloch 2004, 2). To differentiate between these two interpretations he considers a subset of the sample that is more likely to be subject to financial constraints and uses "Expected Q" to control for cash flow's predictive power for future earnings.[1] The empirical model used in this paper measures R&D intensity as R&D expenditures divided by total assets. The independent variables are Tobin's Q, cash flow divided by total assets, and sales divided by total assets. He uses a fixed effects approach to allow for individual firm effects. The Hausman-Taylor instrumental variables approach is also used and provides similar results to the fixed effects approach. He finds that financial constraints play an important role in determining the size of R&D investments.

Baldwin, Gellatly, and Gaudreault (2002) look at the effect access to financing has on small firms in Canada. Their paper asks three questions, with the first dealing with whether the balance sheet of small firms gives any indication that they are geared towards riskier sources of funds. The second question is whether there is a difference in the financial instruments used by successful and unsuccessful firms. The last question is whether the firms with more debt financing succeed in producing more innovations. The data set used to answer these questions is made up of small firms that have survived their first ten years of operation, which accounts for 20% of the population of small firms. It is found that small firms obtain most of their financing from retained earnings, which accounts for 40% of their financing, and short-term and long-term debt account for 11.6% and 16% respectively. They use multivariate techniques to examine the

[1] Q is calculated here as the market value of equity plus the book value of long-term debt, divided by the book value of assets. Expected cash flow takes into account the effect of cash flow, sales and Q on the next period's value of Q.

differences between R&D intensity and financial structure, where R&D intensity is measured as the share of investment expenditure allocated to R&D. The model includes two equations to be estimated separately using OLS and then using 2SLS. The dependent variables of the two equations are R&D intensity and financial structure, both of which are assumed to be endogenous to each other. The other independent variables in the equations are various firm and industry characteristics. They find evidence from both the OLS and 2SLS models that R&D intensity is negatively related to debt intensity, or in other words firms with more debt in their capital structure perform less R&D.

The introduction of the Research and Development tax credit in 1981 in the United States has been used by many authors to observe the effects tax policy has on R&D. Berger (1993) uses pooled regressions along with individual firm regressions to do a regulatory event study of the introduction of the tax credit. This paper investigates the tax credit in two ways: first, by looking at the impact of the credit on the level of investment in R&D; and second, by estimating the size of the implicit tax credit created. These effects are interrelated because an increase in the level of R&D investment will increase the demand for R&D inputs, which will reduce the pre-tax rate of return from R&D activity (Berger 1993, 131). The 1981 tax credit was an incremental tax credit worth 25% of the expenditures in the current year over the average of the three preceding years. He uses an enactment parameter, which measures the change after the credit comes into place, to develop an upper-bound estimate on how much of any R&D spending represents implicit taxes and the tax cost of operating in the wrong tax clientele with respect to R&D. The tax clienteles arise because of implicit taxes and since R&D is a tax-favoured investment, the correct tax clientele for R&D investment is a firm with a high marginal tax rate (Berger 1993, 137). Berger runs both individual and pooled regressions with a dependent variable of R&D intensity, which is measured as R&D expenditures divided by sales. The independent variables are the firms' pre-R&D cash flow, R&D intensity for the industry, level of GNP, Tobin's Q, lagged R&D, a credit usability dummy variable, and for the pooled regressions, a dummy variable equal to 1 if the firm is never able to use the credit over the period 1981-1989. Cash flow is divided by sales to control for heteroscedasticity, and lagged R&D intensity is included to reduce the autocorrelation created by nonstationarity in the time-series process (Berger 1993, 145). The individual regressions do not require equal slope coefficients across firms, but the pooled regressions do. The pooled regressions are run using a fixed effects method, which allows for a separate intercept for each firm. It is performed by replacing the original observation of the firm with the deviations from the sample mean for the time series of the firm and then applying OLS. Berger finds a positive effect on R&D intensity for cash flow and lagged R&D, with a negative effect for GNP and Tobin's Q, although the effect of Tobin's Q is statistically insignificant.

McCutchen (1993) also performs a regulatory event study on the introduction of the tax credit in the U.S. in 1981, but looks at the topic from the perspective of business strategy. In this paper he states three hypotheses about firms, the first being that R&D tax credits should cause increases in research intensity. The second hypothesis is that in a given industry, firms will attempt to maintain their relative ranking in terms of R&D intensity. The last hypothesis is that firms with a high cash flow margin prior to the enactment of the credit will react more strongly than firms with low cash flow margins. In order to test whether these hypotheses are true he uses a sample of 20 pharmaceutical firms in the prescription drug industry. The model used in this paper was proposed by Grabowski and Vernon (1981) and is based on investment theory. Like Berger he uses R&D divided by sales as the dependent variable, but uses as independent variables past R&D success, diversification of the firm, cash flow margin, market share, a dummy variable equal to 1 when the tax credit is available, the interest rate, and firm size. Past R&D success is measured by creating an index of sales of new chemical entities over a two period lag of R&D expenditures. The diversification variable is based on the number of therapeutic categories in which a firm has significant sales. Regression analysis is applied to the pooled time-series cross-section sample over the period 1975-1985. Similar to Berger he finds that the effect of the tax credit on the level of research intensity is positive, and that the higher the cash flow of a firm the higher its R&D intensity. He also introduces the finding that when looking at an industry like the pharmaceutical industry with a strong reliance on research intensity as a factor of success, firms will attempt to maintain their relative ranking in the industry in terms of R&D intensity.

Not only are there studies focusing on one country, but also there are studies that utilize comparisons of countries to make conclusions about the R&D performed in Canada. Le and Tang (2001) compare Canada to eleven other major OECD countries in an attempt to determine why Canada spends less on R&D than its key trade competitors. To do this they focus on the manufacturing industry. R&D intensity is defined here differently than in other studies - instead of using sales as the denominator, GDP is used. When comparing Canada to the other major OECD countries they find that Canada ranks first in tax subsidies for R&D, but Canada ranks last on government R&D funding and second last in business enterprise R&D funding, all of which leads to Canada ranking second last in R&D intensity for the manufacturing industry. In this paper they attempt to explain the determinants of R&D by analyzing three factors: foreign ownership, industry composition, and firm size. They state that R&D intensity of foreign-controlled firms is generally lower than the national average in the host country. Their reasoning is that multinationals tend to centralize R&D spending at home and mainly only adopt technologies in host countries, and if the denominator is output, intensity is generally lower because foreign firms are more productive. Large firms tend to do more R&D than small firms and therefore countries with a high proportion of large firms are more than likely to be more intensive. Canada ranks fourth in the number of large firms. Industry composition also plays a major role in a country's R&D intensity, and the higher the concentration of high-tech industries the higher the R&D intensity; Canada ranks 7th in their measure of high-tech concentration. Regression analysis is then performed using OLS and the results that emerge are a negative coefficient for foreign ownership, and positive coefficients for high-tech concentration and firm size as expected. They also calculated the deviation from the mean of all countries for Canada and found the largest deviation to be for foreign ownership.

Whewell (1999), like Le and Tang (2001) uses output to measure R&D intensity, but only compares Canada to the United States. The purpose of this paper is to identify the potential causes of low R&D in Canada relative to the U.S., and then to derive modified R&D intensity rates by making both cross-country and within-country adjustments. The cross-country adjustment imposes U.S. industrial and firm characteristics in calculating Canada's R&D intensity rate. To make within-country adjustments the R&D intensity rate of domestic-owned firms is imposed on foreign-controlled firms. The factors affecting R&D intensity in this paper are firm size, industry differences, and foreign ownership. Small firms have a higher intensity than large firms, but since the objective of the paper is to correct for differences between Canada and the U.S. and not between small and large firms, only the differences between countries will be observed. Two types of industry differences are considered. First, differences between the Canadian and the U.S. economy may lead to differences in the intensity rates. Second, the allocation of R&D expenditures in industries may be different in the two countries. Finally, it is likely that the high level of foreign ownership in Canada will lead to lower levels of R&D expenditures. Foreign firms are also less likely to convert their sales into R&D investments than domestic firms are and therefore R&D intensity will be lower in Canada. She finds that the cross-country differences between the Canadian and the U.S. industrial structure and spending patterns across industries only explains one-third of the gap, but when performing this exercise for small and large firms the gap is eliminated. She finds that making the within-country adjustments also eliminates the R&D intensity gap between Canada and the U.S.

Baldwin and Hanel (2000) do not use cross-country comparisons like Whewell (1999) and Le and Tang (2001), but examine whether the nationality of the firm affects the organization of R&D activity. Foreign-owned firms are thought to perform R&D abroad for more than one reason. The first is to exploit the foreign firms' specific capabilities in the foreign environment. The second is to augment a firm's knowledge base by using the potential spillovers from existing local resources (Baldwin and Hanel 2000, 3). They compare multinational firms to Canadian firms to see whether there is an indication of a disadvantage for multinationals. Then they also compare foreign multinationals and domestic multinationals, which means Canadian firms with a foreign orientation, or in other words, those with operations abroad or who have export sales. They use a multivariate logit model to test whether a firm performs R&D or not. Their explanatory variables are foreign ownership, the global orientation of the domestic firm, firm size, a variable identifying the industry of the firm, and the degree of competition. They use the 1993 Survey of Innovation and Advanced Technology, which is based on all firms possessing a Canadian manufacturing establishment. Their results show a positive effect on R&D for everything except for the domestic ownership variable. The finding that foreign firms are more likely to perform R&D than domestic firms leads one to question the findings of Le and Tang (2001). It suggests that the main factor in their finding that foreign firms are less likely to perform R&D than domestic firms is because foreign firms are more productive. In the end one has to ask oneself whether one is interested in intensity or incidence of R&D.

Another way to attack this problem is to use a user cost of capital approach. Bloom, Griffith, and Van Reenen (2000) use the user cost framework in a study on the impact of fiscal incentives on the level of R&D investment. Their study is performed on nine OECD countries including the U.S. and Canada over the time period of 1979-1997. The user cost of capital shows the cost of an investment project after tax multiplied by the interest rate plus depreciation and all of this less depreciation. This user cost is calculated for a domestic investment in R&D for three assets, each country, and each year. The three types of asset for use in R&D are current expenditures, buildings, and plant and machinery and these are assigned weights of 0.9, 0.064, and 0.036 respectively. They used the OECD database (ANBERD) for information on business enterprise R&D. They use a simple model with the natural log of industry funded R&D as the dependent variable, and the natural log of output and the natural log of the user cost as independent variables. Their OLS results show that the sign of the user cost is negative as expected and is significant. There are however problems with the user cost approach related to the endogeneity of the user cost. The endogeneity may lead to an upward bias since it is a function of the tax system and other economic variables (Bloom et al. 2002, 13). For a more detailed review of the literature on the user cost of capital in relation to R&D see Hall and Van Reenen (1999). This technique was not really focused on here, as the proper information to implement it was not available.

A literature review on the determinants of R&D is a difficult task as there are many ways to tackle the issue. This makes it difficult to compare studies as different techniques, sets of data, and industries have been used to estimate models. There is somewhat of a consensus on the determinants of R&D investment in Canada and these include financial, foreign ownership, and industry related characteristics.

Data

The data set used in this paper is very large relative to that used in other studies as the data set used is a panel data set consisting of the entire population of Canadian firms who filed Schedule 31 for their corporate tax return from the year 2000 until 2003. The information for 2003 is not fully complete, as only about two-thirds of the returns have been incorporated in the GIFI, but for the purposes of this paper it can still be used without any problems.

The sources used to collect the data are Cortax and the GIFI. The Cortax data set provides information from the T2, which is the corporate tax return, and all the schedules accompanying the return. Schedules and forms used in this paper are the T2, the T106 for foreign ownership information, and Schedule 31 for the R&D investment tax credit information. The benefit of the Cortax data set is that it provides tax information on the entire universe of firms that file a corporate tax return. This kind of coverage cannot be found in any other data set, as this information is not available to the public. The fields on the tax form captured by Cortax are any field with a black box with a number next to it and this represents most of the form. The main problem with this data set is of course that there is a large opportunity for human error, but this problem should be minimized since it is the tax return and will be filled out with due care by the corporation. Human error does show up, though and is observed in the "type of corporation" field, which makes that field useless. Overall though, the Cortax database is a very useful data set.

The GIFI is the General Index of Financial Information (GIFI) for Corporations and is collected by the Canada Revenue Agency along with the T2 form. The GIFI includes all the financial information from the balance sheet and the income statement and is required to be filed along with the corporate tax return. The benefits of the GIFI are that it includes all the financial information for both public and private corporations and can easily be linked to the Cortax data by the business number of the corporation. However, there are a few problems with the GIFI system that limit its effectiveness. The limiting design feature is that companies can choose to report only aggregates of the information, even though there are fields that can break this total down. In order for the GIFI to be a more useful data set, companies should be required to report both the total and the accounts that make up the totals. This problem does not really affect the data set in this paper, but it would be nice to have the higher level of detail. Another problem is that again there is plenty of opportunity for human error in the entry of the data, which leads to some of the crucial accounting equations not always being valid. Moreover, the GIFI is only available since the year 2000.

Building the Data Set

The data set, as indicated above, is a combination of the GIFI and Cortax data for companies that filed the Investment tax credit (ITC) form (Schedule 31) along with their corporate tax return. The first step is to remove any firm that didn't perform R&D, which is done by deleting any company that does not have a positive value for their ITCs and for their R&D expenses. The second thing removed is a problem with the database in that some firms filed twice in the same year, which created two possibilities. If the number of days for the two filings summed to a full year, then the appropriate fields were summed and created one full year of filing for the company. The second possibility is that the two entries did not sum to a full year; in this case I took the filing with the greater number of days. After this I performed a double check on performance of R&D and removed any other corporation using the same technique as before. Next I removed any company with an expenditure limit for R&D that is greater than $2,000,000, since this is not possible according to the tax act. Following this, I removed any entries where they didn't give all of the information for the GIFI by deleting any corporation that left blank an entry on the balance sheet or income statement. If a blank did exist here the whole statement was left blank and therefore could not be used.

Breaking down the data by industry is something that is very desirable when it comes to work on R&D and therefore I removed any firms that didn't give their information for the NAICS[2] field. Next I removed all the large corporations from the data set, which means deleting any firm that has capital greater than $15,000,000. Large corporations were removed since they are very different from small corporations and were removed for simplicity. After this various financial ratios were calculated, which created the problem of having zeros in the denominator of the equation and therefore forced me to delete any situation where this occurred. Next I performed a validity check on the GIFI that required total assets to equal total liabilities plus owner's equity, and if a firm didn't pass this check the entry was dropped. Finally, I performed an analysis of the outliers by assuming that all variables were distributed normally and dropped anything that did not lie between the 0.05 and 0.995 percentiles.[3] Later, when performing regressions, I noticed that there tended to be a lot of outliers associated with the farming industry, which I decided to remove since the accounting for this industry is different than the others. The financial industry was also deleted due to it having different accounting practices. After all of this the data set is left with 34,882 corporations.

I also created a second sample of this data set in order to have a balanced sample for the fixed effects model. To create this set I only included firms that performed R&D in all four years. There were a few firms with a blank for R&D intensity in one year, so I had to delete all years for these firms. Another problem was that in a few cases there was a change in the CCPC classification for a corporation, which caused problems with a couple of model specifications and for simplification purposes these firms were deleted.[4] This sample contains 2,655 corporations over the 4-year period for a total of 10,620 observations.

[2] NAICS refers to the North American Industry Classification System for the year 2002.
[3] This technique is due to Montgomery (1996).
[4] See Appendix 1 for the definition of a CCPC.

Descriptive Statistics

It is expected that the amount of R&D performed by different industries will vary greatly. In order to see if this is true I have compiled the total R&D expenditures for each year by the firms' two-digit NAICS code and their corporate organization. Tables 1 and 2 display the numbers of firms carrying out R&D and the distribution of R&D expenditures across firms and years for the unbalanced and balanced sample respectively. During the four-year period from 2000 to 2004, firms in the unbalanced sample spent a total of $13.27 billion on R&D, while firms in the unbalanced sample spent $4.54 billion.

From these tables, one can see that CCPCs account for two-thirds of total expenditures on R&D during the time period. The reason for the fall in total R&D expenditures in 2003 for the unbalanced sample is that the data are not complete.[5] The year 2001 accounted for about 3% more of the total R&D spending of both CCPCs and Other firms in the unbalanced sample than the year 2000. This increase in the share of total R&D spending was the result of a 34% increase in nominal R&D spending by Other firms and an 18% increase in nominal R&D spending by CCPCs. In 2002, the total amount of expenditures remained virtually the same as in 2001. In the balanced sample R&D expenditures grew at rates of 27% for Other firms and 23% for CCPCs.

Looking at the frequency, one can see that CCPCs clearly outnumber the others in terms of performing R&D. This is as expected since the previous literature has found that most firms perform their R&D in their home country. The most interesting piece of information without looking at industries in this table is that even though CCPCs make

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[5] The data for 2003 is incomplete as not all tax returns had been processed, but I felt a large enough amount had been to use this year.

up about 90% of the companies in both samples, they only account for about two-thirds of the R&D expenditures in Canada.

Focusing on the industrial distribution, one can see that the manufacturing and professional, scientific and technical services industries account for three-quarters of the companies that undertake R&D expenditures. In terms of frequency of performing R&D the manufacturing industry is larger, but the professional services industry spends more on R&D in the unbalanced sample (39.74% of the total, as compared to 36.98% for manufacturing). This is not surprising since these industries include high tech sectors such as computer manufacturing, semiconductors, scientific research and development, and computer systems design. In the balanced sample the opposite is true: the manufacturing industry spends more on R&D during the 2000-2004 period because manufacturing firms constitute a larger proportion of the firms in the balanced sample than in the unbalanced sample. An interesting piece of information from this table is that there is only one industry for which CCPCs account for a lower share of R&D spending than non-CCPCs, which is the wholesale trade industry. One of the explanations for this is that the industry classification does not necessarily mean that is the area the company performs their R&D in, so in this case it could be foreign companies locating a distributor in Canada and transferring their R&D into the products to be sold.

In Table 3, I look at how the dependent variable for my econometric analysis, R&D intensity, is distributed by industry. R&D intensity is measured as R&D expenditures divided by the firm's total expenditures. It is thus a variable with a range between 0 and 1 and does not include any firms with an intensity of 0. The first thing one notes is the large standard deviations of some of the industries relative to their means. A lot of this variation occurs because there are quite a few companies in the data set with expenditures on R&D only, leading to them having an intensity of near 1.0. The averages for the industries are nowhere near this level as the highest comes from the Arts, Entertainment and Recreation industry at 0.5056 for Others and 0.2656 for CCPCs. This table also shows that the industries with the highest levels of R&D expenditures do not necessarily have high intensities. An example of this is manufacturing, which has a low average intensity of 0.0712 for Others and 0.1075 for CCPCs, but this is not surprising since there are many other expenditures needed for a manufacturing company.

One of the purposes of this paper is to see if the differences in characteristics of CCPCs and other corporations lead to a difference in their R&D intensity. The cases where the CCPCs do not have a higher intensity than non-CCPCs tend to come from industries that are not very high in R&D expenditures, but looking at the Professional, Scientific, and Technical Services industry, which is the largest in terms of expenditures, there is virtually no difference in the mean intensity for the unbalanced sample. This result makes sense since in order to be successful, R&D must be performed and will be done regardless of the differences between firms.

Lastly I performed sample t tests on the dependent variable of R&D intensity to test whether the sample means for industries were significantly different for CCPCs and other corporations. The test statistics are shown in table 4. These tests were only performed on the unbalanced data set, as there are not enough observations to break the balanced sample up by industry. The industries are broken down mainly at the 2-digit classification level of the NAICS, but the industries with high expenditures are disaggregated to the 3 and 4-digit levels. Manufacturing was disaggregated to the 3-

digit level, with computer manufacturing being taken to the 4-digit level of aggregation. CCPCs for the most part have higher intensities as about 42 of the 51 industries show this to be true. Most of these differences in the intensities turn out to be statistically significant, as for 29 of these 42 industries, I reject the null of equal means and find CCPCs do have a higher mean at the 5% significance level. Looking at the cases where CCPCs have lower mean intensities, only two of these industries have a statistically significant difference. These industries are the Health Care and Social Assistance industry and the Motion Picture and Sound Recording Industry.

Performing the *t* tests shows there are differences between the two types of corporate organization, but they do not allow for other things to be controlled for like regression analysis will. The differences are not solely due to the corporate organization and could be due to other factors such as availability of financing, amount of foreign ownership, and market share.

Model

Variables

In this paper, I test the effect of the various determinants of R&D on a corporations' R&D intensity. R&D intensity is measured in different ways in the literature, for example using sales, investment, or some form of assets as the denominator. I measure R&D intensity differently than others have previously, using the corporation's R&D expenditures divided by their total expenditures. My reasoning for using a different measure is that other denominators are more problematic than expenses. Sales have the problem that they have no particular relationship with R&D expenditures; for example, it would be hard to distinguish between a company just having a slow year for sales, and a start up company performing a lot of R&D with no sales because the product is not complete.[6] Investment was not used, as it was not possible to get the data for the corporations' cash flow statement. I considered using assets as somewhat of a proxy for investment, but it did not make sense to use a flow divided by a stock. In addition, non-R&D-related capital asset purchases could affect the intensity levels for some years.

Total expenditures are calculated as total expenses less the corporation's R&D expenses on the income statement plus its R&D expenses claimed for tax purposes. They are calculated in this manner because without using the R&D expenses reported on the tax form corporations had intensity levels of greater than one. The one problem in this calculation is that there will possibly be some double counting in total expenses that can't be controlled for, but this is less of a problem than firms having intensities greater than one.

For the most part the independent variables follow the literature reviewed. The study performed by Berger (1993) is followed closely in terms of variables used. One of the variables missing from his study is the lag of R&D intensity; I leave this out, as it was unclear how to include this in a correct manner. The user cost of capital also is another variable that wasn't included although Hall and van Reenen (1999) show its importance, as the necessary information on investment was not available. Even though the data set used prevented me from including the user cost of capital it allowed me to differentiate between CCPCs and others, which is something other studies are not capable of doing. The independent variables used are described below.

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[6] Regressions were run with sales as a denominator and while the fit as measured by R^2 was higher, some of the coefficients were no longer significant.

In order to measure the flow of internal funds available I created a variable showing the cash flow of the firm. Cash flow is measured as net income minus taxable R&D expenditures plus current assets minus inventories, all of which is then divided by total operating expenses. Current assets less inventories are included since they include assets such as cash or marketable securities that could be used for internal funds.[7] Internal funds are an important determinant of R&D expenditures, as companies like to use internal funds over external funds since it allows them to keep their R&D projects secret. Based on this I would expect this variable to have a positive effect on the R&D intensity of the corporation. The observations for this variable range from –1.5 to 418.24.

Since this data set is composed of small firms with less than $15 million in capital assets it is likely their liquidity will be a factor in their ability to get financing for R&D. Liquidity provides a measure of how capable a firm is of covering its short-term liabilities. Liquidity is important for small firms because they are seen as being at risk of not surviving in the long-term, as there generally is not a lot of money available to them. The quick ratio is used to measure liquidity and is calculated as current assets minus inventories divided by current liabilities. Again, I would expect this variable to have a positive effect on the R&D intensity of the firm. The observations for this variable range from 0.01 to 36.87.

The last financing variable is the level of debt of a firm. The level of debt for a firm shows two things: first, it shows how much debt the firm has already taken on; and second, it shows whether it is capable of taking more on. Debt here is measured using the total debt, both long- and short-term, divided by the total assets of the firm. Assets are used because there was a division by zero problem with the data set when using

[7] "Current assets" are assets that can be turned into cash within a year.

equity. It also allows this measure to be consistent with the non-equity portion of Tobin's Q used by Berger (1999).[8] This ratio has the opportunity to have both a positive and negative effect, but due to total expenses being in the denominator of the dependent variable, it is expected to have a negative effect on R&D intensity. The reasoning is that since not all debt would be R&D related, an increase in debt will lead to an increase in interest expenses and hence an increase in the denominator of total expenses.

Another variable that could have an ambiguous effect is the market share of the firm. It is unclear whether the market leaders would tend to be more research-intensive since they are always trying to improve and have the money to do it, or whether their extra production costs would make them less research-intensive. To measure the true market share of the firm I retrieved the sales data of every firm that filed a tax return in Canada. With this information, I computed the total sales of each industry by their 4-digit NAICS code. To find the market share I divided the sales of each firm by the total sales for the industry.

The industry a firm is in also will affect its intensity. One would expect that the more research-intensive an industry is, the more likely the firm will be R&D intensive. To measure this I created a variable that is the sum of R&D expenditures over all firms in the industry and all four years in the sample, divided by the sum of total expenses for the industry during each of the four years covered by the sample. By construction this variable does not vary from year to year. The industries are again defined by their 4-digit NAICS code.

[8] Tobin's Q was defined by Berger as [(price*shares of common share) + book value of preferred share+ long-term debt + short-term debt] / assets.

Any Canadian study performed must include a variable for foreign ownership, since there are a lot of multinational firms in Canada. However, there is a problem with the data for this variable in that I was only able to get the percentage of foreign ownership for the other corporations, and therefore had to set the foreign ownership of all CCPCs to zero. I would expect this variable to have a negative effect since it is found in the literature that most firms keep their R&D in their home country.

I also include a dummy variable for differences in corporate organization. The dummy variable is used to show whether the firm is a CCPC or not, which is set equal to one if the firm had expenditures at the 35% credit level. This variable is included since there are various differences between the two, for example, the availability of financing, tax treatment, and export oriented firms.

Table 5 shows the mean and standard deviation of the variables included in the regression. The mean for R&D intensity is consistently higher for the unbalanced sample compared to the balanced sample.[9] A possible explanation is that the stability of the firms in the balanced sample has opened them up to other forms of expenses than R&D. The debt to assets ratio is also consistently higher for the unbalanced sample. This also could be explained by the stability of the firms in the balanced sample if the firms in the balanced sample showed a higher cash flow, but the opposite is true. The true explanation therefore could be that the firms in the unbalanced sample are more willing to take on the risk associated with the additional debt, which causes some firms to fail and drop out of the sample. The opposite for the previous variables is true for the quick ratio, as it is consistently higher in the balanced sample. This is definitely a sign of

[9] The mean of R&D intensity varies across time series as in different years there are some industries that don't exist in the sample causing a slight variation in the mean each year.

stability as firms with stability are more likely to have a strong quick ratio and their lesser reliance on debt will decrease the level of current liabilities and hence lower the denominator.

Modelling Techniques

First, cross-section and pooled OLS regressions including the variables mentioned above are performed on the unbalanced and balanced samples of the data set. For the pooled OLS regressions, the model used is a simple linear regression model of the form

$$y_i = \iota\alpha + X_i\beta + \varepsilon_i \;, \qquad (1)$$

where i indexes the firms, y_i is a Tx1 vector, T is the number of time periods, X_i is a TxK matrix of explanatory variables for firm i, K is the number of explanatory variables, ι is a Tx1 vector of ones, α is the constant term, β is a Kx1 vector of slope coefficients, and ε_i is a Tx1 random error vector. The regressions are performed using robust estimators of the variances, which apply White's correction for heteroscedasticity. This is needed since tests for heteroscedasticity found it to be a significant problem.[10] These models do not allow the panel data to be used to its fullest capability; since the business number can track each firm there is the opportunity for there to be specific firm effects that can be taken into account using a fixed or random effects model.

The fixed effects model creates a dummy variable for each individual company, which allows each company to have a different intercept. In contrast to equation (1), the fixed effects model is of the form

$$y_i = \iota\alpha_i + X_i\beta + \varepsilon_i \;. \qquad (2)$$

[10] The Breusch-Pagan test for the pooled regression without robust estimators yields a test statistic of 3081.39 with a p-value of 0.000.

In this model the constant α_i is multiplied by ι, which allows each company to have its own intercept and should remove the bias created by the heterogeneity of the companies. To avoid having to create a few thousand dummy variables the data are transformed by subtracting the average over the four years of each variable for that company from each observation of the variable. OLS on the transformed data then produces the fixed effects estimator. The one problem with the fixed effects model is that you cannot include variables that do not vary over time for a company. This occurs because for a dummy variable, the average subtracted from each observation is equal to zero for each observation. Using this model therefore makes it impossible to use the dummy variable to designate whether the firm is a CCPC or not.

The random effects model is designed to overcome this problem. This model is of the form

$$y_i = \iota\alpha + X_i\beta + \iota u_i + \varepsilon_i \,. \tag{3}$$

It also allows for different intercepts like the fixed effects model, but these intercepts are random. The error term in this model has two components: the traditional random error ε_i and the random part of the intercept term, u_i, which constitutes the difference between the firm's intercept and the overall intercept. The data are transformed again to remove the heterogeneity and then GLS is performed to estimate the coefficients.[11] The limitation of the random effects model is that the random effect must be independent of the explanatory variables.

[11] Information for the modelling techniques came from the panel data sections of Greene (2003) pages 283-338 and Kennedy (2003) pages 301 - 318

Results

Cross-Section Regressions

The cross section regressions are run using all the variables outlined earlier for each year in the data set and are presented in Table 6. There is no information about foreign ownership in the year 2003, so that variable is dropped when the regression is performed for that year. The results are presented in table 6 with the coefficient on the top, the *t* statistic on the bottom left and the p-value on the bottom right of each cell. Looking at the coefficients in the table the size of the coefficients for market share and R&D intensity for the industry are noticeable. The signs of the coefficients for both variables are not surprising and are statistically significant at the 1% level, but their magnitudes are extremely high compared to those of other coefficients. The strength of the effect of the R&D intensity of the industry does not really surprise me since the industry a firm is in will dictate its R&D activities in order to compete within the industry.

The negative coefficient for market share implies that the larger the market share, the smaller is R&D intensity, which is as expected. But its magnitude is unexpectedly large. To see why, consider the case of a monopoly, for which the market share would equal one. The large coefficient of market share implies that if all the other variables were zero, then R&D intensity would be negative, even though it is restricted to being between zero and one. However, in the real world the other explanatory variables will not be zero and could offset the effect of market share, ensuring that R&D intensity for a monopoly would be positive. It is also interesting that market share's coefficient almost doubles over the four-year period for the unbalanced sample, but in the balanced sample it stays relatively constant.

The signs of the other coefficients are all positive, which is somewhat surprising for foreign ownership and the debt to assets ratio. Another interesting point about these two variables is that their coefficients are not statistically significant in the balanced sample, but are for the most part in the unbalanced sample. In the literature reviewed for this paper it was usually assumed that firms would perform more of their R&D in the home country except for the study by Baldwin and Hanel (2000). The positive coefficient obtained in this regression is consistent with the findings of Baldwin and Hanel (2000). The positive coefficient could also be reflecting the use of expenses in the denominator though, as foreign firms may just be bringing their R&D to Canada and nothing else, causing their intensity to be higher than that of Canadian-owned firms.

The debt to assets ratio is doing the opposite of what was expected, as I thought expenses might pick up the added interest expense created by more debt, but it shows that firms are using debt as an instrument in funding their R&D. The coefficient of CCPC is positive and significant as expected in both samples and shows that CCPCs are likely to be more intensive in R&D than the Other firms are. The R^2 values for the regressions are low, being in the 0.2-0.3 range, but it is interesting that for the unbalanced sample the R^2 is increasing over time, while for the balanced sample it is decreasing over time. Because the balanced sample only includes firms that did R&D in all four years, this result suggests that the link between R&D intensity and the explanatory variables becomes weaker the longer a firm engages in R&D.

The implications of the coefficient estimates in Table 6 can be illustrated by looking at the effect of a 10% increase in a variable on the dependent variable.[12] The results are presented in Table 7. These calculations were performed on the debt to assets ratio, quick ratio, cash flow, and market share. First looking at the debt to assets ratio in the unbalanced sample, the volatility of its importance is very interesting. For both CCPCs and Others a 10% increase in the debt to assets ratio on R&D intensity is twice as large in 2000 and 2003 than in 2001 and 2002. The gap between CCPCs and Others stays at about 0.02 percentage points for the first three years, but then in 2003 it widens greatly to 0.07 percentage points. The volatility could largely be due to the burst of the technology bubble during this period as firms in that industry became viewed as too risky to issue debt to. Another possibility is that during 2001 and 2002 firms that relied heavily on debt were the firms that dropped out of the sample and now that the market has recovered, some firms are beginning to rely on debt to fund their R&D. The balanced sample might show the latter possibility, but the coefficient is not statistically significant so no conclusions can be drawn from these results.

The impact of the quick ratio is very different from that of the debt to assets ratio in the unbalanced sample, as its effect is stable from year to year and it has a higher effect for Others than for CCPCs. Compared to a 10% increase in the debt to assets ratio, a 10% increase in the quick ratio has five times the effect, as it leads to a 1.5% and 1.1% increase in R&D intensity for Others and CCPCs respectively. The magnitude of the effect relative to that of the other variables is not surprising at all since the sample of companies is comprised of small firms. The quick ratio measures liquidity, which shows

[12] This is calculated as 10%*mean of variable*coefficient. The values in Table 7 express this change as a percentage of the sample mean R&D intensity.

the ability of a company to cover its short-term liabilities. This is important for small firms, as there is always a risk of not being able to survive since they tend not to have many assets. The difference between Others and CCPCs is at 0.4 percentage points across the time period.

Now looking at the balanced sample, one can see that over time the gap between Others and CCPCs in the effect of a 10% increase in the quick ratio decreases each year. In 2000, the importance of the quick ratio is twice as high for Others as for CCPCs, but by 2003, that difference decreases to 1.5 times as high. Another interesting difference between the balanced and unbalanced samples is in the magnitude of the effects of a 10% increase in the quick ratio. Initially in 2000, the effect for both Others and CCPCs was much higher in the balanced sample, with differences of 1.4% for Others and 0.6% for CCPCs. However, in 2003 those differences are down to 0.23 percentage points for Others and 0.1 percentage points for CCPCs. These changes could reflect the tech bubble burst again as the balanced sample only includes firms that survived the burst. In order to survive a corporation would have to have had the ability to cover their short-term obligations successfully. This is shown by the higher values before the burst in 2001, but now that the market has stabilized the role of the quick ratio is not as great.

A 10% increase in cash flow has nowhere near the effect that a 10% increase in the quick ratio does on R&D intensity. In 2000, the year with the largest effect for both Others and CCPCs in the unbalanced sample, a 10% increase leads to increases of only 0.425% and 0.175% in R&D intensity for Others and CCPCs respectively. Following this year there is a large decrease in the importance of cash flow as the effect of a 10% increase drops to 0.143% for Others and 0.083% for CCPCs. In the next two years the effect stabilizes at 0.19% for Others and 0.13% for CCPCs. My only explanation for this occurrence is again the tech bubble burst of 2001. In the balanced sample the effect of cash flow is higher than for the unbalanced sample at 0.492% for Others and 0.284% for CCPCs in 2000. The balanced sample experiences the same fall in importance in 2001, but it is not as large as for the unbalanced sample.

Next, I will look at the effects of market share, which turn out to be the most interesting. Market share is interesting in that it has extremely large coefficients, but has low mean values; so overall the effect is not as strong as it looks. A 10% increase in the market share in the unbalanced sample leads to a decrease in R&D intensity of 0.886% for Others and a decrease of 0.124% for CCPCs in 2003. These decreases have grown over the time period, as in 2000 they were 0.535% and 0.08%. A possible reason for the decreased importance of market share is that more firms are performing R&D now than before, which would increase the number of small firms with low market share. In the balanced sample the importance of market share has also decreased over time, but the magnitude of the decrease is not as high as for the unbalanced sample. This is as expected since the firms in the balanced sample have been around since at least the year 2000 and likely longer, providing them with the opportunity to achieve a higher market share, which is shown by the higher means for this variable in Table 3.

Lastly, consider the effect of a 10% increase in the R&D intensity of the industry. A 10% change in this variable leads to the largest increase in R&D intensity of all the variables examined. This is not surprising since the R&D requirement of an industry will largely dictate the amount of R&D performed by a specific firm. The effect is larger for Others than for CCPCs in each of the years at about 7% for Others and about 5% for

CCPCs for the unbalanced sample. The results for the balanced sample are almost exactly the same.

Panel Data Estimates

The pooled regression results are very similar for the two samples and are shown in Table 6. The only difference is that the coefficients of the debt to assets ratio and foreign ownership are not significant for the balanced sample. The signs of the coefficients are all the same and the magnitudes are very similar except in the case of cash flow, for which the coefficient is double the size for the balanced sample. The reason for this may be that the firms in the balanced sample have to be performing R&D in each year and would likely have been performing it for more than four years, so they have had time to build up operations that would give them a sustained cash flow, which they could rely on for their R&D. The results are very similar to the cross-section results in both sign and magnitude. The only difference is in the debt to assets ratio for the balanced sample, but the coefficient of this ratio is not statistically significant in either the pooled or the cross-section regressions.

Using a fixed effects model specification provides some interesting results that are presented in Table 8, the first being that the debt to assets ratio now has a negative coefficient as predicted. As in the pooled regressions the cash flow coefficient is twice as large for the balanced sample. Cash flow being twice as important in the balanced sample isn't surprising since these firms have been around for multiple years and have likely built up a steady flow of cash. There are some issues with the significance of the coefficient of the debt to assets ratio in this specification since for the unbalanced sample it is significant at the 5% level, but it is not significant for the balanced sample.

An F test is used to carry out a test of the significance of the firm effects. The null hypothesis for this test is that the firm effects are equal and thus the efficient estimator is pooled least squares. For both samples I reject the null and conclude that there are group effects, or in other words that the fixed effects model is more appropriate than pooled OLS estimation.

The random effects model includes two variables not included in the fixed effects model, which are the CCPC dummy variable and the R&D intensity by industry. These variables are not included in the fixed effects model since they do not vary over time and hence the fixed effects model is not capable of estimating their coefficients. It is interesting that the coefficient of the CCPC variable for the balanced sample double the size of the same coefficient for the unbalanced sample. Also, debt to assets and foreign ownership do not have significant coefficients in the balanced sample. Another interesting characteristic of the coefficient of debt to assets is that it has now switched to having a positive coefficient in the unbalanced sample, but its coefficient is insignificant. As before the coefficient of the cash flow variable is twice the size in the unbalanced sample.

To test for the appropriateness of the random effects model there are two tests, the LM test of Breusch and Pagan and the Hausman specification test. The LM test is used to test whether the variance of the intercept component of the error term is zero, which is the null hypothesis. From the results, shown in Table 8, I reject the null in both samples and conclude that the random effects model is more appropriate than a pooled regression model. The Hausman specification test shows whether the fixed effects or random effects specification should be used. More specifically, the Hausman test tests whether the random effects estimator is unbiased, which occurs when the error term is not correlated with the explanatory variables. The null hypothesis is that the random effects estimator is unbiased and thus the random effects model is more appropriate. In both cases the null hypothesis is rejected and I conclude that the random effects estimator is biased. Hence the fixed effects specification is more appropriate. This is a problem, since in the fixed effects model it is not possible to include the dummy variable to show if the firm is a CCPC or not.[13]

For purposes of comparison with the cross-section and pooled regression results the effect of a 10% change in each of the explanatory variables was computed for the fixed and random effects models also, using the sample means for the pooled sample. It can be seen from Table 7 that the coefficients of the fixed and random effects models imply that the explanatory variables do not have nearly as strong an effect as in the pooled and cross-section models. Ten percent increases in all of the variables have less than a 0.1% effect on R&D intensity except for the R&D intensity of the industry, which has an effect in the range of 0.785 – 0.926%. This is because the fixed and random effects coefficient estimates are smaller in magnitude than the pooled OLS estimates, which is likely due to the various firm effects captured by these models that are not captured in the pooled or cross-section models.

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[13] One way to remedy this problem would be to use an estimation technique like the GMM estimation method of Arellano and Bond (1991). This method allows for the coefficients of time invariant dummy variables like CCPC to be estimated. This estimation method was not used, however, as there were not enough years in the panel for the method to work properly.

Again, it is not surprising that R&D intensity would have such a significant effect as the type of industry dictates the R&D performance of the firm. The differences between Others and CCPCs for the unbalanced and balanced sample are very interesting. In the unbalanced sample the two are practically equal at 0.925 percentage points for Others and 0.926 percentage points for CCPCs. In the balanced sample the effect is larger for CCPCs at 0.837%, compared to 0.785% for Others.

Comparing these effects for the fixed and random effects model for the debt to assets ratio is less interesting as its coefficient is not significant for either model (except for the unbalanced sample). The quick ratio offers some interesting comparisons as it has a much larger effect in the random effects model, except for CCPCs in the balanced sample. Cash flow has the exact opposite effect as all the results are similar for both models except for the balanced sample CCPCs, who experience twice the increase from cash flow in the fixed effects model than in the random effects model. For the fixed and random effects model, market share has similar results for the models in the balanced sample, but in the unbalanced sample the effects are twice as large for the random effects model.

Conclusion

My analysis of the determinants of R&D intensity for corporations looked at financial, corporate organization, and industry variables. The financial variables included the cash flow, the debt to assets ratio, and the quick ratio. Berger (1993) estimated a similar model to the one I used and obtained very similar results, but his measure of R&D intensity uses sales instead of expenses as the denominator. Berger finds a small positive coefficient of 0.001 for Tobin's Q ratio, but I find debt to assets to have a small negative coefficient of –0.00803 in the fixed effects model (unbalanced sample). Our measures are different in that Tobin's Q also includes equity in the numerator, but both show that debt does not have a large effect on R&D intensity. We also have similar results for cash flow as he finds a small positive coefficient of 0.179, while I find cash flow to have a small positive coefficient of 0.00312. The quick ratio has not been included by other studies, but since only small firms are included it was expected to have a significant effect, which it turns out to have although its coefficient is just 0.00146 in the fixed effects model (unbalanced sample).

The corporate organization variables include whether the corporation is a CCPC or not and the effect of foreign ownership. These variables are again an addition by this paper to the literature as the other authors have not been able to utilize the tax data. The results of the cross-section and random effects model show that CCPCs are more likely to be R&D intensive than Others. Foreign ownership has a very small effect in all models and this could be due to the design of the variable, as the level of foreign ownership for CCPCs is not captured.

The industry variables of market share and R&D intensity for the industry show extremely large effects. Berger used the same industry R&D intensity variable and obtained a positive result, but not near the size of mine as he obtained a coefficient of 0.5783 compared to 0.998 for my results from the random effects model with an unbalanced sample. The result for market share appears to be odd at first, but since the actual values of the variable are so small its actual effect is not as large as it looks.

The effects of these variables lead to potential future areas to expand on this paper. The strong effect of the R&D intensity of the industry suggests that maybe instead of pooling all firms and industries, one should examine the industries separately. The determinants of R&D for each industry are likely to be different and this would allow one to better capture the true determinants by adding additional industry specific determinants. Market share includes all firms in the industry, but the data set used for the regression only included small firms, so another possibility would be to expand the data set to include all firms performing R&D.

Another obvious area for future research is to repeat the empirical analysis three or four years from now, when the number of years of GIFI data has increased, which would make it possible to include lags of the dependent variable or use lags of explanatory variables. The lag of the dependent variable would be a great addition to the model as R&D investments generally span more than one year and therefore performing R&D in a previous year would be a strong indicator of future R&D. Lags of the financial variables like cash flow would be useful, since some business decisions are based on financial conditions of previous years as they take time to implement. With the extra years of data the dynamic model created by Arellano and Bond (1991) could be estimated as it is intended with lags of two and three years of the dependent variable being used as instruments. Another data limitation was that the GIFI did not offer information from the Statement of Changes in Financial Position, which includes information on the firm's investment activities. If this information could be found for the full population of corporations it would allow one to look at R&D as a capital investment and utilize other modelling techniques. An example would be the user cost approach outlined by Hall and

Van Reenen (1999), Bloom, Griffith, and Van Reenen (2002), and others as it would allow one to better capture the tax effects.

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Appendix 1

Scientific Research and Experimental Development (SR&ED) Tax Credit Program

The current federal SR&ED tax credit program has been in place since 1995, but the program overall has been in place since 1975 in a limited fashion. "Scientific research and experimental development" is defined according to the 2003 edition of *Preparing Your Corporate Tax Returns* as

> "systematic investigation or search carried out in a field of science or technology by means of experiment or analysis". The term includes basic research, applied research, and development. The *Income Tax Act* (formerly Income Tax Regulation 2853) defines scientific research very broadly to include:
>
> (a) Basic research, which includes work undertaken for the advancement of scientific knowledge without a specific practical application in view;
>
> (b) Applied research, which includes work undertaken for the advancement of scientific knowledge with a specific practical application in view
>
> (c) Experimental development, which includes, work undertaken for the purposes of achieving technological advancement for the purposes of creating new, or improving existing, materials, devices, products or processes; or
>
> (d) Work undertaken by or on behalf of the taxpayer with respect to engineering, design, operations research, mathematical analysis, computer programming, data collection, testing and psychological research where such work is commensurate with the needs and directly in support, of the work described in (a), (b) or (c) above that is undertaken in Canada by or on behalf of the taxpayer." (Mallin 2003, 622)

The investment tax credit is available at 20% and 35%. In order to qualify for the 35% credit the corporation must be a CCPC with taxable income in the prior year under $400,000. A CCPC is a Canadian-controlled private corporation, which means that it is a private corporation that was incorporated in Canada and cannot be controlled directly or indirectly by non-residents, public corporations, or a combination thereof. "Control" refers to greater than 50% ownership of the corporation. The 35% credit is only available on the first $2 million of qualifying expenditures unless an associated corporation reduces the expenditure limit, as they are required to share the full expenditure limit between them.

For taxation years starting after 1994 the 35% credit is phased out for every dollar of Canadian income in excess of $200,000, and disappears at $400,000 of taxable income, which reduces the $2 million expenditure limit. The expenditure limit is calculated as $4 million less ten times the greater of (i) $200,000 and (ii) the taxable income of the corporation. Where the taxable income is greater than $200,000, the expenditure limit is reduced by $10 for every dollar of income over $200,000.

In order to qualify for a refundable investment tax credit the corporation must be a CCPC with income less than the prior year's business limit. The business limit refers to the maximum amount of income available for the small business deduction, which is at most $200,000. A 100% refundable credit is available for current expenditures on any investment tax credits at the 35% rate. Capital expenditures eligible for the 35% credit rate are eligible only for a 40% refund. The refundability is not modeled in this paper for confidentiality reasons.

There are also various provincial tax credits for R&D, but these were ignored in this paper. The reason these credits are being ignored is that I only have information on where the corporation's headquarters is located, and not where the R&D is performed. The credits are based on R&D performed in that province and therefore it would not be possible to accurately apply these credits to the corporate headquarters.

Table 1: Frequency and Percentage of Total Expenditures for Unbalanced Sample

		Frequency										
		Others				Others	CCPC				CCPC	Grand
		2000	2001	2002	2003	Total	2000	2001	2002	2003	Total	Total
21	Mining and Oil and Gas Extraction	8	9	13	8	38	34	46	49	37	166	204
22	Utilities	0	0	0	0	0	7	7	11	9	34	34
23	Construction	16	20	22	17	75	191	238	307	248	984	1,059
31	Manufacturing	52	44	56	43	195	294	369	450	356	1,469	1,664
32	Manufacturing	127	155	141	130	553	669	741	828	653	2,891	3,444
33	Manufacturing	345	387	375	294	1,401	2,084	2,332	2,547	1,995	8,958	10,359
41	Wholesale Trade	97	101	104	86	388	546	654	749	590	2,539	2,927
44	Retail Trade	8	13	9	9	39	114	134	148	109	505	544
45	Retail Trade	2	3	3	0	8	40	57	66	45	208	216
48	Transportation and Warehousing	3	8	6	7	24	28	34	44	32	138	162
49	Transportation and Warehousing	3	4	3	2	12	8	11	10	9	38	50
51	Information and Cultural Industries	46	50	43	32	171	285	334	337	258	1,214	1,385
53	Real Estate and Rental and Leasing	2	5	3	2	12	47	48	48	39	182	194
54	Professional, Scientific and Technical Services	226	285	277	198	986	2,164	2,509	2,698	2,144	9,515	10,501
55	Management of Companies and Enterprises	15	18	14	12	59	41	36	46	44	167	226
56	Administrative and Support, Waste Management and Remediation Services	15	19	21	13	68	114	136	164	119	533	601
61	Educational Services	1	2	3	1	7	25	28	26	23	102	109
62	Health Care and Social Assistance	7	11	13	9	40	66	71	72	59	268	308
71	Arts, Entertainment and Recreation	1	2	0	1	4	14	18	25	19	76	80
72	Accommodation and Food Services	1	1	1	2	5	15	18	19	12	64	69
81	Other Services (except Public Administration)	7	13	17	11	48	133	165	193	161	652	700
91	Public Administration	1	1	0	1	3	11	13	11	8	43	46
	Grand Total	983	1,151	1,124	878	4,136	6,930	7,999	8,848	6,969	30,746	34,882

		Percentage of Total Expenditures										
		Others				Others	CCPC				CCPC	Grand
		2000	2001	2002	2003	Total	2000	2001	2002	2003	Total	Total
21	Mining and Oil and Gas Extraction	0.06%	0.05%	0.03%	0.02%	0.16%	0.04%	0.07%	0.07%	0.07%	0.25%	0.41%
22	Utilities	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%	0.04%	0.04%
23	Construction	0.10%	0.10%	0.05%	0.09%	0.34%	0.21%	0.26%	0.34%	0.27%	1.08%	1.41%
31	Manufacturing	0.10%	0.10%	0.13%	0.11%	0.44%	0.28%	0.42%	0.48%	0.40%	1.58%	2.03%
32	Manufacturing	0.26%	0.60%	0.44%	0.40%	1.71%	0.88%	0.90%	1.07%	0.86%	3.71%	5.42%
33	Manufacturing	2.54%	3.14%	3.21%	2.24%	11.13%	4.26%	4.70%	5.12%	4.33%	18.41%	29.53%
41	Wholesale Trade	1.05%	1.03%	1.01%	0.95%	4.05%	0.72%	0.98%	0.96%	0.89%	3.55%	7.60%
44	Retail Trade	0.07%	0.48%	0.10%	0.12%	0.77%	0.23%	0.21%	0.23%	0.14%	0.80%	1.57%
45	Retail Trade	0.00%	0.01%	0.01%	0.00%	0.02%	0.04%	0.07%	0.06%	0.04%	0.22%	0.24%
48	Transportation and Warehousing	0.00%	0.01%	0.01%	0.01%	0.04%	0.05%	0.07%	0.06%	0.05%	0.23%	0.26%
49	Transportation and Warehousing	0.01%	0.02%	0.01%	0.01%	0.05%	0.01%	0.01%	0.01%	0.01%	0.04%	0.09%
51	Information and Cultural Industries	0.81%	0.80%	0.46%	0.36%	2.42%	0.90%	1.26%	1.21%	0.80%	4.18%	6.59%
53	Real Estate and Rental and Leasing	0.00%	0.01%	0.00%	0.00%	0.02%	0.04%	0.07%	0.04%	0.04%	0.19%	0.21%
54	Professional, Scientific and Technical Services	2.77%	4.23%	4.64%	2.64%	14.29%	5.51%	6.76%	6.99%	6.19%	25.45%	39.74%
55	Management of Companies and Enterprises	0.05%	0.06%	0.02%	0.05%	0.19%	0.11%	0.06%	0.06%	0.05%	0.29%	0.48%
56	Administrative and Support, Waste Management and Remediation Services	0.09%	0.08%	0.05%	0.06%	0.28%	0.20%	0.26%	0.24%	0.19%	0.88%	1.16%
61	Educational Services	0.00%	0.01%	0.01%	0.00%	0.02%	0.03%	0.04%	0.04%	0.04%	0.15%	0.17%
62	Health Care and Social Assistance	0.10%	0.28%	0.26%	0.27%	0.92%	0.37%	0.25%	0.24%	0.20%	1.06%	1.97%
71	Arts, Entertainment and Recreation	0.00%	0.01%	0.00%	0.01%	0.02%	0.01%	0.02%	0.03%	0.02%	0.07%	0.09%
72	Accommodation and Food Services	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.01%	0.01%	0.00%	0.03%	0.04%
81	Other Services (except Public Administration)	0.03%	0.05%	0.03%	0.05%	0.17%	0.14%	0.20%	0.27%	0.16%	0.76%	0.93%
91	Public Administration	0.01%	0.00%	0.00%	0.00%	0.01%	0.00%	0.01%	0.01%	0.01%	0.03%	0.04%
	Grand Total	8.07%	11.07%	10.48%	7.41%	37.03%	14.06%	16.62%	17.53%	14.76%	62.97%	100.00%

Grand Total R&D Expenditures = $13,272,872,238

Table 2: Frequency and Percentage of Total Expenditures for Balanced Sample

		Frequency										
		Others				Others	CCPC				CCPC	Grand
		2000	2001	2002	2003	Total	2000	2001	2002	2003	Total	Total
21	Mining and Oil and Gas Extraction	1	1	1	1	4	13	13	13	13	52	56
22	Utilities	0	0	0	0	0	2	2	2	2	8	8
23	Construction	4	4	4	4	16	56	56	56	56	224	240
31	Manufacturing	5	5	5	5	20	96	96	96	96	384	404
32	Manufacturing	43	43	43	43	172	271	271	271	271	1,084	1,256
33	Manufacturing	86	86	86	86	344	797	797	797	797	3,188	3,532
41	Wholesale Trade	29	29	29	29	116	198	198	198	198	792	908
44	Retail Trade	1	1	1	1	4	27	27	27	27	108	112
45	Retail Trade	0	0	0	0	0	9	9	9	9	36	36
48	Transportation and Warehousing	1	1	1	1	4	5	5	5	5	20	24
49	Transportation and Warehousing	2	2	2	2	8	4	4	4	4	16	24
51	Information and Cultural Industries	9	9	9	9	36	102	102	102	102	408	444
53	Real Estate and Rental and Leasing	1	1	1	1	4	5	5	5	5	20	24
54	Professional, Scientific and Technical Services	40	40	40	40	160	720	720	720	720	2,880	3,040
55	Management of Companies and Enterprises	1	1	1	1	4	8	8	8	8	32	36
56	Administrative and Support, Waste Management and Remediation Services	2	2	2	2	8	27	27	27	27	108	116
61	Educational Services	0	0	0	0	0	7	7	7	7	28	28
62	Health Care and Social Assistance	3	3	3	3	12	27	27	27	27	108	120
71	Arts, Entertainment and Recreation	0	0	0	0	0	5	5	5	5	20	20
72	Accommodation and Food Services	0	0	0	0	0	4	4	4	4	16	16
81	Other Services (except Public Administration)	2	2	2	2	8	40	40	40	40	160	168
91	Public Administration	0	0	0	0	0	2	2	2	2	8	8
	Grand Total	230	230	230	230	920	2,425	2,425	2,425	2,425	9,700	10,620

		Percentage of Total Expenditures										
		Others				Others	CCPC				CCPC	Grand
		2000	2001	2002	2003	Total	2000	2001	2002	2003	Total	Total
21	Mining and Oil and Gas Extraction	0.00%	0.00%	0.01%	0.01%	0.02%	0.07%	0.09%	0.08%	0.11%	0.34%	0.36%
22	Utilities	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
23	Construction	0.04%	0.08%	0.05%	0.06%	0.22%	0.17%	0.21%	0.26%	0.26%	0.90%	1.13%
31	Manufacturing	0.03%	0.04%	0.04%	0.05%	0.16%	0.29%	0.35%	0.43%	0.52%	1.59%	1.75%
32	Manufacturing	0.27%	0.37%	0.34%	0.41%	1.39%	1.04%	1.13%	1.26%	1.37%	4.81%	6.20%
33	Manufacturing	2.04%	2.63%	2.65%	2.50%	9.82%	4.76%	5.55%	5.83%	6.43%	22.58%	32.39%
41	Wholesale Trade	1.25%	1.35%	1.56%	1.71%	5.87%	0.87%	1.29%	1.02%	1.21%	4.39%	10.26%
44	Retail Trade	0.01%	0.05%	0.05%	0.05%	0.16%	0.10%	0.13%	0.12%	0.15%	0.49%	0.66%
45	Retail Trade	0.00%	0.00%	0.00%	0.00%	0.00%	0.05%	0.04%	0.05%	0.06%	0.20%	0.20%
48	Transportation and Warehousing	0.00%	0.01%	0.01%	0.02%	0.04%	0.09%	0.11%	0.10%	0.09%	0.39%	0.43%
49	Transportation and Warehousing	0.03%	0.02%	0.03%	0.02%	0.10%	0.01%	0.01%	0.01%	0.03%	0.06%	0.15%
51	Information and Cultural Industries	0.46%	0.35%	0.36%	0.33%	1.50%	0.82%	1.01%	1.03%	0.97%	3.83%	5.33%
53	Real Estate and Rental and Leasing	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.02%	0.05%	0.05%
54	Professional, Scientific and Technical Services	1.36%	2.04%	2.05%	1.98%	7.43%	5.39%	6.93%	7.62%	8.19%	28.14%	35.57%
55	Management of Companies and Enterprises	0.00%	0.00%	0.00%	0.00%	0.01%	0.08%	0.07%	0.07%	0.09%	0.31%	0.32%
56	Administrative and Support, Waste Management and Remediation Services	0.05%	0.07%	0.04%	0.03%	0.18%	0.24%	0.33%	0.33%	0.24%	1.15%	1.33%
61	Educational Services	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%	0.04%	0.04%	0.04%	0.15%	0.15%
62	Health Care and Social Assistance	0.16%	0.24%	0.24%	0.41%	1.06%	0.34%	0.39%	0.50%	0.50%	1.72%	2.78%
71	Arts, Entertainment and Recreation	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.02%	0.02%	0.07%	0.07%
72	Accommodation and Food Services	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
81	Other Services (except Public Administration)	0.02%	0.01%	0.01%	0.01%	0.05%	0.15%	0.18%	0.23%	0.22%	0.78%	0.83%
91	Public Administration	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%
	Grand Total	5.72%	7.26%	7.45%	7.59%	28.02%	14.53%	17.88%	19.05%	20.51%	71.98%	100.00%

Grand Total R&D Expenditures = $4,540,515,897

Table 3: Statistics of R&D Intensity by Industry

Unbalanced

		Frequency		Mean		Standard Deviation	
		Others	CCPC	Others	CCPC	Others	CCPC
21	Mining and Oil and Gas Extraction	38	166	0.1406	0.1523	0.1885	0.2013
22	Utilities	0	34	0.0000	0.2111	0.0000	0.2296
23	Construction	75	984	0.0714	0.1009	0.1060	0.1499
31	Manufacturing	195	1,469	0.0358	0.0796	0.0986	0.1731
32	Manufacturing	553	2,891	0.0452	0.0784	0.0839	0.1162
33	Manufacturing	1,401	8,958	0.0712	0.1075	0.1081	0.1388
41	Wholesale Trade	388	2,539	0.0699	0.1027	0.0988	0.1552
44	Retail Trade	39	505	0.1785	0.1610	0.1766	0.2105
45	Retail Trade	8	208	0.0585	0.1831	0.0762	0.1794
48	Transportation and Warehousing	24	138	0.0307	0.0976	0.0299	0.1621
49	Transportation and Warehousing	12	38	0.0743	0.1682	0.1075	0.2501
51	Information and Cultural Industries	171	1,214	0.1789	0.2237	0.1799	0.1687
53	Real Estate and Rental and Leasing	12	182	0.0428	0.1647	0.0327	0.2065
54	Professional, Scientific and Technical Services	986	9,515	0.2566	0.2535	0.2229	0.1975
55	Management of Companies and Enterprises	59	167	0.1473	0.2214	0.2473	0.2670
56	Administrative and Support, Waste Management and Remediation Services	68	533	0.0922	0.1696	0.1236	0.2013
61	Educational Services	7	102	0.0655	0.1946	0.0598	0.1604
62	Health Care and Social Assistance	40	268	0.3557	0.2309	0.2305	0.1977
71	Arts, Entertainment and Recreation	4	76	0.5056	0.2656	0.5239	0.2488
72	Accommodation and Food Services	5	64	0.0219	0.1409	0.0160	0.2490
81	Other Services (except Public Administration)	48	652	0.0701	0.1140	0.1047	0.1542
91	Public Administration	3	43	0.1593	0.3382	0.1557	0.2454
	Grand Total	4,136	30,746				

Balanced

		Frequency		Mean		Standard Deviation	
		Others	CCPC	Others	CCPC	Others	CCPC
21	Mining and Oil and Gas Extraction	4	52	0.1604	0.1280	0.0815	0.1606
22	Utilities	0	8	0.0000	0.1725	0.0000	0.1263
23	Construction	16	224	0.0994	0.0960	0.0786	0.1100
31	Manufacturing	20	384	0.0290	0.0612	0.0192	0.1233
32	Manufacturing	172	1,084	0.0540	0.0731	0.0979	0.0966
33	Manufacturing	344	3,188	0.0632	0.1021	0.0705	0.1165
41	Wholesale Trade	116	792	0.0731	0.1080	0.0934	0.1616
44	Retail Trade	4	108	0.0669	0.1627	0.0062	0.1957
45	Retail Trade	0	36	0.0000	0.1782	0.0000	0.1121
48	Transportation and Warehousing	4	20	0.0317	0.1953	0.0230	0.1546
49	Transportation and Warehousing	8	16	0.0292	0.1461	0.0064	0.2442
51	Information and Cultural Industries	36	408	0.1274	0.2014	0.1037	0.1387
53	Real Estate and Rental and Leasing	4	20	0.0547	0.0811	0.0154	0.0821
54	Professional, Scientific and Technical Services	160	2,880	0.2302	0.2428	0.1918	0.1802
55	Management of Companies and Enterprises	4	32	0.0258	0.0904	0.0052	0.0657
56	Administrative and Support, Waste Management and Remediation Services	8	108	0.1535	0.1822	0.0530	0.2088
61	Educational Services	0	28	0.0000	0.1783	0.0000	0.1819
62	Health Care and Social Assistance	12	108	0.5578	0.2933	0.1165	0.1871
71	Arts, Entertainment and Recreation	0	20	0.0000	0.3987	0.0000	0.2936
72	Accommodation and Food Services	0	16	0.0000	0.2742	0.0000	0.4334
81	Other Services (except Public Administration)	8	160	0.0468	0.1022	0.0309	0.1166
91	Public Administration	0	8	0.0000	0.4716	0.0000	0.4229
	Grand Total	920	9,700				

Table 4: *t*-Test Results

Code	Name of Industry	Mean Other	Mean CCPC	Diff in Mean	tValue	DF	Probt	Sig at 5%
21	Mining and Oil and Gas Extraction	0.140646	0.1523146	0.0116685	-0.3398	57.9607	0.73524	equal
23	Construction	0.071365	0.1009499	0.0295844	-2.2512	98.1012	0.0266	different
31	Manufacturing	0.035812	0.0796313	0.043819	-5.227	376.82	2.9E-07	different
41	Wholesale Trade	0.069941	0.1027389	0.032798	-5.5733	718.337	3.5E-08	different
44	Retail Trade	0.178458	0.1609995	-0.0174587	0.58598	46.7536	0.56071	equal
45	Retail Trade	0.058534	0.1831233	0.1245894	-4.2002	10.2917	0.00172	different
48	Transportation and Warehousing	0.03075	0.0975581	0.0668084	-4.428	159.497	1.8E-05	different
49	Transportation and Warehousing	0.074324	0.1681956	0.0938715	-1.8378	43.2022	0.07298	equal
53	Real Estate and Rental and Leasing	0.042841	0.1647304	0.1218898	-6.7763	101.819	8.2E-10	different
55	Management of Companies and Enterprises	0.147308	0.2214031	0.0740947	-1.9371	109.145	0.05532	equal
56	Administrative and Support, Waste Management and Remediation Services	0.092216	0.1696398	0.0774236	-4.465	118.295	1.8E-05	different
61	Educational Services	0.065487	0.1945856	0.1290991	-4.674	13.1929	0.00042	different
62	Health Care and Social Assistance	0.355664	0.2308881	-0.1247761	3.24944	47.9489	0.00212	different
71	Arts, Entertainment and Recreation	0.505598	0.2655782	-0.2400197	0.91093	3.07164	0.42807	equal
72	Accommodation and Food Services	0.021903	0.1408554	0.1189525	-3.7238	66.8986	0.0004	different
81	Other Services (except Public Administration)	0.07008	0.1139748	0.0438943	-2.6973	63.0901	0.00896	different
91	Public Administration	0.15926	0.3381951	0.1789353	-1.8379	2.74929	0.1717	equal
321	Wood Product Manufacturing	0.040301	0.0522853	0.0119844	-0.8072	71.3475	0.42223	equal
322	Paper Manufacturing	0.015839	0.0447675	0.0289289	-4.9019	112.303	3.2E-06	different
323	Printing and Related Support Activities	0.018057	0.0720366	0.0539794	-7.4471	278.827	1.2E-12	different
324	Petroleum and Coal Products Manufacturing	0.027091	0.10223	0.0751389	-3.4577	62.4677	0.00099	different
325	Chemical Manufacturing	0.072501	0.0985634	0.026062	-2.948	347.755	0.00342	different
326	Plastics and Rubber Products Manufacturing	0.031385	0.0655718	0.0341864	-6.9394	387.299	1.7E-11	different
327	Non-Metallic Mineral Product Manufacturing	0.020127	0.0965456	0.0764189	-8.3599	340.137	1.6E-15	different
331	Primary Metal Manufacturing	0.05988	0.0760197	0.01614	-0.9747	67.9657	0.33315	equal
332	Fabricated Metal Product Manufacturing	0.041038	0.0708424	0.0298048	-4.9108	264.461	1.6E-06	different
333	Machinery Manufacturing	0.05619	0.09619	0.0399997	-8.0726	703.85	3E-15	different
335	Electrical Equipment, Appliance and Component Manufacturing	0.078459	0.1062973	0.0278384	-2.1497	155.848	0.03312	different
336	Transportation Equipment Manufacturing	0.030994	0.1116286	0.0806343	-9.2629	467.511	7.3E-19	different
337	Furniture and Related Product Manufacturing	0.039443	0.0426421	0.0031988	-0.3022	65.7134	0.76347	equal
339	Miscellaneous Manufacturing	0.055701	0.1291052	0.0734044	-7.4026	233.985	2.4E-12	different
511	Publishing Industries (except Internet)	0.186657	0.2444248	0.0577681	-3.4808	150.703	0.00065	different
512	Motion Picture and Sound Recording Industries	0.257611	0.151584	-0.1060273	3.09987	8.46233	0.0137	different
513	Broadcasting and Telecommunications	0.242428	0.0888152	-0.1536126	1.69789	13.6349	0.11222	equal
514	Information Services and Data Processing Services	0.059012	0.1600371	0.1010253	-5.532	19.6433	2.2E-05	different
517	Telecommunications	0.168604	0.1715087	0.0029049	-0.0491	14.7717	0.96147	equal
518	Internet Service Providers, Web Search Portals, and Data Processing Services	0.111062	0.2616992	0.1506369	-3.9712	17.7591	0.00092	different
519	Other Information Services	0.170209	0.1310403	-0.0391684	0.57387	4.18012	0.59553	equal
3341	Computer and Peripheral Equipment Manufacturing	0.153178	0.2085612	0.0553827	-2.1095	81.183	0.03798	different
3342	Communications Equipment Manufacturing	0.136026	0.1474187	0.0113922	-0.5746	126.188	0.56658	equal
3343	Audio and Video Equipment Manufacturing	0.020907	0.1380386	0.1171312	-8.3952	75.3025	2.1E-12	different
3344	Semiconductor and Other Electronic Component Manufacturing	0.195171	0.1919826	-0.0031882	0.13179	84.302	0.89546	equal
3345	Navigational, Measuring, Medical and Control Instruments Manufacturing	0.107888	0.1692889	0.0614009	-6.1305	290.084	2.9E-09	different
3346	Manufacturing and Reproducing Magnetic and Optical Media	0.094681	0.2118808	0.1171999	-3.0986	13.8507	0.00794	different
5413	Architectural, Engineering and Related Services	0.147331	0.1809389	0.0336076	-2.3209	191.896	0.02134	different
5414	Specialized Design Services	0.282134	0.2244067	-0.0577275	1.16635	20.7997	0.25667	equal
5415	Computer Systems Design and Related Services	0.240052	0.2554142	0.0153625	-1.4977	519.642	0.13481	equal
5416	Management, Scientific and Technical Consulting Services	0.237125	0.226576	-0.0105494	0.38783	74.679	0.69924	equal
5417	Scientific Research and Development Services	0.37187	0.3956567	0.0237863	-1.5545	356.406	0.12096	equal
5418	Advertising and Related Services	0.10256	0.1739315	0.0713712	-1.4092	10.8939	0.18667	equal
5419	Other Professional, Scientific and Technical Services	0.169167	0.1781286	0.0089617	-0.1497	12.7209	0.88333	equal

Table 5: Statistics of Variables in Pooled and Cross-Section Models

Unbalanced	Mean									
	Pooled		2000		2001		2002		2003	
	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC
R&D Intensity	0.1205	0.158699	0.116961	0.1601	0.128146	0.159659	0.119489	0.156129	0.115733	0.159465
Debt to assets ratio	0.099566	0.155247	0.103335	0.153686	0.106141	0.153962	0.098124	0.155873	0.088572	0.157478
Quick	2.2859	2.142012	2.269671	2.071354	2.323034	2.123278	2.291709	2.172647	2.247955	2.194884
Cash flow	0.573863	0.463051	0.613429	0.346629	0.394669	0.285726	0.670553	0.612044	0.640697	0.593189
Market share	0.004205	0.000854	0.004359	0.000888	0.004321	0.000891	0.003933	0.000825	0.004228	0.000815
R&D Intensity by industry	0.09262	0.092692	0.09227	0.09515	0.09527	0.093572	0.092781	0.091481	0.08933	0.090773
Number of Observations	4136	30746	983	6930	1151	7999	1124	8848	878	6969

Unbalanced	Standard Deviation									
	Pooled		2000		2001		2002		2003	
	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC
R&D Intensity	0.172781	0.182874	0.176805	0.184821	0.177474	0.183839	0.169912	0.180799	0.165439	0.182444
Debt to assets ratio	0.179671	0.231325	0.178999	0.231076	0.180622	0.224156	0.194985	0.234886	0.157064	0.235115
Quick	3.328039	2.884603	3.232885	2.800574	3.525802	2.893441	3.45331	2.968567	2.990655	2.847388
Cash flow	4.913423	6.828704	2.634635	2.554594	1.401994	2.492736	7.50691	9.569643	5.590665	8.704137
Market share	0.015891	0.004248	0.019075	0.004319	0.016496	0.00525	0.013583	0.004194	0.013786	0.002662
R&D Intensity by industry	0.088352	0.081645	0.087634	0.083196	0.090772	0.081693	0.087525	0.081138	0.08702	0.080609
Number of Observations	4136	30746	983	6930	1151	7999	1124	8848	878	6969

Balanced	Mean									
	Pooled		2000		2001		2002		2003	
	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC
R&D Intensity	0.101089	0.149309	0.0996	0.151194	0.10126	0.147963	0.101492	0.148122	0.102002	0.149957
Debt to assets ratio	0.084202	0.137272	0.110454	0.140196	0.085337	0.135232	0.071321	0.136132	0.069695	0.137528
Quick	2.437083	2.200166	2.448937	2.064725	2.557339	2.136282	2.401955	2.292401	2.340102	2.307256
Cash flow	0.480992	0.383998	0.546364	0.478273	0.44888	0.370204	0.44114	0.355793	0.487583	0.331723
Market share	0.005242	0.000997	0.004327	0.000908	0.005395	0.000966	0.005444	0.001014	0.0058	0.001101
R&D Intensity by industry	0.086382	0.092142	0.086382	0.092142	0.086382	0.092142	0.086382	0.092142	0.086382	0.092142
Number of Observations	920	9700	230	2425	230	2425	230	2425	230	2425

Balanced	Standard Deviation									
	Pooled		2000		2001		2002		2003	
	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC
R&D Intensity	0.137162	0.163305	0.133828	0.17227	0.141321	0.162762	0.134803	0.158134	0.139438	0.159766
Debt to assets ratio	0.148291	0.186587	0.179166	0.19473	0.143755	0.176585	0.132504	0.178906	0.129826	0.195393
Quick	3.331634	2.592366	3.34138	2.443473	3.620472	2.414831	3.64871	2.752605	2.633148	2.732863
Cash flow	1.163858	2.502787	1.269062	3.826067	1.025605	2.37633	0.816886	1.381127	1.448916	1.690463
Market share	0.021897	0.003199	0.020484	0.00328	0.022373	0.0032	0.022558	0.003129	0.022225	0.003184
R&D Intensity by industry	0.077889	0.079	0.078016	0.079012	0.078016	0.079012	0.078016	0.079012	0.078016	0.079012
Number of Observations	920	9700	230	2425	230	2425	230	2425	230	2425

Table 6: Results for Pooled and Cross Section Models

Unbalanced

	Pooled	2000	2001	2002	2003
Debt to Assets Ratio	0.02278	0.02869	0.01460	0.01900	0.03165
	5.13 0.000	3.00 0.003	1.71 0.087	2.32 0.021	3.40 0.001
Quick	0.00818	0.00830	0.00803	0.00824	0.00761
	21.11 0.000	9.48 0.000	11.32 0.000	11.61 0.000	8.92 0.000
Cash Flow	0.00367	0.00810	0.00464	0.00343	0.00355
	12.35 0.000	6.38 0.000	2.87 0.004	10.89 0.000	7.12 0.000
Market Share	-1.68047	-1.43534	-1.50027	-1.82709	-2.42548
	-5.51 0.000	-2.86 0.004	-3.31 0.001	-2.80 0.005	-2.26 0.024
R&D Intensity by Industry	0.95865	0.92146	0.97458	0.97090	0.96715
	72.00 0.000	32.26 0.000	37.25 0.000	39.91 0.000	34.44 0.000
Foreign Ownership	0.01903	0.00869	0.02338	0.02784	
	3.45 0.001	0.89 0.372	2.35 0.019	2.82 0.005	
CCPC	0.03700	0.04033	0.03610	0.03979	0.03245
	13.67 0.000	6.71 0.000	6.89 0.000	8.08 0.000	5.48 0.000
Constant	0.01145	0.00891	0.01298	0.00598	0.01742
	3.93 0.000	1.39 0.166	2.30 0.022	1.11 0.268	2.62 0.009
R^2	0.257	0.237	0.250	0.280	0.264
Number of Obs.	34,882	7,913	9,150	9,972	7,847

Balanced

	Pooled	2000	2001	2002	2003
Debt to Assets Ratio	0.00665	0.02148	-0.00672	-0.00631	0.01319
	0.75 0.456	1.21 0.226	-0.38 0.704	-0.36 0.722	0.76 0.446
Quick	0.00938	0.01226	0.01018	0.00841	0.00743
	12.89 0.000	7.15 0.000	6.95 0.000	6.05 0.000	6.11 0.000
Cash Flow	0.00859	0.00896	0.00847	0.00796	0.00731
	7.01 0.000	6.24 0.000	3.37 0.001	1.22 0.222	1.46 0.146
Market Share	-1.20128	-1.17490	-1.14099	-1.17201	-1.31025
	-3.09 0.002	-1.40 0.161	-1.64 0.101	-1.60 0.109	-1.52 0.130
R&D Intensity by Industry	0.86819	0.89515	0.87585	0.82951	0.86160
	37.17 0.000	17.91 0.000	19.05 0.000	19.08 0.000	18.57 0.000
Foreign Ownership	0.01429	0.03054	0.01378	0.00585	
	1.66 0.096	1.91 0.056	0.87 0.384	0.39 0.700	
CCPC	0.04434	0.05680	0.04639	0.04065	0.03732
	9.67 0.000	6.63 0.000	4.94 0.000	4.05 0.000	4.23 0.000
Constant	0.00132	-0.01964	-0.00199	0.01098	0.01330
	0.27 0.789	-1.98 0.047	-0.20 0.842	1.05 0.294	1.38 0.169
R^2	0.260	0.290	0.268	0.245	0.239
Number of Obs.	10,620	2,655	2,655	2,655	2,655

Table 7: Effect of 10% Increase in Independent variable on Dependent

Pooled & Cross Section

Unbalanced	Effect of 10% Increase in Independent on Dependent									
	Pooled		2000		2001		2002		2003	
	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC
Debt to assets ratio	0.188%	0.223%	0.254%	0.275%	0.121%	0.141%	0.156%	0.190%	0.242%	0.313%
Quick	1.552%	1.104%	1.610%	1.073%	1.456%	1.068%	1.581%	1.147%	1.477%	1.047%
Cash flow	0.175%	0.107%	0.425%	0.175%	0.143%	0.083%	0.192%	0.134%	0.197%	0.132%
Market share	-0.586%	-0.090%	-0.535%	-0.080%	-0.506%	-0.084%	-0.601%	-0.096%	-0.886%	-0.124%
R&D Intensity by industry	7.368%	5.599%	7.269%	5.476%	7.245%	5.712%	7.539%	5.689%	7.465%	5.505%

Balanced	Effect of 10% Increase in Independent on Dependent									
	Pooled		2000		2001		2002		2003	
	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC	Other	CCPC
Debt to assets ratio	0.055%	0.061%	0.238%	0.199%	-0.057%	-0.061%	-0.044%	-0.058%	0.090%	0.121%
Quick	2.262%	1.382%	3.016%	1.675%	2.570%	1.469%	1.989%	1.301%	1.705%	1.143%
Cash flow	0.409%	0.221%	0.492%	0.284%	0.376%	0.212%	0.346%	0.191%	0.350%	0.162%
Market share	-0.623%	-0.080%	-0.510%	-0.071%	-0.608%	-0.074%	-0.629%	-0.080%	-0.745%	-0.096%
R&D Intensity by industry	7.419%	5.358%	7.764%	5.455%	7.472%	5.454%	7.060%	5.160%	7.297%	5.294%

Fixed and Random Effects

	Unbalanced		Balanced	
Fixed	Others	CCPC	Others	CCPC
Debt to Assets Ratio	-0.008%	-0.012%	-0.005%	-0.008%
Quick	0.033%	0.031%	0.051%	0.069%
Cash Flow	0.018%	0.014%	0.031%	0.026%
Market Share	-0.040%	-0.008%	-0.095%	-0.014%
R&D Intensity by industry				

	Unbalanced		Balanced	
Random	Others	CCPC	Others	CCPC
Debt to Assets Ratio	0.005%	0.008%	-0.005%	0.007%
Quick	0.075%	0.070%	0.076%	0.072%
Cash Flow	0.020%	0.016%	0.033%	0.013%
Market Share	-0.073%	-0.015%	-0.076%	-0.017%
R&D Intensity by industry	0.925%	0.926%	0.785%	0.837%

Table 8: Results for Fixed Effects and Random Effects Models

Fixed Effects

	Unbalanced Sample			Balanced Sample		
	Coefficient	*t*	Prob	Coefficient	*t*	Prob
Debt to Assets Ratio	-0.00803	-1.99	0.046	-0.00642	-0.95	0.340
Quick	0.00146	5.50	0.000	0.00208	5.45	0.000
Cash Flow	0.00312	12.17	0.000	0.00645	16.02	0.000
Market Share	-0.94855	-3.80	0.000	-1.81453	-3.59	0.000
Foreign Ownership	0.01164	2.16	0.031	0.00000	0.00	1.000
Constant	0.15158	151.20	0.000	0.14130	88.57	0.000
R^2	0.036			0.048		
Number of Observations	34,882			10,620		
Number of Groups	15,765			2,655		
F test	11.99		0.000	21.27		0.000

Random Effects

	Unbalanced Sample			Balanced Sample		
	Coefficient	*z*	Prob	Coefficient	*z*	Prob
Debt to Assets Ratio	0.00499	1.52	0.128	-0.00564	-0.91	0.364
Quick	0.00327	14.15	0.000	0.00313	8.54	0.000
Cash Flow	0.00341	26.67	0.000	0.00677	17.49	0.000
Market Share	-1.74146	-10.98	0.000	-1.44906	-4.99	0.000
Foreign Ownership	0.00731	1.62	0.105	0.00206	0.28	0.782
CCPC	0.01857	6.66	0.000	0.03904	4.29	0.000
R&D Intensity by Industry	0.99848	65.41	0.000	0.90847	28.74	0.000
Constant	0.04102	12.87	0.000	0.01928	2.08	0.037
R^2	0.2499			0.2493		
Number of Observations	34,882			10,620		
Number of Groups	15,765			2,655		
Wald Test	5662.14		0.000	1341.58		0.000

Hausman test $X^2(5)$	249.23	Prob	0.000	106.23	Prob	0.000
LM test $X^2(1)$	14600.67	Prob	0.000	9829.99	Prob	0.000