# CORPORATE OWNERSHIP STRUCTURE AND INNOVATION IN CANADA

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## RÉSUMÉ

*L'objectif de cette étude est de vérifier la relation entre les structures de propriété des sociétés canadiennes et leurs activités d'innovation. Nous prévoyons qu'une forte concentration de contrôle ainsi que la présence de structures à contrôle minoritaire (CMS) aient un impact négatif sur les activités de R&D des sociétés manufacturières canadiennes. Nos résultats indiquent que la concentration de contrôle dans les mains d'actionnaires dominants de sociétés CMS affecte négativement les résultats des investissements en R&D. Plus spécifiquement, nous constatons que l'écart entre les droits de contrôle et les droits de propriété des actionnaires dominants est positivement associé à l'intensité des investissements en R&D mais négativement associé aux résultats de ces activités. Ces résultats peuvent suggérer que les actionnaires dominants des sociétés CMS investissent en R&D pour réaliser des gains privés plutôt que d'être performants en matière d'innovation.*


**Mots clés:** Structures de propriété, structures à contrôle minoritaire (CMS), enracinement, activités de R&D, innovation.


## ABSTRACT

*This study examines the link between ownership structures and R&D activities in Canada. Our main hypothesis is that highly concentrated ownership structures or the presence of controlling minority shareholders negatively affects R&D intensity of Canadian manufacturing firms. We observe a negative relationship between the concentration of voting rights in firms endowed with a controlling minority structure (CMS) and the outcome of R&D activities. Furthermore, we show that the level of separation between the voting and cash flow rights held by controlling shareholders has a positive effect on R&D intensity but a negative effect on R&D outcome. These results may suggest that CMS shareholders' incentives regarding investments in R&D are not oriented towards innovative improvement but rather towards obtaining private gains.*


**Keywords:** Corporate ownership, controlling minority structures (CMS), entrenchment, R&D activity, innovation.

**Introduction**

As innovation contributes to the evolution of living standards, investments in research and development (R&D) play a major role in the economic growth of developed countries (Cox, 2001; Romer, 1986). The economic importance of innovation was notably established by Schumpeter (1939) who argued that creative destruction is indispensable in assuring the growth of capitalist societies. Since then, empirical studies have shown that R&D investments have a positive impact on economic growth, on firm value (Lev and Sougiannis, 1996; Chan et al., 2001; Johnson and Pazderka, 1993; Cho, 1998), and on firm performance (Hill and Snell, 1988; Lau, 1998).

Morck, Strangeland and Yeung (2000), on the other hand, show that heir controlled firms invest less on R&D than other firms that are widely held or controlled by the founding owners. In their view, because innovation is logically associated with the renewal of products and services, the concept of creative destruction could threaten the actual wealth of families who control large firms around the world. Creative destruction in itself may cause a reluctance to invest in R&D for large shareholders who want to maintain their vested interest in their firm's capital. Thus, inefficiencies in certain forms of firm ownership structures could have a negative impact on R&D investments.

In this study, we investigate whether corporate ownership structures affect the R&D activity of Canadian firms. More specifically, we investigate whether the widely documented ownership concentration of Canadian firms (Bozec and Laurin, 2004) affects R&D investments and the outcome of R&D. Our results show that the concentration of controlling shareholders' voting rights negatively affects R&D intensity of Canadian manufacturing firms. Furthermore, our results indicate that the level of separation between the voting and cash flow rights held by controlling shareholders has a positive effect on R&D intensity but a negative effect on R&D outcome.

The article is structured as follows. In Section I, we provide a theoretical framework and discuss the empirical findings of previous research linking ownership concentration and R&D. The research hypotheses are discussed in Section II. In Section III, we explain the data collection process, our choice of variables, and our research model. The empirical results are discussed in Section IV. In the final section of the article, we provide a conclusion and we suggest avenues for future research.

## Section 1: Theoretical framework and literature review

Based on agency theory, Jensen and Meckling (1976) argue that the separation of ownership and control affects firm performance through sub-optimal investment decisions. Agency theory predicts that a manager's incentive in making optimal investment decisions increases as a function of his stake in the firm's equity. Thus, concentrated ownership could alleviate manager-shareholders' conflict of interest in inducing investment decisions that creates value for the shareholders. Ownership concentration could therefore be considered as a mean to reduce Type I agency costs associated with sub-optimal investment decisions (Villalonga and Amit, 2006). This theory, conceptualized to better understand agency issues in modern widely held firms, has gathered a relatively strong empirical support from earlier studies (Hill and Snell, 1988).

While it could reduce Type I agency costs, ownership concentration can also raise other agency problems. Villalonga and Amit (2006) argue that concentrated ownership is a source of conflict between large shareholders, who control the firm's assets, and minority shareholders, who provide financing but run the risk of expropriation. In this context, Type II agency costs exist mostly because large shareholders are entrenched and can impose their choices even when these choices run against firm value maximization. Previous research has shown that at certain levels of concentration, the positive impact of corporate ownership concentration on firm value reverses and becomes negative (Morck et al., 1988; McConnell and Servaes, 1990; Hermalin and Weibach, 1991; Gompers et al, 2004).

Type II agency costs have many potential sources. For instance, wealthy families who own a large proportion of voting rights could make suboptimal investment decisions, such as over-expanding through mergers and acquisition instead of pursuing an R&D strategy that leads to creative destruction (Morck et al. 2003). These kinds of decision can increase the socio-political influence of the family, but can alter the value of minority holdings (Johnson et al., 2000). Also, in firms with concentrated ownership, strategic roles, such as leading research and development, are often assigned to member of the controlling family rather than to the most capable manager (Caselli and Gennaioli, 2003).

But if ownership concentration is a necessary condition for Type II agency costs, it is not a sufficient condition. *A priori*, large shareholders do not have a clear incentive to reduce firm value deliberately if they have cash-flow rights that are equivalent to their voting rights. But in

many countries showing high levels of corporate voting rights concentration, a considerable number of firms are incorporated as controlling minority structures (CMS). A CMS allows a controlling shareholder to retain high levels of voting right while owning a smaller proportion of the firm's cash flow rights. Under these circumstances, the controlling shareholders of CMS firms could benefit from private gains without incurring a fair share of the costs associated with their decisions. Therefore, Type II agency costs are likely to be more important for firms endowed with a CMS.

Previous research investigating the link between ownership structure and firm value or performance has yielded mixed results. Using a sample of 1,301 firms in Eastern Asia, Claessens et al. (2002) find a positive relationship between the concentration of cash flow rights of main shareholders and firm value. Furthermore, the authors find that the difference between voting rights and cash flow rights held by the largest shareholder has a negative impact on firm value. Faccio and Lang (1999) perform a similar study on 3,740 European firms. They also find a positive relationship between the concentration of cash flow rights of the main shareholder and firm value but only when there is no other important shareholder. However, they do not find any significant relationship between the separation of voting and cash flow rights and firm value. Studying a sample of 309 Swedish firms, Cronqvist and Nilsson (2003) observe a negative relationship between the voting rights of main shareholders and firm value.

In Canada, Bozec and Laurin (2004) conduct a study on a sample of 487 Canadian firms. They find that the concentration of voting rights held by the main shareholder is positively related to firm performance. However, they find a negative relationship between the separation of voting and cash flow rights of the main shareholder and firm performance but only when the cash flow rights of that shareholder is less then 25%. Bozec and Laurin(2007) show that this relationship is even stronger in the presence of free cash flows.

Other studies investigate the impact of ownership concentration controlling for the type of dominant shareholder. The general findings suggest that when the company founder is still involved in the administration or the management of the firm, concentration has a positive impact on value creation. Otherwise, in the case of heir controlled firms, value tends to be destroyed (Villalonga and Amit, 2006; Morck et al., 2002). Moreover, CMS firms controlled by non-founding families seem to have the highest agency costs (Cronqvist and Nilsson, 2003).

**Corporate ownership structures and R&D activity**

Although investing in research and development can contribute to value maximisation (Lev and Sougiannis, 1996; Chan et al., 2001; Johnson and Pazderka, 1993; Cho, 1988) and financial performance (Hill and Snell, 1988; Lau, 1998), such investments may be risky, requiring on average 3 to 6 years of ongoing efforts and expenses before a firm could actually benefit from research outcomes. Even then, more than 30-90% of all new products fail (Needles, 1994, cited by Persons, 1999). Holmstrom (1989) explains that agency costs associated with innovative activity are likely to be high because such projects are risky, labor-intensive, idiosyncratic, and their profitability, if any, can only been assessed in the long run.

Studies analyzing the relationship between ownership concentration and R&D investments show that when corporate ownership is widely-held, ownership concentration has a positive effect on R&D investments (Hill and Snell, 1988; Cho, 1998; Baysinger et al., 1991 Gompers et al., 2004), and R&D outcomes (Francis and Smith, 1995). However at higher levels of concentration, agency problems associated with entrenchment seem to reverse the effect of ownership concentration on R&D, which becomes significantly negative (Cho, 1998; Gompers et al., 2004). Because recent research globally shows that widely-held firms tend to be more the exception than they are the norm (La Porta et al., 1999), it is worthwhile to investigate the links between R&D, ownership concentration and Type II agency costs.

Gugler, Mueller and Yurtuglu (2004) analyze the relationship between corporate governance, ownership structures, and investment performance including R&D activity on a sample of 19,000 firms from 61 different countries. They show that in countries with weaker legal governance systems, widely-held firms have a better investment performance than closely-held ones. They argue that in countries where legal shareholder protection systems are not strongly enforced and ownership concentration is prevalent, entrenchment issues are more severe and lead to poorer investment performance.

Canada offers an interesting setting to study the link between ownership concentration and R&D outcomes. In Canada, corporate ownership is highly concentrated yet the legal shareholder protection system is strongly enforced (La Porta et al, 1998). Thus, empirical results drawn from previously cited non-Canadian studies can hardly be generalized to the Canadian context. Morck et al. (2002) conducted the main empirical study that investigates the relationship between corporate control and R&D activity in Canada. Analyzing the relationship between the

type of controlling shareholders and R&D investments, they find that heir controlled firms invest significantly less on R&D than widely-held Canadian firms.

Morck et al. (2002) mention the importance of CMS in the Canadian economy but they do not control for this variable. Cronqvist and Nilsson (2003) explain that because controlling shareholders of CMS firms have fewer stakes in the firm's capital, they may choose to invest in projects that maximize their private gains even if such projects are non-value-maximizing for the firm. Bebchuk et al. (2000) illustrate in their theoretical model that, when faced with two investment choices – one that is value maximizing and one that is not but allows the controlling shareholders to benefit from private gains – shareholders will choose the one that generates private gains so long as their benefits from private gains exceed their benefits from the value-maximizing investment. Moreover, Morck and Young (2003) explain that in pyramid formed CMS firm groups, controlling shareholders may expropriate other minority shareholders through "tunnelling," a process by which they transfer profits from the firms at the bottom of the pyramid to the ones at the top. Similarly, losses from firms at the top of the pyramid are shifted to the firms at the bottom.

Although no study has directly analysed the impact of the separation of voting and cash flow rights on R&D activity, many studies have shown that such a separation has a negative impact on firm value (Claessens et al., 2002, Villalonga and Amit, 2006), and on financial performance especially when the stakes on the controlling shareholders' cash flow rights are low (Bozec and Laurin, 2004).

## Section 2: Research hypothesis

In this study, we analyse the relationship between the concentration of corporate control and R&D activity. In addition, we analyze the impact of the separation of voting and cash flow rights of the main shareholders on Canadian firms' R&D activities. Empirical findings on the relationship between corporate ownership concentration and R&D activity are mixed and differ according to economic contexts. In economies mostly characterised by widely-held firms, ownership concentration could resolve the alignment problem and contribute to R&D intensity. However, in some countries where corporate ownership structures are highly concentrated, entrenchment issues could negatively affect investments in R&D (Czarnitzki and Kraft, 2005) or the outcome of these investments (Gugler et al., 2004).

In Canada, high levels of ownership concentration pave the way to entrenchment. Because the benefits of R&D remain highly uncertain, large shareholders may be reluctant to invest in innovative activities which may lead to creative destruction of the firm's actual capital. In addition, entrenched shareholders are shielded against hostile takeover. As a result, they may become somewhat inert and avoid investments such as R&D projects, which require a great amount of effort. Hence, we predict a negative relationship between corporate control concentration and R&D activity. We also argue that less investment will most likely lead to fewer outcomes from R&D activities. H1a and H1b reflect these predictions:

***H1a:*** ***In Canada, the concentration of a corporation's voting rights in the hands of a dominant shareholder has a negative impact on the intensity of R&D investments.***

***H1b:*** ***In Canada, the concentration of a corporation's voting rights in the hands of a dominant shareholder has a negative impact on the outcome from R&D activities.***

Our second research hypothesis pertains to the impact of ownership structures on R&D outcome. Based on Bebchuk and al's (2000) theoretical model, we argue that when their cash flow rights are very small, the controlling shareholders externalize most of the costs associated with suboptimal investment decisions. Accordingly, the greater the gap between their voting and cash flow rights, the greater the incentive for controlling shareholders to expropriate other shareholders using sub-optimal investment decisions. Therefore, whether controlling shareholders expropriate other public shareholders by suboptimal investment choices, or whether the expropriation results from tunnelling procedures, the proportion of the separation between voting and cash flow rights of the controlling shareholders should have a negative impact on R&D activity.

***H2:*** ***In Canada, the outcome of R&D activities is negatively affected by difference between voting and cash flow rights held by a controlling shareholder.***

## Section 3: Methodology

### 3.1 Data collection

Our initial sample consists of 259 Canadian manufacturing firms (sic codes ranging from 2000 to 3999) listed on the CanCorp Financials Professional database and for which data was

available for any financial period between 1998 and 2003. We excluded one firm with the head office located outside Canada as well as four firms for which financial or corporate ownership data was not available. To make sure that the absence of R&D activity of selected firms was not driven by the specific characteristics of their industries, we excluded all firms for which the average industry level of R&D spending was equal to zero. Our final sample consists of 205 firms and 1,192 firm-year observations.

Financial data covering fiscal periods from 1998 to 2003 inclusively, and 2004 if available, were retrieved from the Stock guide database. Information on corporate ownership structure was collected using management proxies available on the SEDAR database; patents information was drawn from the Canadian Intellectual Property Office (CIPO) website. Other firm-specific data, such as the presence of the firms' original founders and the firm age, was drawn from the firms' annual reports or from their website.

### 3.2 Model and variables definition

To test our research hypotheses, we use the following pooled cross-sectional time series model:

$$R\&D\ activity_j = \alpha_0 + \alpha_1 OWNERSHIP\ STRUCTURE_j + \alpha_2 SIZE_j + \alpha_3 AGE_j + \alpha_4 II_j + \alpha_5 IND_j + \alpha_6 FOUNDER_j + \alpha_7 DEBT_j + \varepsilon_j \quad (1)$$

We analyse R&D activity from two different perspectives: R&D intensity, and R&D outcome. Accordingly, our first dependent variable (*R&D*) represents the level of R&D intensity as defined by the ratio of a firm's R&D expense divided by total assets. This measure of R&D intensity is also used by Francis and Smith (1995), Cho (1988) and Abdullah et al. (2002). Our second proxy of R&D activity relates to the outcome of R&D investments. We measure R&D outcome by the number of patents granted to a firm in a given year (*PGY*). [1]

We use two approaches to proxy for OWNERSHIP STRUCTURE. Our first research hypothesis predicts a negative relationship between the concentration of corporate control and R&D activity. To test H1a and H1b, OWNERSHIP STRUCTURE is proxied by the corporate control concentration (CONT), a variable measured by the percentage of voting rights held by the ultimate controlling shareholder [2] of a firm. Our second hypothesis predicts that the outcome of

R&D activity is negatively affected by the difference between voting and cash flow rights of CMS controlling shareholders. To test H2, OWNERSHIP STRUCTURE is proxied by a measure of the separation between voting and cash flow rights of the controlling shareholders (SEPDIFF). SEPDIFF is simply calculated by the difference between the percentage of voting rights and cash flow rights.[3] Hence, the variable SEPDIFF measures the excess voting rights of controlling shareholders which, in a conventional non-CMS firm, will be equal to 0.

To control for firm specific characteristics, we include in our analyses a series of control variables that previous studies have linked to R&D. In line with Francis and Smith's (1995), we control for the size (SIZE) and the age (AGE) of firms, the industry to which they belong (IND), as well as the presence of the firms' founders in a top management or a board position (FOUNDER). Many other studies that have examined R&D activity show that the presence of institutional investors (Graves, 1988) as well as a firm's leverage (Czarnitzki and Kraft, 2005) may have a significant impact on R&D activity. In line with these findings, we also include in our analyses the percentage of institutional shareholdings (%II) and the ratio of long term debt to total assets (DEBT). Appendix 3 presents our list of dependent and independent variables and their description.

In order to compare our findings with other studies, we initially use OLS regression technique.[4] However, the OLS technique may not be a suitable approach for at least two reasons. First, in a cross-sectional time series sample such as ours, serial correlation of the error terms for observations from the same company can lead to misspecification. Second, since the distribution of the R&D intensity variable is truncated at 0, we cannot meet OLS's requirement that residuals need to be normally distributed in order to obtain unbiased estimators. To avoid these econometrics problems, we run panel data analysis using maximum likelihood estimator (MLE) models. We use the Tobit estimator to analyse R&D intensity. The Tobit model is also used in more recent studies analysing R&D intensity (Sanguinnetti, 2005; Gompers et al., 2004; Morck et al., 2002).

OLS is not suitable to analyse count data such as the number of granted patents (PGY). For models ran on PGY, we used the Poisson model,[5] which accounts for the discrete distribution inherent to this variable. Moreover, this model is suitable when 0 is frequent in the value distribution of the dependant variable. Therefore, we analyse R&D outcome using a version of the POISSON model adapted for panel data.

## Section 4: Results

### 4.1 Descriptive statistics

Table 1 provides descriptive statistics for the variables included in this study. The first section provides statistics for the R&D activity variables. In our sample, R&D spending averages 7% of total assets, a result similar to those obtained in other North American studies (see for instance Cho, 1998). The average number of yearly granted patents (PGY) is slightly less than 1. The second section of Table 1 reports descriptive statistics for the ownership structure variables. These statistics reveal that controlling shareholders hold, on average, 28 % of firms' voting rights. The CMS dummy variable statistics reveal that firm-year observations for which the controlling shareholder holds more voting rights than flow rights represent 17.6% of the sample. The average difference between voting and cash flow rights for all firm-year observation amounts to 6 %. Finally, in the last section of Table 1, we report statistics on the control variables, such as the presence of firms' founders, the percentage of institutional ownership and other firm characteristics. Most of these statistics are similar to those reported in other Canadian studies (Bozec and Laurin, 2007).

[Insert Table 1]

### 4.2 Univariate analysis

In Table 2, we compare R&D activities based on different types of ownership structures. Firms where a controlling shareholder holds 20% or more voting rights (identified as closely held) are first compared with the other firms included in the sample. In line with our predictions, we observe that closely held firms spend significantly less in R&D then do the other firms. However, no significant differences are observed between closely held and the other firms with respect to R&D outcomes. Then, we compare CMS firms with conventional (non-CMS) firms. The univariate results suggest that CMS firms have higher R&D outcomes than conventional non-CMS firms, a result which contradicts H2.

[Insert Table 2]

Table 3 presents a partial Pearson's correlation matrix including ownership structure and R&D activity variables. The correlations observed between R&D intensity and ownership concentration indicators are significantly negative. These results support H1. The matrix reveals no significant correlation between ownership concentration (CONT) and PGY. However, we

report a significantly positive correlation between CMS firms and granted patent. Although these results tend to support H1 and to contradict H2, the univariate analyses remain incomplete until we perform more compelling analyses that take into consideration the other factors that may influence R&D activity.

[Insert Table 3]

**4.3 Multivariate analysis**

The results of MLE regression analyses are reported in Table 4.[6] In the first two columns, we test the impact of voting rights concentration on R&D intensity (H1a) and on R&D outcome (H1b). The impact of the separation between voting and cash flow rights on R&D outcome (H2) is presented in the last column of table 4.

[Insert Table 4]

As H1a predicts, the results in the second column of Table 4 indicate a significantly negative relationship between the percentage of voting rights held by controlling shareholders (CONT) and R&D intensity ($\alpha_1$ = -0.067; P<5%). However, no significant relationship is found between CONT and R&D outcome (PGY), as shown in column 3 of Table 4.

The relationship between the separation of the voting and cash flow rights of controlling shareholders (SEPDIFF) and R&D outcome (PGY) is tested in column 4. Because SEPDIFF increases with the proportion of voting rights held by the controlling shareholder, it can serve as a proxy for ownership concentration. To avoid capturing control concentration effects by the use of SEPDIFF, we also include CONT in the regression. Consistent with H2, we obtain a statistically negative coefficient for SEPDIFF ($\alpha_2$ = -4.419; P<1%). However, we also find a significantly positive coefficient for CONT ($\alpha_1$ = 2.509; P<1%). These findings suggest that while the voting rights of controlling shareholders favour R&D outcomes, the proportion of separation between voting and cash flow rights impedes on these outcomes.

In general, our findings are consistent with our research hypotheses H1a and H2. Results in table 4 suggest that the voting rights of controlling shareholders limit R&D investments whereas R&D outcome is decreasing as the gap between voting rights and cash flow rights increases. Results reported in Table 4 also show that some of our firm-specific variables have a significant impact on R&D activity. We observe a generally negative relationship between firm size and R&D intensity. These results contradict earlier theoretical and empirical studies (Schumpeter, 1942, Baysinger et al. 1991) but are in line with more recent argumentations and

findings (Holmstrom 1989, Scherer 1984, Barker and Mueller, 2002). Consistent with the results of previous studies, we also find a significantly positive relationship between R&D intensity levels, R&D outcomes, and the industry's R&D activity (Baysinger and al., 1991). In addition, our results show a significantly positive relationship between firm leverage and R&D activity. These latter findings suggest that creditors may encourage value-creative activity such as R&D, regardless of the risky nature of such investments. Finally, we find that when analysing R&D outcome, firm age is a significant variable that positively influences patent grants.

**4.4 Sensitivity analysis**

While our basic model assumes a monotonic relationship between the concentration of voting rights of controlling shareholders and R&D activity, previous empirical results have shown that the monotonicity of this relationship could be challenged (Gompers et al., 2004; Abdullah et al. 2002; Cho, 1998). Based on these results, we test an alternative model which allows for a non-monotonic relationship between CONT and R&D activity. To do so, we include CONT50+ in the regression model.CONT50+ measures the percentage of voting rights held by controlling shareholders when the concentration of these voting rights are 50% and above. The results of the sensitivity analyses that include CONT50+ are presented in table 5.

[Insert Table 5]

The results displayed in the first regression of table 5 indicate a significantly negative relationship between CONT and R&D but a significantly positive relationship between CONT50+ and R&D. These results suggest that if the concentration of voting rights impedes on R&D investment, this seems to be particularly true when the controlling shareholder holds less than 50% of the voting rights. In fact, the relationship between concentration and R&D becomes positive when the level of concentration of the voting rights is above 50%. The relationship between the concentration of voting rights and PGY (regression 2, table 5) is also reversed for CONT50+. The results indicate that while voting rights concentration seems to favour R&D outcome, the positive effect of concentration on PGY seems to be eradicated when the controlling shareholder holds more than 50% of the voting rights.

To explain these contradictory results, one could argue that the alignment effect at higher levels of concentration alleviates the negative relationship between CONT and R&D intensity. But the previous literature (Morck et al., 1988) has also shown that at higher levels of concentration, the entrenchment of controlling shareholders may temper the positive effect of

alignment, thereby reinforcing the assumption of a negative relationship between CONT and R&D outcome. Given that the entrenchment problem is likely to be more severe in the case of CMS firms, it is quite possible that the relationship between voting rights concentration and R&D activity varies depending on the nature of the ownership structure. To account for this possibility, we further examine the relationship between the concentration of voting rights and R&D activity (R&D and PGY) for two sub-samples: CMS and conventional non-CMS firms. The results of these analyses are reported in regressions 3, 4, 5 and 6 of table 5.

The results obtained from these analyses show that for conventional firms, the controlling shareholders' voting rights concentration has a significantly negative impact on R&D intensity but a significantly positive impact on R&D outcome. These results show that in conventional non-CMS firms, investment in R&D activities is decreasing as a function of voting rights concentration. But for these firms, R&D investment tends to be more fruitful as voting rights concentration increases.

For the sub-sample of CMS firms, we find a positive (but not statistically significant) relationship between the concentration of voting rights and R&D intensity and a significantly negative relationship between concentration and R&D outcome. In the case of CMS firms, as the concentration of voting rights increases, R&D investment tends to be less fruitful. This result indicates that the money invested in R&D by the decision makers in highly concentrated CMS firms tends to generate less tangible results. This result could be worrisome for minority shareholders. In fact, this result supports the idea that for CMS firms, R&D investment could be used for purposes other than to generate patents, and these purposes could include expropriation through woeful R&D investments (Morck et al., 2002).

The next series of sensitivity analyses measures the impact of excess voting rights on R&D activity in CMS firms. Previous studies on ownership structures and firm performance have shown that the negative impact of excess voting rights on firm performance could be exacerbated when the cash flow rights of controlling shareholders are low (Bozec and Laurin, 2007). To account for this possibility, we include CFR10SEPDIFF in the regression. This interactive term measures excess voting rights of the controlling shareholder when her cash flow rights are lower than 10%. Previous studies also suggest that controlling shareholders of pyramid shaped CMS structures may use tunnelling procedures to expropriate minority shareholders by transferring gains upwards in the pyramid and shifting losses downwards (Morck et al., 2002). To test

whether the potential use of such tunnelling procedures might generate more R&D investment in pyramid shaped CMS structures, we include a third interactive term, PYRSEPDIFF, which measures the excess voting rights of controlling shareholders involved in pyramid structures. The results of these analyses are presented on the right hand side of Table 5 (regressions 7 to 10).

Results obtained from regressions 7 and 8 suggest that for the sub-sample of CMS firms, excess voting rights held by controlling-minority shareholders positively affects R&D investments but negatively affects PGY. Therefore, it is possible that controlling-minority shareholders may be seeking private gains by investing large sums in suboptimal R&D activity instead of focussing their attention on R&D that creates value. The significantly negative coefficient for CFR10SEPDIFF in regression 7 suggests that the positive effect of SEPDIFF on R&D intensity may be less important when controlling shareholders own a small proportion of cash flow rights. In regression 8, the coefficient for CFR10SEPDIFF is insignificant, implying that the relationship between SEPDIFF and R&D outcome is unaffected by the proportion of cash flow rights owned by the controlling shareholders.

Results obtained in regressions 9 suggest that the relationship between PYRSEPDIFF and R&D intensity is significantly positive. To some extent, the fact that R&D investments seem to be greater in pyramids supports the notion of tunnelling. This notion is further supported by the results of regression 10, which reveals that the relationship between PYRSEPDIFF and PGY is insignificant. By putting these two results together, it could be argued that although R&D investment is greater in pyramid, the outcome, as measured by the number of patents granted, is not affected by the nature of the structure. This could suggest that when seeking private gains, controlling shareholders of pyramids may choose to invest in R&D activity in firms located at the lower levels and then find means to transfer this money towards the pyramid's apex (Morck et al. 2003).

In terms of control variables, results in table 5 show that the relationship between firm specific characteristics and the dependant variables differs according to the corporate ownership type. For example, the positive relationship between firm age and R&D activities is only significant for CMS firms. Moreover, the relationship between leverage and R&D activity is significantly positive for conventional non-CMS firms but significantly negative for CMS firms. To explain this result, we hypothesize that given the risk of tunnelling and expropriation in CMS firms, creditors may be closely monitoring these firms' investing activities and blocking risky

projects such as R&D. Results in Table 5 also show that for CMS firms, the presence of the founders has a significantly positive effect on R&D investments and R&D outcome. To that effect, Morck et al. (2002) argue that when the founders are involved in the administration of CMS firms, they will tend favour value-creative investments such as R&D.

We also conduct additional sensitivity tests to analyze the robustness of the main results. All our multivariate tests have been rerun while performing the following independent manipulations: 1) using dummy variables for the level of voting rights concentration (instead of continuous variables), 2) including alternative measures of the separation between voting and cash-flow rights (dummy variable and the ratio of cash-flow rights to voting rights) in the regressions, 3) running a quadratic regression to test the non-monotonic relationship between voting rights concentration and R&D activity, 4) including alternative measures of R&D intensity such as industry adjusted R&D investments and, 5) excluding observations for which the residuals fall beyond three standard deviations from the mean. Although not reported here, the results remained qualitatively unchanged.

## 5. Conclusion

The purpose of this study is to understand the impact of Canadian corporate ownership structures on R&D activity. We provide empirical evidence on the effects of ownership concentration, CMS structures, and excess voting rights held by controlling-minority shareholders on R&D intensity and R&D outcome. Our results indicate that, in the case of conventional non-CMS firms, ownership concentration is negatively associated with R&D intensity but positively associated with R&D outcome. For CMS firms, ownership concentration does not seem to affect R&D intensity but hampers on R&D outcome, especially when the cash flow rights of the dominant shareholders are at low levels. We also find that the percentage of excess voting rights is positively associated with R&D intensity but negatively associated with R&D outcome. This latter finding may cast some doubt on the real objectives that controlling-minority shareholders pursue when they decide to increase R&D spending.

Our research contributes to the literature on two different fronts. First, we provide empirical support to the more theoretical research that has hypothesized a negative link between concentrated ownership, separation and value creative R&D. Earlier research by Morck et al. (2002, 2003) especially comes to mind. Second, our research builds on previous empirical

findings published by Francis and Smith (1995), who also have investigated the links between ownership structure and R&D, but who have done so in a US context where Controlling Minority Structures are infrequent. By studying the Canadian context, we have shown that the relationship between ownership structures and R&D activity can be affected by the magnitude of the separation between voting rights and cashflow rights.

Our research is, of course, not free from limitations. First, measuring R&D outcome by the number of granted patents could be challenged. The fact that some firms may willingly decide not to patent their innovations affects the quality of our proxy. Another limitation lies in our research design, which measures the investments in innovative activities through R&D spending as reported by the firms in their annual report. This design does not recognize other forms of innovative activity. It is certainly possible that firms could find ways to innovate without reporting all of their innovating activities through their R&D accounts. In order to better understand the impact of corporate ownership on innovative activity, other forms of innovative activity should probably be taken into consideration. We leave these questions for future research.

## Endnotes

1. Francis and Smith (1995) also use this measure of R&D outcome while Czarnitzki and Kraft (2005) use the number of issued patents as their proxy of R&D outcome. Because we assume only the granted patents officialise the actual innovation ensuing from R&D activity, we chose Francis and Smith's proxy.

2. This proxy is also used in other studies analysing the effects of voting rights concentration on firm performance (Bozec and Laurin, 2004; Gompers et al., 2004; Cronqvist and Nilsson, 2003). In Canada, the presence of pyramid structures suggests that identifying the voting rights owned by the immediate controlling shareholder may not be sufficient to fully appreciate ownership concentration. Therefore, when the principal shareholder of a firm is another corporate entity, we find the principal shareholder of that entity, and so on, until we find the ultimate controlling shareholder.

3. We also have performed test using 1) the ratio of cash flow rights on voting rights, and 2) a dummy variable which takes the value of one when there is separation between voting rights and cash flow rights, zero otherwise. See the sensitivity analysis section.

4. The results are not reported.

5. Greene, W.C, "Econometric analysis, fifth edition" 2003, p.740, note 66.

6. Although the full sample size consists on 1192 observations, the sample size drops to 873 firm-year observations when control variables such as firms' age and founders are included. Furthermore, because patent information is not available for every observation, the full sample size for regressions run on PGY is reduced to 740 observations.

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## Appendix 1
## R&D intensity by industry

| | R&D | | | |
|---|---|---|---|---|
| **INDUSTRY** | **Average** | **Minimum** | **Maximum** | **Std deviation** |
| Metals & Mining | 0.027 | 0.000 | 0.244 | 0.060 |
| Gold & Precious Metals | 0.000 | 0.000 | 0.000 | 0.000 |
| Chemicals & Fertilizers | 0.010 | 0.000 | 0.082 | 0.018 |
| Containers | 0.011 | 0.000 | 0.037 | 0.013 |
| Oil & Gas - Integrated | 0.008 | 0.000 | 0.025 | 0.007 |
| Oil & Gas - Exploration & Production | 0.012 | 0.000 | 0.049 | 0.018 |
| Energy: Drilling | 0.000 | 0.000 | 0.000 | 0.000 |
| Energy: Equipment & Services | 0.010 | 0.000 | 0.035 | 0.012 |
| Aerospace & Defense | 0.002 | 0.000 | 0.011 | 0.003 |
| Building Products | 0.001 | 0.000 | 0.010 | 0.003 |
| Commercial Printing | 0.002 | 0.000 | 0.012 | 0.004 |
| Commercial Services | 0.155 | 0.071 | 0.295 | 0.075 |
| Construction, Engineering, Fabricating | 0.006 | 0.000 | 0.054 | 0.015 |
| Electrical Equipment | 0.064 | 0.004 | 0.715 | 0.119 |
| Environment | 0.016 | 0.000 | 0.047 | 0.021 |
| Industrial Conglomerates | 0.053 | 0.000 | 0.177 | 0.061 |
| Industrial Machinery | 0.019 | 0.000 | 0.099 | 0.025 |
| Office Equipment & Services | 0.000 | 0.000 | 0.000 | 0.000 |
| Specialty Industries | 0.000 | 0.000 | 0.000 | 0.000 |
| Auto Parts | 0.047 | 0.000 | 0.722 | 0.134 |
| Household Durables | 0.003 | 0.000 | 0.025 | 0.006 |
| Movies & Entertainment | 0.004 | 0.000 | 0.015 | 0.005 |
| Food - Processing | 0.000 | 0.000 | 0.000 | 0.000 |
| Tobacco & Agriculture | 0.005 | 0.000 | 0.015 | 0.006 |
| Telecom Services - Wireless | 0.122 | 0.000 | 0.569 | 0.193 |
| Telecom Services - Alternative | 0.000 | 0.000 | 0.000 | 0.000 |
| Computers & Peripherals | 0.241 | 0.000 | 1.719 | 0.403 |
| Electronic Equipment | 0.050 | 0.000 | 0.189 | 0.063 |
| Internet | 0.000 | 0.000 | 0.000 | 0.000 |
| IT Consulting | 0.036 | 0.000 | 0.077 | 0.029 |
| Networking | 0.139 | 0.023 | 0.392 | 0.107 |
| Semiconductors | 0.162 | 0.000 | 0.380 | 0.099 |
| Software | 0.154 | 0.045 | 0.503 | 0.108 |
| Telecom Equipment & Systems | 0.074 | 0.004 | 0.408 | 0.065 |
| Other Technologies | 0.085 | 0.015 | 0.278 | 0.060 |
| Financial & Investment Services | 0.009 | 0.000 | 0.025 | 0.012 |
| Biotechnology | 0.288 | 0.000 | 1.838 | 0.298 |
| Pharmaceuticals | 0.122 | 0.000 | 0.685 | 0.158 |
| Equipment, software, systems and services | 0.237 | 0.006 | 0.608 | 0.177 |

## Appendix 2
## Patents Granted per year by industry

| | PGY | | | |
|---|---|---|---|---|
| **INDUSTRY** | **Average** | **Minimum** | **Maximum** | **Std deviation** |
| Metals & Mining | 11.600 | 0 | 266.000 | 42.938 |
| Gold & Precious Metals | 0.000 | 0 | 0.000 | 0.000 |
| Chemicals & Fertilizers | 0.264 | 0 | 10.000 | 1.430 |
| Containers | 0.889 | 0 | 6.000 | 1.605 |
| Oil & Gas - Integrated | 5.778 | 0 | 35.000 | 10.229 |
| Oil & Gas - Exploration & Production | 0.056 | 0 | 1.000 | 0.236 |
| Energy: Drilling | 0.000 | 0 | 0.000 | 0.000 |
| Energy: Equipment & Services | 0.300 | 0 | 3.000 | 0.758 |
| Aerospace & Defense | 0.259 | 0 | 3.000 | 0.764 |
| Building Products | 0.514 | 0 | 5.000 | 1.422 |
| Commercial Printing | 0.167 | 0 | 1.000 | 0.408 |
| Commercial Services | 0.167 | 0 | 1.000 | 0.408 |
| Construction, Engineering, Fabricating | 0.067 | 0 | 2.000 | 0.365 |
| Electrical Equipment | 1.000 | 0 | 7.000 | 2.112 |
| Environment | 0.875 | 0 | 4.000 | 1.458 |
| Industrial Conglomerates | 1.000 | 0 | 6.000 | 1.859 |
| Industrial Machinery | 1.025 | 0 | 6.000 | 1.819 |
| Office Equipment & Services | 0.059 | 0 | 1.000 | 0.243 |
| Specialty Industries | 0.000 | 0 | 0.000 | 0.000 |
| Auto Parts | 0.714 | 0 | 12.000 | 2.127 |
| Household Durables | 0.326 | 0 | 5.000 | 0.889 |
| Movies & Entertainment | 0.000 | 0 | 0.000 | 0.000 |
| Food - Processing | 0.900 | 0 | 9.000 | 2.846 |
| Tobacco & Agriculture | 0.750 | 0 | 4.000 | 1.357 |
| Telecom Services - Wireless | 0.000 | 0 | 0.000 | 0.000 |
| Telecom Services - Alternative | 0.000 | 0 | 0.000 | 0.000 |
| Computers & Peripherals | 0.000 | 0 | 0.000 | 0.000 |
| Electronic Equipment | 0.143 | 0 | 1.000 | 0.356 |
| Internet | 0.000 | 0 | 0.000 | 0.000 |
| IT Consulting | 0.000 | 0 | 0.000 | 0.000 |
| Networking | 1.200 | 0 | 5.000 | 2.168 |
| Semiconductors | 0.697 | 0 | 6.000 | 1.591 |
| Software | 0.059 | 0 | 1.000 | 0.243 |
| Telecom Equipment & Systems | 0.024 | 0 | 1.000 | 0.156 |
| Other Technologies | 0.944 | 0 | 10.000 | 2.190 |
| Financial & Investment Services | 0.000 | 0 | 0.000 | 0.000 |
| Biotechnology | 0.333 | 0 | 5.000 | 0.783 |
| Pharmaceuticals | 0.611 | 0 | 15.000 | 2.201 |
| Equipment, software, systems and services | 0.591 | 0 | 4.000 | 1.008 |

**Appendix 3**
**List of Research Variables**

| Dependant Variables | Description |
|---|---|
| R&D | R&D expense/Total assets |
| PGY | Number of granted patents in a given year |
| **Independant Variables** | **Description** |
| CONT | % of voting rights of the main controlling shareholder |
| CONT50+ | = % of voting rights of the main controlling shareholder when equal or over 50%.<br>= 0, otherwise |
| CMS | = 1, if % of voting rights of controlling shareholders is higher than their % of cash flow rights.<br>= 0, otherwise |
| SEPDIFF | = the difference between voting and cash flow rights of controlling shareholders (excess voting rights) |
| CFR10SEPDIFF | = the difference between voting and cash flow rights of controlling shareholders (excess voting rights) when cash flow rights are under 10% |
| PYRSEPDIFF | = the difference between voting and cash flow rights of controlling shareholders (excess voting rights) for pyramidal structures. |
| **Control Variables** | **Description** |
| SIZE | LN (SALES) |
| AGE | Number of years in operation |
| IND | Industry's average R&D/Asset ratio |
| FONDATEUR | = 1, if the founder is present in top management or board.<br>= 0, otherwise |
| % II | % of voting rights held by institutional investors |
| DEBT | Long term debt/ Total assets |

**Table 1**
**Descriptive statistics**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| **Dependant variables** | | | | | |
| R&D | 1192 | 0.000 | 1.838 | 0.069 | 0.151 |
| PGY | 1013 | 0.000 | 266.000 | 0.962 | 9.034 |
| **Ownership variables** | | | | | |
| CONT | 1192 | 0.000 | 1.000 | 0.283 | 0.251 |
| CMS | 1192 | 0.000 | 1.000 | 0.176 | 0.381 |
| SEPDIFF | 1192 | 0.000 | 0.660 | 0.059 | 0.149 |
| **Control variables** | | | | | |
| % II | 1192 | 0.000 | 0.800 | 0.056 | 0.110 |
| FOUNDER | 949 | 0.000 | 1.000 | 0.658 | 0.475 |
| AGE | 1085 | 1.000 | 170.000 | 29.328 | 26.888 |
| SIZE | 1192 | 3.664 | 16.912 | 11.387 | 2.422 |
| DEBT | 1192 | 0.000 | 24.493 | 0.158 | 0.737 |
| IND | 1192 | 0.000 | 0.555 | 0.071 | 0.099 |

Table 1 provides descriptive statistics of all the variables in this study. See Appendix 3 for the detailed description of these variables

**Tableau 2**

Univariate comparisons between R&D activity variables across ownership levels and ownership structures

| Section 1 | Closely held firms (20% level) | Widely held firms | t-test [a] | Sig (two tailed) |
|---|---|---|---|---|
| | N = 597 | N = 578 | | |
| R&D | **0,024** | **0,117** | **-10,954** | **0,000** |
| PGY | 0,885 | 1,050 | -0,292 | 0,771 |
| Section 2 | CMS firms | Conventional firms | t-test [a] | Sig (two tailed) |
| | N= 210 | N=965 | | |
| PGY [b] | **1,964** | **0,728** | **2,011** | **0,045** |

**In table 2, R&D is a proxy for R&D intensity, estimated by the R&D/Assets ratio. PGY is a proxy for a R&D outcome, estimated by the number of yearly granted patents.** See Appendix 3 for the detailed description of R&D variables. The first section of table 2, compares R&D activity across different ownership levels. In this analysis, Closely held firms are defined as firms for which the controlling shareholder holds 20% and more voting rights. All other firms are considered Widely held firms. Section 2 of table 2 compares R&D outcome across different ownership structure types. In this analysis, we compare CMS to Conventional non-CMS firms. CMS firms are defined as firms for which the voting rights of the controlling shareholders exceed their cash flow rights. All other firms are considered, Conventional non-CMS firms

[a] :t statistics are adjusted for unequal variances obtained by Levine's tests.

**Table 3**
**Univariate analysis of corporate ownership structures and R&D activity**

| | | CONT | SEPDIFF | CMS | R&D | PGY |
|---|---|---|---|---|---|---|
| CONT | Pearson Correlation | 1.000 | | | | |
| | Sig. (2-tailed) | . | | | | |
| SEPDIFF | Pearson Correlation | **0.566*** ** | 1.000 | | | |
| | Sig. (2-tailed) | **0.000** | . | | | |
| CMS | Pearson Correlation | **0.565*** ** | **0.863*** ** | 1.000 | | |
| | Sig. (2-tailed) | **0.000** | **0.000** | . | | |
| R&D | Pearson Correlation | **-0.296*** ** | **-0.164*** ** | **-0.192*** ** | 1.000 | |
| | Sig. (2-tailed) | **0.000** | **0.000** | **0.000** | . | |
| PGY | Pearson Correlation | -0.018 | 0.020 | **0.054*** | -0.029 | 1.000 |
| | Sig. (2-tailed) | 0.569 | 0.517 | **0.088** | 0.362 | . |

**Table 3 presents Pearson's correlation matrix between ownership structure variables and R&D activity variables of this study.** See Appendix 3 for the detailed description of these variables.
The symbols *, **, *** indicate statistical significance levels at 10 %, 5 % et 1 % respectively.

**Table 4**
**Corporate ownership structures and R&D activity**

| Dependent variable | | R&D | PGY | |
|---|---|---|---|---|
| Regression | | TOBIT PANEL | POISSON PANEL | |
| | | H1a | H1b | H2 |
| CONT | Coeff. | **-0.067**** | 0.898 | **2.509***** |
| | t-value | **-2.58** | 1.23 | **2.67** |
| SEPDIFF | Coeff. | | | **-4.419***** |
| | t-value | | | **-2.72** |
| SIZE | Coeff. | **-0.020***** | -0.02 | 0.09 |
| | t-value | **-7.77** | -0.20 | 0.95 |
| IND | Coeff. | **0.42***** | 2.23 | **3.51*** |
| | t-value | **6.54** | 1.16 | **1.74** |
| AGE | Coeff. | 0.00 | **0.03***** | **0.02**** |
| | t-value | 1.16 | **2.99** | **2.26** |
| FOUNDER | Coeff. | -0.00 | 0.12 | 0.08 |
| | t-value | -0.08 | 0.27 | 0.18 |
| %II | Coeff. | -0.07 | -0.52 | -1.80 |
| | t-value | -1.41 | -0.39 | -1.27 |
| DEBT | Coeff. | **0.10***** | **4.61***** | **4.62**** |
| | t-value | **3.59** | **5.77** | **5.78** |
| CONST. | Coeff. | **0.316***** | -1.443 | **-2.523**** |
| | t-value | **8.45** | -1.55 | **-2.46** |
| N | | **879** | | **742** |
| Log likelihood | | **622.51***** | | **-723.63***** |

In table 4, R&D is a proxy for R&D intensity, estimated by the R&D/Assets ratio. PGY is a proxy for a R&D outcome, estimated by the number of yearly granted patents. See Appendix 3 for the detailed lists of independent and control variables. The symbols *, **, *** indicate statistical significance levels at 10 %, 5 % and 1 % respectively.

## Table 5
## Sensitivity analysis

| | | ALL FIRMS | | CONVENTIONAL (NON-CMS) FIRMS | | CMS FIRMS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dependent Variable | | R&D | PGY | R&D | PGY | R&D | PGY | R&D | PGY | R&D | PGY |
| Regression | | Tobit | Poisson | Tobit | Poisson | Tobit | Poisson | Tobit | Poisson | Tobit | Poisson |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| CONT | Coeff. | **-0.136**$^{***}$ | **3.745**$^{***}$ | **-0.105**$^{**}$ | **2.871**$^{**}$ | 0.004 | **-2.215*** | **-0.031**$^{***}$ | -0,476 | **-0.018**$^{***}$ | -0.943 |
| | t-value | **-3.08** | **2.78** | **-2.84** | **2.62** | 1.01 | **-1.88** | **-7,42** | -0,32 | **-3.95** | -0.63 |
| CONT50+ | Coeff. | **0.712**$^{*}$ | **-3.325**$^{**}$ | | | | | | | | |
| | t-value | **1.89** | **-2.49** | | | | | | | | |
| SEPDIFF | Coeff. | | | | | | | **0,050**$^{***}$ | **-4,811**$^{*}$ | **0.038**$^{***}$ | -2.881 |
| | t-value | | | | | | | **8,26** | **-1,80** | **6.67** | -1.22 |
| CFR10 SEPDIFF | Coeff. | | | | | | | **-0,029**$^{***}$ | 2,210 | | |
| | t-value | | | | | | | **6,94** | 1,34 | | |
| PYRSEPDIFF | Coeff. | | | | | | | | | **0.011**$^{**}$ | 1.058 |
| | t-value | | | | | | | | | **2.50** | 0.60 |
| SIZE | Coeff. | **-0.024**$^{***}$ | 0.002 | **-0.03**$^{***}$ | **0.26**$^{*}$ | **-0.00**$^{***}$ | -0.05 | **-0.005**$^{***}$ | 0,139 | **-0.005**$^{***}$ | 0.083 |
| | t-value | **-7.93** | 0.03 | **-7.45** | **1.89** | **-16.86** | -0.29 | **-9.77** | 0,66 | **8.90** | 0.36 |
| IND | Coeff. | **0.410**$^{***}$ | 2.893 | **0.46** | **4.19**$^{*}$ | **0.11**$^{***}$ | -6.34 | **0.079**$^{***}$ | -1,710 | **0.072**$^{***}$ | -3.301 |
| | t-value | **6.60** | 1.51 | **6.33** | **1.82** | **9.90** | -1.33 | **5,41** | -0,35 | **5.49** | -0.65 |
| AGE | Coeff. | 0.000 | **0.034**$^{***}$ | 0.00 | 0.01 | -0.00 | **0.04***** | **0.000**$^{**}$ | **0,033**$^{**}$ | **0.000**$^{***}$ | **0.0338**$^{**}$ |
| | t-value | 1.22 | **3.21** | 1.49 | 0.89 | -1.30 | **2.78** | **2.49** | **2,30** | **6.00** | **2.16** |
| FOUNDER | Coeff. | 0.001 | 0.134 | -0.00 | 0.13 | -0.00 | **2.07**** | **0.010**$^{***}$ | **1,847*** | **0.011**$^{***}$ | **1.861**$^{*}$ |
| | t-value | 0.02 | 0.30 | -0.20 | 0.26 | -0.08 | **2.02** | **4,83** | **1,93** | **4.80** | **1.84** |
| %II | Coeff. | -0.038 | -1.694 | -0.06 | -2.28 | -0.01 | 4.31 | 0.008 | 2,57 | -0.005 | 2.875 |
| | t-value | -0.76 | -1.21 | -1.17 | -1.42 | -0.75 | 0.75 | 0,65 | 0,48 | 0.37 | 0.51 |
| DEBT | Coeff. | **0.092**$^{***}$ | **4.656**$^{***}$ | **0.12**$^{***}$ | **3.72**$^{***}$ | **-0.01**$^{***}$ | **-4.21**** | **-0.016**$^{***}$ | **-3,533**$^{*}$ | **-0.006** | **-3.692**$^{*}$ |
| | t-value | **3.50** | **5.80** | **3.94** | **3.76** | **-3.72** | **-2.15** | **-4.23** | **-1,82** | **-1.57** | **-1.90** |
| CONST. | Coeff. | **0.323**$^{***}$ | **-1.980**$^{**}$ | **0.353**$^{***}$ | **-3.970**$^{**}$ | 0.056 | -0.696 | **0.066**$^{***}$ | **-2,863** | **0.056**$^{***}$ | **-2.223** |
| | t-value | **8.73** | **-2.07** | **8.25** | **-2.98** | **.** | -0.27 | **10,04** | **-1,04** | **6.81** | **-0.76** |
| N | | **879** | **742** | **713** | **596** | **166** | **146** | **166** | **146** | **166** | **146** |
| Log likelihood | | **624.30**$^{***}$ | **-724.66**$^{***}$ | **445.78**$^{***}$ | **-532.10**$^{***}$ | 515.73 | **-141.84** | **522.91**$^{***}$ | **-140.46**$^{***}$ | **518.46** | **-141.11** |

In table 5, R&D is a proxy for R&D intensity, estimated by the ratio R&D/Assets. PGY is a proxy for a R&D outcome, estimated by the number of yearly granted patents. Regressions 1 and 2 are performed on all firms in our sample. See Appendix 3 for the detailed lists of independent and control variables. Regressions 3 and 4 are performed on a subsample of conventional non CMS firms and regressions 4 to 10 are performed on a subsample of CMS firms. The symbols *, **, *** indicate statistical significance levels at 10 %, 5 % and 1 % respectively.