AN ANALYSIS OF THE DETERMINANTS OF RESEARCH & DEVELOPMENT VOLUNTARY DISCLOSURE BY CANADIAN FIRMS

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ABSTRACT

This paper analyses the determinants of voluntary disclosure on research and development (R&D) activities by listed Canadian firms. Using content analysis, we examine the extent of R&D voluntary disclosure by examining the annual reports from 150 companies listed on the Toronto Stock Exchange (TSX). By using a large set of factors that are expected to impact on voluntary disclosure, this study investigates the extent to which firm characteristics (size, leverage, listing status), R&D related variables (R&D intensity, R&D partnership agreement, R&D accounting policy) and corporate governance attributes (board independence and the separation of the CEO and Board Chair roles) influence voluntary disclosure on R&D activities. After controlling for industry membership, our results, obtained from a negative binomial regression, show that firm size, R&D intensity, R&D partnership agreement and the separation of the CEO and Board Chair functions have a significant positive impact on the extent of voluntary disclosure on R&D activities. However, the findings reveal that leverage, listing status, R&D accounting policy and board independence are not significant in explaining the level of R&D voluntary disclosure.

INTRODUCTION

Research and development (R&D) activities have become an increasingly fundamental factor for any business strategy and a significant share of an enterprise's expenditures and worth (Khadaroo and Shaikh, 2003). Many countries plan to increase their investment in R&D, as they believe that R&D is the key component to sustain long-term growth in major sectors of the economy. Concurring with this trend, the Canadian government, in launching its Innovation Strategy in 2002, has set a national goal of advancing Canada from fifteenth to fifth position in the OECD R&D ranking by 2010 (Barber and Crelinsten, 2004). Although investment in research and development often leads to new and improved products that may benefit the firm for several years (Gelb, 2002), current Canadian generally accepted accounting principles (GAAP) require all operating expenditures on research to be immediately expensed while development activities can only be capitalised under restrictive conditions. Consequently, conventional accounting reports become a relatively ineffective way of communicating to users the potential economic benefits resulting from the firm's R&D investments. Healy and Palepu (1993) suggest that firms which fail to communicate their economic conditions and future prospects effectively face an increased cost of capital. This cost is partly caused by the existence of an information asymmetry between the firm and outside parties. By disclosing information over and above the mandatory requirements, firms – especially those engaged in R&D investments – tend to reduce the information asymmetry, thereby increasing the owners' knowledge of the strategically important aspects related to these projects. Several studies demonstrate that intangibles-intensive firms tend to make more voluntary supplemental disclosures because mandated accounting procedures do not communicate their performance appropriately (Tasker, 1998; Gelb, 2002). Supporting this idea, Amir and Lev (1996) argue that because of the inadequacies inherent in traditional accounting reports firms with significant intangible assets often utilise non-accounting information to supplement their accounting disclosures. In the same vein, Nixon's (1997) survey of managers confirms both that disclosure about R&D is seen as more important than its accounting treatment, and that financial statements are not seen as the primary channel for communicating R&D information. It appears, from the findings of prior studies, that voluntary disclosure is often used by intangibles-intensive firms, presumably due to the inadequacy of the way conventional financial statements reflect these assets (Citron, Holden, Selim and Oehlcke, 2005). However, disclosure is not without cost. The most important disincentive to providing voluntary disclosure is proprietary costs. According to Gray, Kouhy and Lavers (1995) proprietary costs arise when a company discloses relevant information that increases competition or government regulations for its activities. Indeed, companies engaged in R&D investments may face a competitive risk in publishing their strategies and research findings, especially if these voluntary disclosures are done through annual reports, which remain public information and are easily accessible to competitors. This implies that R&D voluntary disclosure will only prevail if the benefits from such disclosures outweigh the costs involved. Consequently, firms will not have identical levels of R&D voluntary disclosure. Many factors need to be examined in order to thoroughly understand disclosure choices.

Many studies investigating disclosure choices have considered a set of factors that influence the amount of disclosure. However, very few studies have been concerned with the nature and extent of corporate voluntary disclosure with respect to R&D activities. Accordingly, this study seeks to extend the financial reporting disclosure literature by investigating a specific aspect of voluntary disclosure, namely R&D disclosures, and by considering a broader set of factors that represent determinants of disclosure. The importance of investigating this issue arises from the increasing focus on improving voluntary disclosure on intangibles, especially after the recommendation of the Financial Accounting Standards Board (FASB), stating that 'additional data about those assets would be beneficial because of the importance of intangibles to a company's value' (FASB, 2001). Similarly, the report of the Securities and Exchange Commission (SEC) concludes that 'improved supplemental disclosures of intangible assets and operating performance measures would provide significant benefits to investors valuing dynamic, high-growth companies' (SEC, 2001). By drawing on agency and signalling theory, eight hypotheses are proposed and then tested using multivariate analysis. The data used in this study covers all TSX-listed firms that reported R&D in their latest available annual reports at the time of the study (150 firms). The empirical procedure used involves cross-sectional analysis based on a negative binomial regression. Results reveal that firm size, R&D intensity, R&D partnership agreements and the separation of the CEO and the Board Chair functions have a significant positive impact on the voluntary R&D disclosure level.

The evidence in this study increases our understanding of disclosure practices on R&D activities. This evidence is of particular importance for accounting standards setters to understand what factors can explain R&D voluntary disclosure so as to incorporate them in future recommendations and to develop relevant accounting standards.

The rest of the paper is organised as follows: section 2 provides a theoretical background on voluntary disclosure; section 3 presents previous literature related to the determinants of voluntary disclosure and lays out the hypotheses; section 4 discusses our research design; section 5 presents the empirical findings; and section 6 concludes the paper.

THEORETICAL BACKGROUND

Most of the prior studies dealing with voluntary disclosure rely on a framework of agency and signalling theories to measure disclosure levels and to develop hypotheses regarding their determinants (Botosan, 1997; Hassan, Giorgioni and *Romilly, 2006*).

Agency Theory and R&D Voluntary Disclosure

Agency theory has been regarded as an important construct for understanding and analysing financial reporting incentives. According to this theory, the firm is based on a relationship between manager (agent) and owner (principal), where the agent

is hired to manage the company on behalf of the principal. The separation of ownership and control gives rise to information asymmetries between managers and principals where managers have better information on the firm's current and future performance than do principals. Agency theory proposes that, in the presence of information asymmetries, managers will choose a set of decisions to maximize their own usefulness. These decisions, in general, differ from the set of decisions required to maximize shareholder wealth. Knowing that shareholders will seek to control their behaviour through monitoring activities, managers may have incentives to convince shareholders they are acting optimally, and voluntary disclosure may be a means of achieving this (Watson, Shrives and Marston, 2002). Several empirical studies examine how agency problems can be mitigated through increased disclosure. Healy and Palepu (2001) discuss the role of disclosures in reducing agency costs by providing shareholders with an effective monitoring tool. Specifically, better disclosure improves shareholders' ability to relate managerial decisions to firm performance (Hope and Thomas, 2007). Similarly, Ball (2006) argues that increased transparency and disclosure will contribute to a better convergence of the interests of managers with those of shareholders. In this sense, agency theory conceives voluntary disclosure as a mechanism to control the managers' performance and to reduce information asymmetry and agency costs of monitoring. Simultaneously, this theory predicts that agency costs will vary with different corporate characteristics. Indeed, it is contended that for firms engaged in risky innovation projects monitoring of the actions of the agent by the principal is more difficult, because there are few informative signals until the outcome of the innovation is known (Holthausen, Larcker and Sloan, 1995). Given this situation, managers may have incentives to provide voluntary information about the firm's R&D activities to bear the agency costs. Berrone, Surroca and Josep (2005) advance three reasons that may explain why agency costs are more important in firms involved in R&D projects. Firstly, R&D projects are inherently risky, as they provide greater variability in outcomes and greater probability of failure. Secondly, R&D activities require long-term investments that may affect the stream of cash flows and therefore may have a negative impact on short-term performances. Thirdly, R&D activities generally require managers with high entrepreneurial skills to be able to take risk and make strategic choices. Together, all these arguments can lead to more managerial opportunistic behaviours and increased agency costs. In this sense, R&D voluntary disclosure practices may theoretically be justified by agency theory.

Signalling Theory and R&D Voluntary Disclosure

Signalling theory was developed by Spence (1973) to explain behaviour in the labour markets. In circumstances of information asymmetry, this theory suggests that companies with superior performance use financial information to send signals to the market. A substantial body of theoretical research which examines the use of voluntary disclosure as a signalling device for a firm exists. In fact, managers can be motivated to disclose private information voluntarily because they

expect this to provide a good signal about their company's performance to the market, thus reducing information asymmetry. In an R&D context, signalling theory may explain management incentives to provide voluntary disclosure. As Cazavan-Jeny and JeanJean (2003) state, the way of reporting R&D costs seems obviously not to be neutral; it carries a signal to the investors. In this sense, firms may have an incentive to disclose high levels of R&D to signal favourable future prospects to the market. Furthermore, managers who have private information about the future economic benefits from R&D spending may use voluntary disclosure as a device to signal those prospects to market participants and thus to reduce the information asymmetry with regards to the success of R&D projects. The accounting of R&D spending may also act as a signal to investors. Under Canadian GAAP, managers can signal to market participants the expected return of their R&D outlays by capitalising such costs. In this case, capitalisation of R&D can be viewed as relevant information for investors of the firm's value creation capacity.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

We draw on previous studies to investigate factors that may influence voluntary disclosure practices. These factors include firm related variables, R&D related variables and governance related variables.

Firm Related Variables

Firm Size

Firm size is considered to be an important determinant of corporate disclosure. Results from prior studies frequently confirm a positive link between firm size and disclosure level (Meek, Roberts and Gray, 1995; Zarzeski, 1996; Ahmed and Courtis, 1999). There are several arguments that may explain this positive link. Firstly, because of their more developed internal reporting system, large companies may have the resources to produce more information, and the cost of producing such information is also lower for these firms. Secondly, large firms have more incentives to disclose information voluntarily, because they face higher political costs and pressures (Buzby, 1975; Watts and Zimmerman, 1978). Thirdly, smaller firms are more likely to hide crucial information because of their competitive disadvantage within their industry (Firth, 1979). From the evidence of prior studies, a positive association between size and voluntary disclosure on R&D activities is expected. This leads to the first hypothesis of this study:

H1: There is a positive association between the extent of voluntary disclosure on R&D activities and firm size.

Leverage

The possible link between leverage and voluntary disclosure could be explained in the light of agency theory. According to this theory, higher leverage suggests higher agency costs due to the potential size of wealth transfers from debt-holders to shareholders. Thus firms with higher leverage have more incentives to disclose information voluntarily, thereby reducing those agency costs. This suggests a positive association between leverage and the extent of voluntary disclosure. In this sense, Hossain, Tan and Adams (1994) argue that, in the case of high leverage, creditors will request more information disclosure to be able to assess and manage their own credit risk. Ahmed and Courtis (1999) conclude, from their meta-analysis, that disclosure increases with leverage. In the context of voluntary disclosure on intangibles, Gandía (2003) has found, as predicted, a positive link between leverage and voluntary disclosure on intangibles. Thus, disclosure choices appear to be a function of capital structure decisions. We can, then, expect a positive link between a firm's disclosure level and its leverage. Accordingly, our second hypothesis is defined as:

H2: There is a positive association between the extent of voluntary disclosure on R&D and leverage.

Listing Status

Agency and signalling theories can support the possible link between listing status and the level of voluntary disclosure. Companies listed on multiple or foreign stock exchanges tend to have greater agency problems. As a consequence, voluntary disclosure can work as a mechanism to reduce the agency costs. Furthermore, a company's disclosure policy is expected to be influenced by the regulations of the exchanges in which it trades. Given that the US GAAP are the strictest in term of accounting and communication on R&D (Lev, 1999), companies that cross-list in a US exchange could expect that compliance with US GAAP and the provision of greater disclosure can be interpreted as good signals by the market. Further, Pinches, Narayanan and Kelm (1996) suggest that information about corporate R&D projects is particularly relevant to American stock market investors at every stage of the whole process, from project initiation to commercialisation. Lang, Lins and Miller (2003) and Lang, Raedy and Yetman (2003) demonstrate that disclosure choices of cross-listing firms in US markets are systematically different from non-listing firms. They provide further evidence on the improvement in a firm's disclosure environment after cross-listing in US markets. All theses arguments lead to the third hypothesis:

H3: Canadian companies listed on both Canadian and US exchanges provide more voluntary disclosure on their R&D activities than Canadian companies listed exclusively in Canada.

R&D related variables

R&D Intensity

Compared to other corporate activities, innovation is highly risky and thus increases the uncertainty in future earnings. The inherent risk makes the disclosure of R&D relatively more useful to investors as they assess the potential payoff of the investment. R&D intensity is also used as a proxy for information asymmetry between managers and investors (Percy, 2000; Aboody and Lev, 2000). Percy (2000) states that high research intensive firms have persistent information asymmetries and significant monitoring costs between managers and investors. The managers of these firms need to provide information about the viability of their R&D projects to reduce the agency costs of information asymmetries and monitoring. Gelb (2002) finds that firms with significant levels of R&D and advertising expenditures are more likely to emphasise voluntary and more flexible disclosures over traditional mandated accounting reports. Gu and Li (2003) analysed a sample of 140 firms that are representative of companies that made substantial investments in technological innovation. Consistent with their predictions, they find that disclosures are greater for firms with higher R&D intensity. This leads to our fourth hypothesis:

H4: There is a positive association between the extent of voluntary disclosure on R&D activities and R&D intensity.

R&D Accounting Policy

In Canada, the accounting rules for R&D are contained in the CICA Handbook Section 3450 (Canadian Institute of Chartered Accountants, 1998), and essentially mirror those of the International Accounting Standard for intangible assets (IAS 38). Research expenditures should be expensed in the period incurred, development expenditures should be deferred if all five capitalisation criteria are met: (1) the product or process is clearly defined and the costs attributable thereto can be identified; (2) the technical feasibility of the product or process has been established; (3) the management of the enterprise has indicated its intention to produce and market or use the product or process; (4) the future market for the product or process is clearly defined, or if it is used internally rather than sold, its usefulness to the enterprise has been established; and (5) adequate resources exist or are expected to be available to complete the project. Given these restricting conditions, the chance to capitalise R&D outlays is greatly reduced in practice. We then expect that a firm, making the choice to defer all or part of its R&D, might give more details about these activities in its annual report. Thus, our fifth hypothesis is defined as:

H5: Firms capitalising their R&D outlays report more voluntary disclosure about their R&D activities than those who expense them.

R&D Partnership Agreement

An R&D partnership arrangement constitutes an agreement between two or more companies that have the goal of taking advantage of their shared expertise and experience, and of providing funding support for R&D projects. When a firm is involved in an R&D cooperation agreement we expect the probability of disclosure to be higher, since cooperation implies an active participation of the partners in the joint R&D projects. As a consequence, these projects become naturally more observable and can constitute a motivation for the company to disclose more information about its R&D activities. Additionally, if a firm does not make the choice of disclosure on these activities, the partner can consider it as a sign that the funds are not properly used, which might decrease the probability of attracting partners in the future. Thus we argue that:

H6: Firms involved in an R&D partnership agreement provide more voluntary disclosure on their R&D activities than do their counterparts leading their R&D projects internally.

Governance Related Variables

Board Independence

Research studies investigating the link between voluntary disclosure and the board of directors focus on the role of outside directors. As suggested by agency theory (Jensen and Meckling, 1976; Fama and Jensen, 1983), the presence of non-executive directors enhances the board's effectiveness. Fama and Jensen (1983) argue that the presence of a majority of independent directors is crucial in ensuring the separation of decision management and decision control, thus making the control of top management more effective. Leftwich, Watts and Zimmerman (1981) suggest that a larger proportion of independent directors on the board increases the board's ability and effectiveness in monitoring managerial opportunism. Therefore, firms whose boards are dominated by outside directors are expected to disclose more voluntary information. This contention is supported by Chen and Jaggi (2000) and Cheng and Courtenay (2006), who confirmed that a significant and positive association exists between the proportion of independent non-executive directors and voluntary disclosure. Overall, it is argued from prior findings that board independence is positively related to the extent of voluntary disclosure. Hence we predict that:

H7: There is a positive association between the proportion of outsiders in the board of directors and the extent of voluntary disclosure on R&D.

The Separation of the Board Chair and the CEO Functions

According to agency theory, the combined functions of the CEO and the chair of the board can significantly impair the board's most important functions of monitoring, disciplining and compensating senior managers. Fama and Jensen (1983) suggested that CEO duality ignores the importance of separating decision control and decision management, and that, when this happens, 'the board is not an effective device for decision control, unless it limits the decision discretion of individual top managers'. Molz (1988) argues that firms that combine the roles of the board chairman and CEO are regarded as managerially dominated. Gul and Leung (2004) argue that concentrated decision-making power, as a result of CEO duality, affects the corporate disclosure policies. Thus, if the board chairman plays both roles, it is predicted that the flow of information will be dominated by the chairman-CEO to his advantage. Therefore, the level of voluntary disclosure is expected to be low (Nasir and Abdullah, 2004). Based on theoretical considerations and on previous empirical studies, we predict that:

H8: There is a positive association between the separation of the CEO and the Board Chair functions and the extent of voluntary disclosure on R&D.

Control Variable

Industry type is included as a control variable. Previous studies have documented an association between industry type and the extent of voluntary disclosure (Cooke, 1991; Watson et al., 2002). According to signalling theory framework, any deviation from the established corporate reporting practices within a particular industry could be perceived by the market as bad news (Giner, 1997). Moreover, prior studies suggest that proprietary costs vary according to industry (Harris, 1998). Different industries have different characteristics relative to market competition, the type of private information and the threat of entry of new firms into the market. These factors provide incentives for companies belonging to the same industry to disclose more (or less) information than firms in other industries (Oliveira, Rodrigues and Craig, 2005). This effect would be captured by integrating industry dummies in our regression analysis.

RESEARCH DESIGN

Objective and Data

The purpose of this study is to explain the level of voluntary disclosure on R&D activities revealed in corporate annual reports. Given this objective, our target

population consists of all Canadian listed companies that reported R&D expenditure and/or made disclosures about R&D expenditures or activities in their latest available financial statements.[1] We used the SEDAR database[2] to locate any discussion of R&D in the 2003 or 2004 financial statements for all Canadian listed companies filed with SEDAR. Financial institutions, banks and government bodies were eliminated from the original search, as different legislation applies to these entities. Only 604 companies mention R&D in their financial statements. In order to avoid biases relative to different quotation systems, we have only retained firms listed on the Toronto Stock Exchange (TSX). Our final sample is composed of 150 firms[3] covering major sectors of the Canadian economy. The sample represents about 25 per cent of the total population. Copies of the corporate annual reports were downloaded from the SEDAR database. Our research covers only one year since firms' disclosure policies appear to remain relatively constant over time (Botosan, 1997, p. 327). We chose the annual report as a voluntary disclosure device because the annual report constitutes the predominant source of voluntary corporate disclosure to investors (Neu, Warsame and Pedwell, 1998; Rockness, 1985), and it is likely to contain well-considered information aimed at influencing investors and regulators (Devinney and Kabanoff, 1999) and is regarded as the most widely disseminated source of information on publicly held companies (Gray, Meek and Roberts 1995). The sample can be broken down as shown in Table 1.

The Dependent Variable: Level of R&D Voluntary Disclosure

A disclosure is considered voluntary when a firm has provided information in excess of that required by Canadian GAAP. The level of R&D voluntary disclosure is measured by the number of sentences on R&D activities provided in the corporate annual report. To determine this level, a content analysis was carried out. Content analysis is a method of codifying the text (or content) of a piece of writing into various groups (or categories) depending upon selected criteria (Weber, 1990). According to Guthrie and Petty (2000), the method involves codifying qualitative and quantitative information into pre-defined categories in order to derive patterns in the presentation and reporting of information. These categories must

TABLE 1: CLASSIFICATION OF FIRMS BY INDUSTRY[4]

Industry	Number of Observations	Percentage
Software	33	22
Hardware	9	6
Technology	41	27.33
Biotechnology	46	30.66
Traditional	21	14
Total	150	100

reflect accurately the items one is seeking to measure. As recently documented, content analysis of annual reports has been held to be empirically valid (Guthrie and Parker, 1990; Hackston and Milne, 1996). All steps used in the calculation of the disclosure levels are presented below.

Categories

Sentences about R&D presented in the texts of annual reports were extracted and coded according to the predefined categories developed by Entwistle (1999). The choice of these categories is mainly justified by their perfect adaptability to the context of our study, which deals specifically with R&D disclosures. Categories developed by Entwistle (1999) were identified on the basis of a questionnaire addressed to 15 financial analysts and 21 directors. They correspond to the most common information disclosed on R&D. Six main categories divided into 19 sub-categories were identified. The detailed items of the R&D disclosure index and examples of information extracted from sampling annual reports are given in Appendix 1.

Disclosure Location

Disclosures about R&D expenditure and activities could appear in any part of the annual report. Annual reports are not all organised similarly, but we can generally distinguish four sections: the corporate overview, the signed letters, the management discussion and analysis, and the financial statements. All these sections were meticulously analysed to identify the relevant information relative to the description of R&D activities. However, given that the study focuses especially on voluntary disclosure, only information beyond that imposed by regulations was recorded for the financial statements and notes to financial statements. Accordingly, a disclosure is treated as voluntary if it is beyond the disclosure requirements required by the section 3450 of the CICA Handbook. This section requires TSX-listed firms that expense their R&D to disclose the R&D amount, and for those that defer development costs, to disclose the amount deferred and the basis of amortization.

Unit of Analysis and Unit of Measure

Holsti (1969) describes the unit of analysis as 'the specific segment of content that is characterised by placing it into a given category'. It appears that the unit of analysis is a problematic issue in content analysis studies. The confusion is about what should form the basis for coding in comparison with what should form the basis for measuring or counting the amount of disclosure. Milne and Adler (1999) state that many studies use different units of analysis and measurement, but without a real distinction. The authors state that the clearest statement of the mixed

usage of a unit of analysis occurs in Zeghal and Ahmed (1990),[5] where, in fact, the authors used the sentence as the unit of coding and the word as the unit of count or measure. For our case, we used the sentence as the unit of analysis, because sentences are far more reliable than any other unit of analysis (Milne and Adler, 1999). Furthermore, they are easily identifiable, which enabled us to easily categorise disclosures into the predefined categories. Other alternatives, such as the word or the paragraph, have been used in the literature. However, individual words have no meaning to provide a sound basis for coding into the predefined categories. In the same way, a single paragraph may be coded into at least two different predefined categories. Concerning the unit of measure, we have also used the sentence, following the recommendation of Milne and Adler (1999), who suggest that if coders are primarily using sentences as the basis for coding they might as well use sentences to count the amount of disclosure, because the extra work to do otherwise is unlikely to yield additional benefits.

Quantification Procedures

Following previous content analysis research literature (e.g. Milne and Adler, 1999; Zeghal and Ahmed, 1990), all R&D content coding was carried out by one of the authors who is the most trained and experienced of the coders. In order to increase reliability, the coding of the first five reports has been done by all three authors and results have been compared.
The following rules governing the application of the content analysis were developed:

1. When some firms present their annual reports in both languages, English and French, only the English version was examined to assure a certain level of comparability.
2. When the same information is published more than once (in the same section of the annual report or in different sections), repetitions were ignored and recorded only once. This is in accordance with the method employed in Bozzolan, Favotto and Ricceri (2003).
3. Where individual sentences are determined to contain more than one main thought, that is the sentence provides information relative to two or more disclosure items, each thought is to be counted as a separate sentence (or separate R&D disclosure).
4. Disclosures by a scientific advisory board are only to be coded where a narrative exists regarding the board members and where such narratives focus upon the members' R&D expertise.

Descriptive statistics for the dependent variable are reported in Tables 2 and 3.

TABLE 2: DESCRIPTIVE STATISTICS FOR THE LEVEL OF R&D VOLUNTARY DISCLOSURE

Dependent variable	No.	Min	Max	Mean	Std Dev.	Total Disclosure	Q3	Q4	Number of firms with no R&D disclosure
Disclosure Level	150	0	69	21.34	16.288	3202	35.18	18.39	2

TABLE 3: NATURE OF R&D VOLUNTARY DISCLOSURES

	Minimum	Maximum	Percentage of Total Disclosure
Input	0	19	10.99
Output	0	56	53.34
Future R&D expenditures	0	8	3.46
R&D financing	0	4	2.31
Accounting or financial disclosure	0	40	28.92
Strategy	0	4	0.98
Total			100

Table 2 shows that, for all 150 firms, the average number of R&D disclosures was about 21. This average ranged from a low of zero to a high of 69. Total disclosure, as measured by the number of sentences, is 3202. Two firms, ComnetiX and Enghouse, had no R&D voluntary disclosures in their annual reports. This is because they belong to the software sector. Quartiles divide the data into four equal segments. The groups formed from the third and the fourth quartile had the highest R&D voluntary disclosure level with 35 and 18 respectively. The highest score of R&D disclosure was recorded by Chemokine Therapeutics, a firm belonging to the biotech industry. A more detailed analysis of the R&D voluntary disclosure content is provided in Table 3.

Table 3 shows that the most disclosed information corresponds to the R&D output, which made up 53.34 per cent of all R&D disclosures. The next most common type of disclosure was accounting or financial disclosure with 28.92 per cent of all disclosure, and ranging from a low score of 0 to a high score of 40 sentences. Of the remaining four main categories, the general pattern of disclosure was for input to be most common followed by future R&D expenditures. The least common disclosures were disclosures about R&D financing and strategy.

Independent Variables

Independent variables are described below and were all extracted from the annual reports.

Numerical Variables

Size: size is measured by the natural logarithm of the book value of total assets.

Leverage: leverage is measured by the ratio of long-term debt to the total of long-term debt plus shareholders' equity.

R&D intensity: is measured by the ratio of annual R&D expenditures to sales.

Board independence: board independence is measured by the ratio of the number of independent directors to the total number of directors. An independent director is a director who is not employed to run the firm's day-to-day business activities.

Qualitative Variables

Listing status: listing status is a dichotomous variable coded 1 if the company is mutually listed on a Canadian and a US exchange and 0 otherwise.

Accounting policy: a firm's accounting policy for development expenses is measured by a dichotomous variable that takes 1 if the firm defers all or part of its development expenses and 0 otherwise.

R&D partnership agreement: R&D partnership is a dichotomous variable coded 1 if the firm uses an R&D partnership agreement for the whole or some part of its R&D projects and 0 otherwise.

The separation of the CEO and Board Chair functions: this is measured by a dummy variable that takes a value of 1 if the functions of the Board Chair and CEO are separated and 0 otherwise.

Control Variables

Industry dummy variables are used in the specification to reflect differences in the level of R&D voluntary disclosure with respect to industry. The traditional sector is taken as a reference. Table 4 provides descriptive statistics for both numerical and qualitative independent variables.

TABLE 4: DESCRIPTIVE STATISTICS FOR INDEPENDENT VARIABLES

Panel A: Descriptive statistics for numerical independent variables

Variables	Minimum	Maximum	Median	Mean	Std Dev.
Size (000,000s)	1.172	16 984	42.83	519.49	1787.8
Leverage	0	0.82	0	0.062	0.122
R&D intensity	0.043%	155.48%	18.19%	30.85%	30.49%
Board composition	0	1	0.77	0.73	0.177

Panel B: Descriptive statistics for qualitative independent variables

Variables	Categories	Percentage
Listing status	– Mutually listed on TSX and US exchange	28
	– Only listed on TSX	72
Accounting policy	– Defers all or part of development expenses	8
	– Expenses all R&D expenditures	92
R&D partnership agreement	– Engagement in R&D partnership agreement	42.66
	– No R&D partnership agreement	57.33
CEO duality	– Separation of the CEO and the Board Chair functions	72.66
	– Duality of CEO and Board Chair functions	27.33

Panel A shows that the size of sampling firms varies from a low of 1.172 million to a high of 17 million for Nortel. Leverage, as measured by the long-term debt to long-term debt plus shareholders' equity, ranges between zero and 0.82, with a mean of 0.062. R&D intensity, as measured by annual R&D expenditures to sales, ranges from a low of 0.043 per cent recorded by Magellan, a company belonging to the traditional sector, to a high of 155.48 per cent recorded by Stressgen, a company from the biotechnology sector. The sample firms invest, on average, 30.85 per cent of their turnover in R&D. Regarding the representation of outside directors on the boards, approximately 73 per cent of board members were independent.

Panel B shows that 28 per cent of sample firms are mutually listed on TSX and a US exchange. Only 8 per cent of the firms defer their development expenses, about 43 per cent of them are engaged in an R&D partnership agreement and, in almost 72 per cent of the companies, the roles of the CEO and the Board Chair are separated.

Choice of Multivariate Analysis

Before deciding on the type of multivariate analysis to run, it is appropriate to determine the nature of our dependent variable. As we have explained, our dependent variable is measured by the number of sentences on R&D activities contained in the annual report. The values of this variable are positive integers that vary between 0 and 69. Thus our dependent variable is defined from a count data.

Inadequacy of Linear Model

Researchers have attempted several statistical approaches when relating count data to explanatory variables. Even though the simple linear regression model has generated many useful findings, studies show that this approach suffers from some undesirable statistical properties. Long and Freese (2003) state that the application of the linear regression model to count outcomes can result in inefficient, inconsistent and biased estimates. In the classical linear model, the dependent variable is expressed as a linear combination of explanatory parameters under the assumption that the dependent variable is normally distributed. Unlike conventional simple linear regression, generalised linear models such as the Poisson model or the negative model are based on alternative distributions. Poisson regression is appropriate for dependent variables that have Poisson distribution and the negative binomial regression assumes a negative binomial distribution for the dependent variable.

Poisson Model vs. Negative Binomial Regression

According to previous research, generalised linear regression is definitely a better approach to treat count data than simple linear regression. For the Poisson regression model, one important basic assumption is that the mean and the variance of the error distribution are equal. If the variance of the dependent variable exceeds the mean, then the data are over-dispersed. When over-dispersion exists in the data and Poisson regression models are used, the variances of the estimated model coefficients tend to be underestimated, which means the significance of the models will be overstated. Miaou (1994) recommended the use of the Poisson regression model, in an initial stage, to establish the relationship between the dependent variable and independent variables. Then, if over-dispersion exists and is found to be moderate or high, both the negative binomial regression models and zero-inflated Poisson regression models can be explored.

To test the over-dispersion of data, the Likelihood-Ratio test provided by STATA was used. The statistic retained to test the over-dispersion is very significant (Chibar2[01] = 808.33, sig = 0.000), suggesting that the negative binomial model is more appropriate to fit the data.

The negative binomial regression equation is formulated as follows:

$$E(DISC) = \exp(\beta_0 + \beta_1 SIZE + \beta_2 LEV + \beta_3 STATU + \beta_4 INTENS + \beta_5 ACPOL + \beta_6 COP + \beta_7 BOIND + \beta_8 SEP + \beta_9 SOFT + \beta_{10} HARD + \beta_{11} TECH + \beta_{12} BIOTECH + \varepsilon_i)$$

where:

E (DISC): expected values of R&D voluntary disclosure levels.

SIZE: size is measured by the logarithm of book value of total assets.

LEV: leverage is measured by the ratio of long-term debt to long-term debt plus shareholders' equity.

STATU: is a dichotomous variable coded 1 if the company is mutually listed on a Canadian and a US exchange and 0 otherwise.

INTENS: R&D intensity is measured by the ratio of annual R&D expenditures to sales.

ACPOL: is a dichotomous variable that takes 1 if the firm defers all or part of its development expenses and 0 otherwise.

COP: is a dichotomous variable coded 1 if the firm is engaged in an R&D partnership agreement for the whole or some part of its R&D projects and 0 otherwise.

BOIND: Board independence is measured by the ratio of the number of independent directors to the total number of directors.

SEP: is a dichotomous variable that takes a value of 1 if there is a separation between the CEO and the Board Chair functions and 0 otherwise.

SOFT: is a dummy variable coded 1 if the firm belongs to the software industry and 0 otherwise.

HARD: is a dummy variable coded 1 if the firm belongs to the hardware industry and 0 otherwise.

TECH: is a dummy variable coded 1 if the firm belongs to the technology industry and 0 otherwise.

BIOTECH: is a dummy variable coded 1 if the firm belongs to the biotech industry and 0 otherwise.

RESULTS

Initially, variables were examined to check whether there is any potential sign of collinearity. Table 5 reports the correlations among the independent and control variables. While the results confirm some statistically significant correlations among the variables, the magnitude of these correlation coefficients do not indicate a serious collinearity problem. Our conviction is reinforced by the Variance

TABLE 5: CORRELATION MATRIX FOR THE INDEPENDENT AND CONTROL VARIABLES*

Variables	SIZE	LEV	STATU	INTENS	ACPOL	COP	BOIND	SEP	SOFT	HARD	TECH	BIO TECH
SIZE	1											
LEV	*0.374*	1										
STATU	**0.57**	0.13	1									
INTENS	***–0.33***	***–0.33***	*–0.1*	*1*								
ACPOL	–0.028	0.1	–0.18	–0.16	1							
COP	–0.063	–0.06	0.06	**0.37**	–0.1	1						
BOIND	0.046	–0.09	0.089	0.145	–0.01	0.213	1					
SEP	–0.028	–0.137	0.1	–0.05	0.088	–0.065	–0.14	1				
SOFT	**–0.287**	–0.087	–0.009	–0.09	–0.038	–0.198	–0.1	0.15	1			
HARD	*0.118*	*–0.038*	*0.03*	*–0.13*	–0.075	0.009	–0.07	–0.09	–0.13	1		
TECH	0.044	0.008	–0.016	–0.06	0.04	0.046	–0.11	–0.11	**–0.32**	–0.15	1	
BIOTECH	–0.160	–0.126	–0.028	**0.472**	–0.090	**0.332**	**0.286**	0.025	**–0.35**	–0.16	**–0.4**	1

* Coefficients significantly different from zero at p-values less than 5 per cent are in boldface type.

Inflation Factors that are lower than 5 (results are not reported here) indicating no multicollinearity between the variables.

Before performing the negative binomial regression an adequacy test was run to check for the negative binomial distribution of the independent variable. The results are shown in Table 6.

Results from the adequacy test allow us to conclude that the negative binomial distribution is a good adjustment for the values of our dependent variable.

Table 7 presents the results issued from the negative binomial regression.

TABLE 6: ADEQUACY TEST FOR THE NEGATIVE BINOMIAL REGRESSION

	Observed	Expected
Mean	21.437	21.347
Variance	302.616	265.302

Chi^2 = 15.266, Significance = 0.436

TABLE 7: RESULTS OF THE NEGATIVE BINOMIAL REGRESSION OF THE EFFECT OF FIRM CHARACTERISTICS ON R&D VOLUNTARY

Disclosure Negative Binomial Model

$$E(DISC) = \exp(\beta_0 + \beta_1 SIZE + \beta_2 LEV + \beta_3 STATU + \beta_4 INTENS + \beta_5 ACPOL + \beta_6 COP + \beta_7 BOIND + \beta_8 SEP + \beta_9 SOFT + \beta_{10} HARD + \beta_{11} TECH + \beta_{12} BIOTECH + \varepsilon_i)$$

	β	z	Sig
Constant	0.245	0.29	0.768
Size	0.22	2.25	0.024**
Lev	–0.195	–0.44	0.660
Statu	0.12	0.9	0.758
Intens	0.0077	3.84	0.000***
Acpol	–0.06	–0.31	0.894
Cop	0.33	3.07	0.002***
Boind	0.47	1.44	0.150
Sep	0.23	1.98	0.048**
Soft	–0.177	–0.69	0.492
Hard	–0.105	–0.36	0.718
Tech	–0.012	–0.05	0.957
Biotech	0.519	2.07	0.038**
Chi^2		91.95	
Significance		0.0000	
Pseudo R^2 Cragg & Uhler		0.544	

***Significant at the 1% level.

**Significant at the 5% level.

Goodness of Fit

In traditional least square regression, the coefficient of determination, R^2, is frequently used to assess the goodness-of-fit of a model. It represents the proportion of variation in the data that is explained by the model. There is no commonly acceptable measure that can give an absolute assessment of goodness-of-fit for generalised linear models. Therefore, several measures are proposed that give a relatively accurate evaluation of the model. One of the measures is the pseudo R^2 of Cragg & Uhler; it equals 0.544 in our case, which indicates a good explanatory power. The chi-squared test of the model verifies if the coefficients for all the explanatory variables except the constant term are zero. The obtained results ($Chi^2 = 91.95$, $p < 0.01$) indicate that the estimators can adequately explain the voluntary disclosure on R&D activities at the 1 per cent level of significance.

Interpretation

Results issued from the negative binomial regression indicate that for firm related variables only size is statistically significant (at the 5 per cent level), suggesting that larger firms provide more voluntary disclosures on their R&D activities than do small firms. Contrary to expectation, cross-listing in a US exchange does not affect the total amount of disclosure on R&D activities. Our result is inconsistent with the findings of Ding and Stolowy (2003), who conducted their analysis in a French context and concluded that an American or British stock market listing positively impacts the level of voluntary disclosure. Our result is also inconsistent with Khanna, Palepu and Srinivasan (2004), who analysed the disclosure practices of a group of 794 firms from 24 countries in the Asia-Pacific region and Europe. Their results show a positive association between disclosure scores and a variety of market interaction measures, including US listing. One possible explanation for this inconsistency may be attributable to the Canadian context in which we operate. Indeed, under the Multi-Jurisdictional Disclosure System (MJDS) agreement implemented in July 1991 between Canadian and US market regulations, Canadian firms can cross-list on a US exchange without conforming to US GAAP and with only minimal reporting to the SEC. Thus, because of the bilateral MJDS agreement, disclosure and reporting requirements for Canadian firms are lax compared to non-Canadian firms. This may reduce the transparency of cross-listed Canadian firms relative to other cross-listed firms (Ammer, Holland, Smith and Warnock, 2004). The results also show that the coefficient on leverage is not significant and is opposite to the expected sign. Our results are similar to those found by Meek et al. (1995). The authors have predicted that highly leveraged firms disclose more information in order to reduce the agency costs of debt. However, their findings suggest that disclosure decreases with leverage. Zarzeski (1996) predicts that disclosure decreases with leverage because creditors may be able to obtain private information. She also finds that disclosure decreases with leverage. The negative

relation between leverage and voluntary disclosure can also be explained in the light of the free cash flow theory developed by Jensen (1986). The author notes that using leverage reduces the availability of free cash flows for spending on projects that are not immediately income producing, and so, in such firms, the need to provide voluntary disclosure is less pressing.

Regarding R&D variables, the results confirm that R&D intensity and R&D partnership agreement are statistically significant at the 1 per cent level while R&D accounting treatment seems to have no effect on the extent of voluntary disclosure on R&D activities and is opposite to the expected sign. This result can be explained by signalling theory, that is, companies which capitalise their R&D can see this fact as a signal to the market since only successful projects can be recognised as assets. In this sense, Hughes and Kao (1991) and Cazavan-Jeny and JeanJean (2003) have demonstrated that the recognition in the balance sheet of R&D is perceived as a positive signal by the market. On the contrary, recognition of R&D as expenses may signal non-profitable or non-achieved R&D projects. In this case, firms may have incentives to voluntarily disclose information to avoid a bad evaluation from market participants for their R&D projects.

With regard to corporate governance variables, the separation of the CEO and the Board Chair functions positively impacts the total amount of information disclosed on R&D activities, as expected. In spite of expectations, the results show that the proportion of independent directors has no effect on R&D voluntary disclosure, suggesting that a higher proportion of independent directors on the board is not associated with higher levels of voluntary disclosure on R&D activities. This result is inconsistent with the findings of Barako (2007) and Nasir and Abdullah (2004). However, our results are similar to those found by Hossain and Reaz (2007) and Lopes and Rodrigues (2006). One possible explanation for our findings is that there may be some drawbacks to having a high proportion of independent directors (Haniffa and Cooke, 2002). For example, non-executive directors may lack the business knowledge needed to be effective (Patton and Baker, 1987) and may also lack true independence (Demb and Neubauer, 1992). Finally, the results suggest that the firms operating in the biotechnological sector have a higher R&D voluntary disclosure level relative to the other sectors. This result is consistent with prior studies (FASB, 2001). Gu and Li (2003) also support this result. The authors argue that the long product development cycle in the biotech and the drug industries tends to postpone revenues for many firms and increase the need for external financing; hence the benefits of disclosure. Moreover, proprietary information costs may be lower, since clear delineation of property rights of biotech and drug companies is expected to decrease opportunities for competitors to benefit from disclosure.

CONCLUSION

This paper has investigated the determinants of the extent of voluntary disclosure on R&D activities in the annual reports of Canadian listed companies. This

study used an innovative statistical approach to analyse the firms' disclosure levels, and so enriches the existing literature, especially as regards voluntary disclosure issues. On the basis of agency and signalling theories, as well as prior literature on voluntary disclosure, we simultaneously tested a large set of factors that represent determinants of voluntary disclosure. By investigating the annual reports of 150 Canadian companies listed on the TSX, we found that voluntary disclosure on R&D activities is positively associated with firm size and R&D intensity. Moreover, firms involved in an R&D partnership agreement provide more voluntary disclosure on their R&D activities than do their counterparts. With regard to corporate governance-related variables, the separation of the functions of CEO and chairman of the board positively impacts the total amount of information disclosed on R&D activities. The results also suggest that the firms operating in the biotechnological sector have a higher R&D voluntary disclosure level relative to the other sectors. However, other hypotheses related to leverage, R&D accounting policy and board independence were rejected. The findings from this research suggest that, while most companies disclose information about their R&D activities, the practices of these disclosures vary widely with different companies disclosing different levels of R&D information. It seems that users would benefit from an increased comparability between the disclosure practices of different companies. A relevant accounting standard on R&D accounting and disclosure requirements would help in this regard, and this study, perhaps, can help accounting standards setters to achieve this.

NOTES

1 The most recent sources of data at the time of the study correspond to the 2003 or 2004 financial statements available at the SEDAR database.

2 SEDAR is the System for Electronic Document Analysis and Retrieval. Since 1 January 1997 this electronic filing system has been used for the disclosure of documents of public companies and mutual funds across Canada. All Canadian public companies and mutual funds are required to file their documents through SEDAR.

3 The 150 sampling firms are composed of all TSX-listed firms at February 2005 that reported R&D information in their financial statements. They include 82 firms with years ending in 2004 and 68 with years ending in 2003.

4 The industry classification we have retained is that provided by SEDAR database.

5 Cited in Milne and Adler (1999).

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APPENDIX 1: ITEMS OF ENTWISTLE'S (1999) R&D DISCLOSURE INDEX AND EXAMPLES

Description of information item	Example of firm disclosure
1. Input:	
– Description of the product object of the R&D activities.	– The focus of our research efforts is to develop key enabling technologies in power conversion (TIR Systems Ltd, 2004, page 24).
– People involved in the management of the R&D.	– We have an R&D team of over 200 qualified staff that complements a strong distribution network throughout North America and Western Europe (Aastra Technologies Limited, 2003, p. 17).
– Physical infrastructure relative to the R&D.	– During fiscal year 2004, DiagnoCure also acquired tangible capital assets in order to improve the equipment used for the R&D and production activities (DiagnoCure, 2004, p. 23).
2. Output:	
– Product development achievement.	– In Fiscal 2004, we commenced Phase I clinical trials of our new HIV entry inhibitor, AMD070 (Anormed, 2004, p. 3).
– Actual achievements beyond product development (customers, revenues, market penetration, etc.).	– The introduction of the GoXML products has enabled recent initiatives in other verticals, the healthcare sector in particular, which appear to be very promising (Xenos, 2004, p. 20).
– Potential achievements from product developments.	– During 2004, we developed a number of new products which will be progressively introduced to markets we serve during 2005 (GSI Lumonics, 2004, p. 6).
– Timing issues (New product launch, etc.)	– The Company's G1 series HEV and EV product is expected to be commercially available in 2005 (Azure Dynamics 2004, p. 7).
3. Future R&D expenditures	
– Dollar amount of future R&D spending.	– In 2004, reflecting our core philosophy and long-term goal of creating high value, we will invest over $30 million in R&D (Aeterna Zentaris, 2003, p. 5).
– Focus of future R&D spending.	– The Company will focus its product development investment in 2005 to further develop, enhance and validate Assurancy SecureData and complete security certifications (Kasten Chase, 2004, p. 9).

(Continued)

APPENDIX 1: *(CONTINUED)*

Description of information item	Example of firm disclosure
4. R&D financing	
– R&D financing sources of previous and current year.	– Since our inception we have made significant investments in R&D. These investments have been funded in part by business partners in connection with specific product development initiatives undertaken by us at their request. We have also received funding from the Canadian government through investment tax credits and from the Israeli government through royalty-free grants (Creo, 2003, p. 23).
– Future R&D financing sources.	– We plan to continue to fund our research and product development efforts in fiscal 2005 at current levels, as well as to pursue additional opportunities for government and non-government assistance in funding our program (Stuart Energy, 2004, p. 22).
5. Accounting or financial disclosure	
– Comparison of R&D expenditures to those of prior year.	– Research and product development expenses for the year ended December 31, 2003 were $103.9 million, a decrease of $10.2 million or 9% as compared to 2002 (Ballard Power Systems Inc., 2003, p. 17).
– Comparison of R&D efforts to competition, industry or other companies.	– Nova Chemicals is one of only a few companies in our industry that has increased its research and development investments in the last three years (Nova Chemicals, 2003, p. 5).
– Comparison of R&D expenditures to budgets or to expectations.	– For the fiscal year ended December 31, 2003, the Company pursued its research and development efforts as per budget (TSO3, 2003, p. 15).
– R&D ratios like R&D spending as a proportion of other financial measures.	– R&D expense, as a percentage of revenue, was 73% for the year ended December 31, 2003 (724 Solutions, 2003, p. 6).
– R&D spending used to explain changes in other financial items.	– This reduction in capital expenditures was primarily a result of reduced research and development activities during 2004 (Questair, 2004, p. 13).
– Reasons explaining the change in R&D spending from prior years.	– R&D expenses declined 30% to $6.2 million as a result of the restructuring in the Systems Division in fiscal 2003 and lower patent and reverse engineering costs in the IP Division (Mosaid, 2004, p. 23).

(Continued)

APPENDIX I: (CONTINUED)

Description of information item	Example of firm disclosure
– R&D accounting policy discussion outside the financial statements.	– All R&D costs, which do not meet generally accepted criteria for deferral, are expensed as incurred. Development costs, which meet generally accepted criteria for deferral, are capitalized and amortized against earnings over the estimated period of benefit. To date, no costs have been deferred (Aeterna Zentaris, 2003, p. 18).
6. Strategy	
This category captures information about the place of R&D activities in the global strategy of the firm.	– Investment in R&D is a key part of our strategy to maintain product and technology leadership. R&D is essential to our continued achievement of our strategic objectives of product and technology leadership (ATI Technologies Inc., 2004, p.16).

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