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# Litigation Risk in Directors' and Officers' Liability Insurance

*The Impact of Company-Related Risk Factors on the Insurance Premium*

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Master's thesis in Financial Economics

NORWEGIAN SCHOOL OF ECONOMICS

# Abstract

A directors' and officers' (D&O) liability insurance policy prices the risk of litigation. The objective of this thesis is to investigate whether company-specific risk factors are incorporated in the pricing, and in such case what effect these risk factors have on the premium.

For a sample of Canadian companies listed on the S&P/TSX Composite Index, we collect information on insurance coverage and premiums for a time period ranging from 2010 to 2020. Insurance data are matched with measures of risk estimated from both market and book values, along with information regarding the governance structure of companies. Before assessing how risk factors affect the premium, this study examines how the choice of coverage limit is affected. The empirical analysis further show that several of our hypothesized risk factors do affect the D&O premium, either directly or through the choice of coverage limit. As such, we find that coverage will be more costly for companies with higher litigation risk, proxied by company size, profitability, leverage, volatility, and others.

By implementing the Merton Model, we estimate the value and volatility of company assets. Analysing the premium based on these variables yield similar results to the estimation based on the directly observable variables of stock volatility and market capitalization. A common feature for both approaches is that the volatility measures are found to be important determinants of the premium. Additionally, the majority of the other risk measures are found to display similar impacts on the premium no matter the measures utilized for size and volatility.

Altogether, the results obtained in this thesis indicate that insurers address and incorporate various company-related risk factors.

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# 1. Introduction

"…We do not provide them directors and officers liability insurance, a given at almost every other large public company. If they mess up with your money, they will lose their money as well." – Warren Buffet, Chairman of the Board of Berkshire Hathaway, 2011.

Board members have a personal responsibility; if someone suffers a financial loss as a result of the board's decisions and decides to sue, the board members may risk losing everything they own. Shareholders investing in a company expect directors and officers to behave in accordance with their best interest. If shareholders suffer at the hands of a corporation in which they have invested they can sue – either as a class or on behalf of the company itself – to right these wrongs (Baker & Griffith, 2010). Since directors and officers may be held liable to their investors for the harm they cause, they will refrain from engaging in conduct that will be non-beneficial for investors and such induce them to sue. Thus, shareholder litigation can regulate corporate conduct. However, directors and officers are typically covered under a form of insurance, known as "Directors' and Officers' Liability Insurance", hereinafter referred to as D&O insurance, that insulates them from personal responsibility in the event of shareholder litigation. The insurance also protects the corporation itself from liabilities it may have in regard to shareholder litigation.

D&O insurance is a corporate-owned insurance that covers directors and officers and works as a source of reducing the risk associated with potential lawsuits. In the case where a director or officer must settle or defend a lawsuit related to their service as a board member, the D&O policy will reimburse the associated expenses, provided that he or she had acted honestly and in good faith (Core, 1997). As such, D&O insurance has become a regular part of companies' risk management. The structure of a D&O insurance policy often consists of three insurance agreements, known as Side-A, Side-B, and Side-C coverage. All three forms of coverage often share a single limit but apply for different cases. The insurance plays a role in risk management, and people are simply unwilling to serve on public company boards without D&O insurance (Baker & Griffith, 2010).

D&O insurance was first introduced in Germany in 1895, but the Imperial Insurance Office quickly banned it because they considered it to be immoral (Egger et al., 2015). Up until the stock market crash in 1929, there was a lack of regulations surrounding the sale of securities and lack of accountability placed on directors and officers. The incident triggered the well-known Great Depression, which resulted in several important acts that increased financial regulation and made companies more responsible towards their shareholders and investors (Sabia & DeMartini, 2016).

The acts did not initially generate a large demand for the D&O insurance, but due to the increase in securities regulation the London insurance market introduced D&O in the late 1930s (Sabia & DeMartini, 2016). Despite the early introduction, the interest in D&O insurance did not increase until the late 1960s, and it was not until the 1980s that the D&O market really began to develop. Nowadays, the demand for such insurance is high, due to a high frequency of lawsuits against directors and officers by different stakeholders (Egger et al., 2015). Nonetheless, there are great differences between North America and Europe regarding the culture for lawsuits, and D&O insurance have been widely used in North America for a long time. In Europe, however, the D&O insurance policy has been of less importance up until recent years. In recent times European companies have found that they are now more exposed than ever to regulatory scrutiny and litigation, which consequently have resulted in an increasing demand for D&O coverage (CMS Law-Now, 2007; Bradford & Bradford, 2012).

There are many different reasons for why stakeholders decide to file a lawsuit against directors and officers. Creditors, for example, are likely to sue in the case of a bankruptcy where they have suffered a loss on their loans extended to the company. Shareholders may also make claims following a bankruptcy in which case they lose their entire investment in the company. However, many such claims also rise following a significant drop in the stock price that does not lead to a bankruptcy. Regardless of who decides to sue and why, D&O insurance provides important protection for board members due to their personal responsibility.

Highly volatile shares are more exposed to large price fluctuations, and thus one can expect such companies to have a greater demand for D&O insurance. On the other side, the insurance company will demand a higher price for their product since the risk of future lawsuits are higher. Various factors are affecting a company’s idiosyncratic risk, which in terms will affect the risk of bankruptcy, crisis, and decreased profitability, among other things. The insurance companies will strive to minimize the risk they are taking on. Therefore, these risk factors should be integrated in the insurance contract between the insured and the insurer.

In this study, we aim to investigate how firm-specific factors are calculated in the price paid for the D&O insurance, and whether high-risk companies are paying a higher price. By looking at various risk factors stemming from accounting data, financial data, and other data, we will examine this in our quantitative analysis. More precisely, we seek to answer the following research question:

*How are different company-related risk factors incorporated in the premium of Director's and Officer's Liability insurance?*

To answer the question, we first create a sample of all companies listed on the S&P/TSX Composite Index in Canada as per 26th of February 2021. For all the companies we collect data on their D&O insurance policies along with accounting data, market prices, and governance structure. Canadian companies are used because of the requirement by law to divulge information on their D&O insurance coverage (Boyer & Delvaux-Derome, 2002). Furthermore, we construct a complex data set where we generate measures of risk expected to affect the pricing of insurance. Finally, we conduct our analysis on the D&O insurance premium, examining the impact of these risk measures on the pricing of the insurance policy.

## 1.1 Outline

This thesis consists of eight chapters that are structured as follows; in Chapter 2 the theoretical framework relevant for this study is presented, including both general insurance theory and D&O insurance theory, in addition to a theoretical presentation of the Merton Model. Furthermore, Chapter 3 presents various risk factors which can serve as proxies for litigation risk, and how these may affect the D&O insurance pricing. Chapter 4 explains the data collection process, in addition to a presentation of the variables used in this study. Next, the methodology is presented in Chapter 5, and Chapter 6 will thereafter present the analysis and thereby our findings. Then these findings will be discussed in Chapter 7. Chapter 8 will summarize the most important findings and provide a conclusion.

## 1.2 Existing Research

There has been conducted several studies on directors' and officers' liability insurance internationally, where the majority of previous studies focuses on the U.S and the Canadian market. In this section, we will provide an overview of the research that has proved the most important for our choice of methods and understanding of the dynamics of D&O insurance.

A widely researched field within D&O insurance is the demand for, and the purchasing of, the insurance. Core (1997) examined the determinants of Canadian companies' demand for D&O insurance and found that companies with higher litigation risk are more likely to purchase the insurance and carry higher limits and deductibles. Further, Core also found that companies with greater probability of distress and utilities are more likely to purchase insurance and carry higher limits. Boyer (2007) made a similar study on Canadian companies for the period 1993 to 1999, where he stated that larger companies are more likely to purchase D&O insurance. Additionally, he found that companies are more likely to purchase D&O insurance when the company is financially weak, and when there are few outsiders on the board of directors. In the purchasing decision, he found that board composition and wealth is an important factor, along with the company size. In accordance with Core (1997), Boyer (2007) also found that companies with a low measure of financial distress are less likely to purchase the insurance.

Egger et al. (2015) also examine the demand for D&O insurance for Canadian companies, but for a longer time period than Boyer (2007). Using a panel of 232 companies for the years 1996-2008, Egger et al. (2015) test whether the existence of new shareholders and volatile markets influence the demand for and supply of D&O insurance. The findings suggests that the existence of new shareholders in the presence of volatility leads to an increase in the amount of insurance coverage purchased by companies.

O'Sullivan (2002) generated similar findings as Core (1997) and Boyer (2002) for UK companies, namely that the purchasers of D&O insurance tend to be larger companies. By comparing insured versus uninsured companies, O'Sullivan also found that the insured companies show more volatile share price performance and possess a greater US presence, and that these differences are consistent with a greater likelihood of litigation. Zou and Adams (2008) conducted a study on Chinese listed companies for the period 1997 to 2003 and found that the demand for D&O insurance in China has a positive relationship with respect to the degree of conflict between controlling shareholders and minority shareholders. These findings suggest that D&O insurance is used to protect controlling shareholders and their agents against the litigation risk arising from the expropriation of minority interests.

The research made on demand for insurance generally examines the out- and inside factors affecting companies' decision to purchase insurance. Taking a different perspective, some studies examine how various company related factors affect the insurance price, and how the insurance may affect litigation risk, cost of equity, and loan spreads. In 2000, Core conducted another study on D&O insurance for Canadian companies, focusing on the premium as a measure of ex ante litigation risk to examine whether there is a detectable variation in the premium associated with proxies for the corporate governance quality. In this study, Core (2000) found evidence that the premium reflects the quality of companies' corporate governance, by showing that measures of weak governance implied by the premium are positively related to CEO compensation. This finding implies that D&O insurers charge higher premiums when companies have governance structures that make shareholders worse off. Taking a different approach, Cao and Narayanamoorthy (2014) examined whether and how financial reporting concerns are priced by the insurance company. By using variables from financial reporting, corporate governance, and PSLRA[1] risk factors as proxies for litigation risk, they found that variations in the premium are associated with financial reporting quality after controlling for the litigation risk factors.

Chen et al. (2016) examined whether D&O insurance affects a company's cost of equity with Canadian companies listed on the Toronto Stock Exchange, for a 13-year period starting from 1996. They found a positive association, whereby information quality and risk-taking appear to be two underlying channels through which the D&O insurance affects the cost of equity. Furthermore, their evidence supports the notion that the D&O insurance weakens the disciplining effect of shareholder litigation, which again leads to an increase in the cost of equity.

A number of studies also examines the D&O insurance with regards to managerial opportunism, moral hazard, and the probability of default and lawsuits. Boyer and Tennyson (2015) conducted a study on the relationship between D&O insurance purchase and firm size, governance characteristics, and business risk, using 328 Canadian companies in the period

[1] The Private Securities Litigation Reform Act of 1995.

1996 to 2005. They estimated the determinants and effects of D&O insurance and showed that greater D&O insurance coverage leads to more aggressive earnings management, thus providing evidence that insurance ownership leads to moral hazard. Correspondingly, Lin et al. (2013) analyzed the effect of D&O insurance on the spread charged on bank loans, and they found that higher level of coverage is associated with higher loan spreads. This finding suggests that lenders view D&O insurance coverage as increasing credit risk, potentially via moral hazard or information asymmetry.

Higher level of coverage is also found to be associated with greater litigation risk in a study conducted by Gillian and Panasian (2015). Further, the findings from this study imply that higher premiums are associated with the likelihood of litigation. These findings are consistent with managerial opportunism or moral hazard related to the insurance purchase decision, thus indicating that insurers price this behaviour. Altogether, Gillian and Panasian's (2015) findings suggest that both coverage and premium levels have the potential to convey information about lawsuit likelihood, and a company's governance quality, to the marketplace. Taking a difference stance, Hwang and Kim (2018) examined how the D&O insurance may affect the company value for Korean companies. By using Tobins Q for the years 2002 to 2008, Hwang and Kim (2018) found that D&O insurance increases firm value, and that the increase is pronounced for companies with greater growth opportunities.

Wang and Chen (2016) showed in their study on Taiwanese companies that even though directors' compensation and firm performance are positively correlated, a D&O insurance significantly weakens the relationship, and may actually worsen the agency problem and increase the companies' agency cost. A recent study by Huang (2021), who also used Taiwanese companies, found that D&O insurance exerts a significantly positive influence on companies' expected default frequency, i.e., companies with D&O insurance have higher default risk than those without. Moreover, according to Weterings (2015) the moral hazard is insufficiently addressed by D&O insurers in the Netherlands, and not all possible instruments are being used to reduce the moral hazard problem. He argues that this most likely also holds true for D&O insurers in other European countries and in the U.S.

# 2. Theoretical Framework

## 2.1 Insurance

Insurance can be described as an economic activity that occurs when one party agrees to pay an indemnity to another party in case of the occurrence of a prespecified random event that generates a loss for the initial risk-bearer (Eeckhoudt et al., 2005). Generally, insurance can be seen as a hedging strategy in that it involves risk transferring and risk minimizing. It provides protection against a random, unforeseen future event, and hence provides coverage against various risks. Different insurances apply to different types of events, and in the case of an unfavourable event the claimant will receive a payout from the insurer.

Borch (1990) states that it is not possible to give a short and precise definition of insurance as there are many different types that simply do not fit one universal definition. For this purpose, he considers an insurance contract as described by two elements: (1) the premium paid by the insurer when the contract is concluded, and (2) the compensation which the insured received if specific events occur, when the contract is in force. This compensation must be described by a probability distribution. The determination of the relationship between these two elements are the essential objective within a theory of insurance. That is, how the premium depends on the properties of the probability distribution.

In this study the focus is on insurance for companies. Companies can, for example, purchase property insurance to insure its assets against hazards, personnel insurance which compensates for the loss of unavoidable absence of crucial employees in the form, or business interruption insurance that protects the firm against the loss of earnings if the business is interrupted due to fire, accidents, or some other insured peril (Berk & DeMarzo, 2017, p.1050). These are, among many others, insurances often purchased by companies. Common for all insurances is that the risk is being transferred from the company to the insurer.

### 2.1.1 **Elements of Insurance**

Premiums, deductibles, and limits are terms often used to describe an insurance policy. These elements explain the price paid for insurance, the minimum amount of any loss carried by the insured, and the maximum amount the insurer will pay out in case of a loss.

Theoretically, in a perfect market without other frictions, the price of insurance will be such that it gives a net present value (NPV) of zero for both the insurer and the insured (Berk & DeMarzo, 2017). When the NPV is zero the price will be actuarially fair. As such, a company must make an upfront payment when deciding to purchase insurance. This upfront payment is known as the premium, which the insurance company demands for taking on the specific risk. The premium should thus reflect the price of the risk that the insurer accepts, and in the case of an unforeseen and unfavorable event the company will receive a payout from the insurance company.

Let $r_L$ be the appropriate cost of capital given the risk of the loss. Then the fair premium can be calculated as (Berk & DeMarzo, 2017)

$$Insurance\ Premium = \frac{\Pr(Loss) * E[payment\ in\ the\ Event\ of\ Loss]}{1+r_L}, \tag{1}$$

where

*Pr(Loss) = probability that a loss will occur*

*E[*] = expected payment conditional on a loss occurring.*

The cost of capital, $r_L$, depends on the risk being insured. Insurance companies can create low-risk portfolios by pooling together the risks from many policies. This makes the annual claims relatively predictable. However, some risks are more difficult to diversify completely, such as hurricanes and earthquakes which create enormous losses. When the risk cannot be fully diversified, the cost of capital will include a risk premium. Risk-adjusted $r_L$ for losses is less than the risk-free rate, which leads to higher insurance premium in Equation 1.

A different formulation more commonly used in insurance theory can be written as

$$Insurance\ premium = \frac{\Pr(Loss) E[payment\ in\ the\ Event\ of\ Loss]}{1+r}(1+\lambda), \tag{2}$$

where $r$ is the risk-free rate and $\lambda$ is a loading term which should cover the insurer's costs as well as provide a profit margin. In terms of D&O insurance, the insurer will set a premium equal to its assessment of the company's litigation risk plus a mark-up for its overhead and profit (Core, 2000).

The insurance company will further set a pre-defined definite sum, a limit, which defines the maximum amount of money the insurer will pay towards a covered claim. Higher coverage limits usually corresponds to higher premium payments. In addition, the insurer may require the claimant to pay an insurance deductible. When this amount is paid, the insurer will contribute to cover the remaining costs of the claim, up to the determined coverage limit.

### 2.1.2 **Insurance Market Imperfections: Asymmetric Information**

Within a perfect market with actuarially fair premiums, the use of insurance for risk management purposes can reduce costs and improve investment decisions (Berk & DeMarzo, 2017). However, market imperfections exist and therefore the cost of insurance may rise above the actuarially fair price and offset some of the benefits.

Modigliani-Miller Proposition 1 (1958) states that a perfect market assumes no asymmetric information, i.e., both the seller and buyer have perfect information regarding the quality of the goods being traded. When both suppliers and demanders of insurance are fully and symmetrically informed, the insurance companies are able to categorize the demanders, and thus offer a contract that perfectly reflects expected costs. In the presence of asymmetric information, things get more complicated. Asymmetric information about product quality in insurance markets arises when companies have difficulties judging the riskiness of those demanding insurance coverage (Puelz & Snow, 1994). Within the subject of asymmetric information there are mainly two fields that are considered: adverse selection and moral hazard.

#### *2.1.2.1 Adverse Selection*

Adverse selection describes a situation in which one party in a deal has more accurate and different information than the other party (Berk & DeMarzo, 2017). In such a situation, the party with less information is at a disadvantage to the counterparty. Adverse selection occurs when asymmetric information is exploited, and this asymmetry causes a lack of efficiency in for example the price provided. There will be asymmetric information in the insurance market as the insured company possesses better information regarding their underlying risk than the insurance company. The cost of insurance raises due to adverse selection since the informational advantage relates to knowledge regarding the company's risk, which directly impacts the insurer's expected costs. For this, the insurance company must be compensated for this adverse selection with higher premiums.

#### *2.1.2.2 Moral Hazard*

Moral hazard occurs when there is a change in the behavior of one party after an agreement between the two parties is reached (Berk & DeMarzo, 2017). When a company purchases insurance, they no longer bear the full cost of a risk. Hence, they will have less incentive to reduce accident probability through prevention. This will yield a positive correlation between the choice of a contract with a smaller deductible and ex post riskiness (Chiappori & Salaniè, 2000). When the risk profile of the company before and after signing an insurance contract differs, the insurers will face problems in calculating optimal contracts.

Moral hazard and adverse selection have similar empirical implications, but with an inverted causality (Chiappori & Salaniè, 2013). Under adverse selection, people are characterized by different levels of ex ante risk, which gives different ex post risk. If insurers are aware of these risk differences, they can choose different contracts, and structure their policies as a way of reducing the adverse selection costs. The choice of a contract will be correlated with the accident probability: more comprehensive coverage is associated with higher risk. Most policies include both a deductible and a policy limit, which implies that the firm still bear some of the risk of the loss despite being insured. In this way, the benefit of acting in a risky way is offset by a cost.

Both moral hazard and adverse selection are relevant aspects related to D&O insurance. As Weterings (2015) argues, there are fewer financial incentives for directors and officers to act with due care in the presence of D&O insurance. Weterings further argues that this makes the function of liability laws undermined, or at least negatively affected, by the insurance. However, the insurance companies providing the D&O insurance can take various measures in attempt to mitigate the moral hazard.

### 2.1.3 **Why Do Companies Buy Insurance?**

Most companies use insurance as a part of their risk management (Nordahl, 2015). However, according to classical financial theories such as Modigliani and Miller (1958) and CAPM, companies does not have to consider the unsystematic risk. Since insurance are meant to eliminate exactly this risk, the company will have no incentive to spend resources on eliminating the risk themselves. Nordahl (2015) shows how some simple violations of Modigliani and Millers assumptions can make insurance an effective way of reducing risk. Specifically, Nordahl presents a model which takes into account double taxation and costs of bankruptcy. By using insurance, companies are able to keep their equity down and still avoid too high risk of bankruptcy.

Examining the demand for insurance policies for corporations, Mayers and Smith (1982) suggest that the higher the employees', customers', and suppliers' fraction of the claims to the firm's output, the higher the probability that the firm will purchase insurance. Further, they claim that the incentive to purchase insurance will increase due to the existence of transaction costs of bankruptcy for firms with widely dispersed ownership. The probability of incurring the costs is lowered by shifting the risk related to certain hazards to the insurance company.

Another source of demand for insurance is related to the conflict of interest between the owners and the managers of a corporation. Mayers and Smith (1982) exemplifies this by referring to the difference in time horizons: the manager's working life is limited while the corporate form gives the company an infinite life. This difference produces an incentive conflict, since the manager may receive bonuses based on financial performances, he or she will have an incentive to maximize his or her individual utility by for example postponing selected expenditures until after retirement. Mayer and Smiths' analysis suggests that firms whose managers have greater discretion over the choice of hazard-reducing projects will be more likely to purchase insurance.

## 2.2 D&O Insurance

As previously stated, board members face a personal responsibility that may make them liable in the case of a lawsuit. In Canada specifically, board members have a number of personal liabilities under the *Canada Business Corporations Act 1985*, commonly known as CBCA. Even if the lawsuit is directed at the board, each individual board member is personally responsible. The liability risk to corporate directors and officers can come from shareholder litigation or lawsuits brought by other parties, raising a need for protection. A widely used method to get such protection is to purchase D&O insurance. The D&O is purchased and owned by the company, and covers the company's directors and officers (Core, 1997).

D&O insurance can be classified as a third-party insurance. Third-party insurance is purchased to cover damage to any person who is not one of the parties named in the insurance contract, i.e., not the insured company nor the insurance company (Ivanovic & Collin, 2006, p. 258). The insurance is purchased by an insured (first party) from an insurer (second party) for protection against the claims of another (third party). Related to D&O insurance, the insured will be the company who purchases the insurance on behalf of their directors and officers. The insurer will be the insurance company, and the third party will be the aggrieved party. Directors and officers are facing pressure to meet and exceed expectations from several stakeholders such as employees, stockholders, governmental bodies, special-interest groups, and the general public. Any member of one of these groups can file lawsuits claiming a wrongful act.

D&O insurance protects officers and directors from most liability-related costs arising out of any wrongful acts alleged to have been committed in the course of their duties (Baker & Griffith, 2010). There are two common types of insurance: corporate coverage and personal coverage. The first type reimburses the firm when it indemnifies a director or officer for the costs of a lawsuit, while the second type provides direct payment to a director or officer when the firm is not able to indemnify him/her (Kranz, 2020). Overall, D&O insurance reduces directors' and officers' fear that a liability claim will erode their private assets.

In addition, the elements included in a D&O insurance can be indicators of the quality of corporate governance in a company (Otto & Weterings, 2019). Corporate governance can be seen as the whole of structures, rules, and guidelines within a company, which determines how the company is managed and controlled, the effectiveness of such management and control, and the relationship between the board, shareholders, and stakeholders. Among the elements of D&O insurance, Otto & Weterings (2019) states that, theoretically, the premium would be the most relevant one. The insurance company providing D&O insurance has an interest in identifying the corporate governance of a company and thereby reflect this in the premium, because the governance quality partially affects the risk of liability claims against directors and officers. There is a higher risk of managers failing to exercise due care and diligence with poorer corporate governance, in addition to a higher risk of compensation claims against those directors.

Besides the premium, other insurance elements such as the deductible and coverage limit may also be quality indicators of the corporate governance and the liability risk of the company.

As the quality of corporate governance is lower, the board of the company will opt for a lower deductible or retention and higher sum insured. If these insurance elements are indicative of corporate governance, a D&O insurance policy can contain valuable information for investors and other stakeholders.

### 2.2.1 Side A, Side B, and Side C Coverage

The general label "D&O insurance" is often applied to three distinct insurance arrangements that are commonly provided as parts of a single D&O insurance policy. Hwang and Kim (2018) states that corporations purchase D&O insurance in order to cover directors and managers for legal liability on behalf of the company. More specifically, they give the following description of D&O insurance:

*A typical D&O insurance policy (1) provides litigation costs for claims made against individual directors and officers for their wrongful act to the extent which indemnification does not apply, (2) reimburses the firm for its indemnification payments, and (3) provides optional coverage for the corporation's own liability.*

It typically comprises three core, separate agreements called Side A, Side B and Side C coverage. From Hwang and Kims' description above, Side A relates to point (1), Side B to point (2), and Side C to point (3). The only form of D&O insurance that actually insures individual directors and officers is the Side A coverage. Side B does not protect individual directors and officers, but rather reimburses the corporation for indemnifying its directors and officers. The policy limits of Side A and Side B are typically equal, but Side B coverage often includes a deductible while Side A does not (Lin et al. 2013). Under both Side A and Side B, coverage obligations arise when a claim is brought against a company's officers and directors (Baker & Griffith, 2010). Neither Side A nor Side B coverage is available for liabilities arising directly against the company as a defendant in shareholder litigation. Side C coverage is entity securities coverage and emerged to fill this void.

***Table 1**: Description of the three sides of D&O insurance (Allianz Global Corporate & Specialty, n.d.).*

| Cover | Description | Who is the insured? | What is at risk? |
|---|---|---|---|
| Side A | Protects assets of individual directors and officers for claims where the company is not legally or financially able to fund indemnification | Individual directors and officers | His/her personal assets |
| Side B | Reimburses the company for indemnifying its directors and officers | Company | Its corporate assets |
| Side C | Extends cover for public company for securities claims only | Company | Its corporate assets |

### 2.2.2 **Motivation for Buying D&O Insurance**

In the wake of the Enron scandal several experts conjectured that the number of lawsuits against company managers would increase due to angry stakeholders feeling kept in the dark regarding the company's operations (Boyer & Delvaux-Derome, 2002). This statement is supported by Bailey (2005), who states that the size of settlements in securities class actions against directors and officers exploded post-Enron, making D&O insurance increasingly important. Among the stakeholders, shareholders are probably the most likely ones to complain about the management team in place, especially in times of weaker company performance. Since directors and officers have a personal responsibility, a D&O insurance can be an important source of risk reduction. The fear of financial distress can also be argued to be a good reason to hedge in order to calm consumer's and supplier's fears that the corporation will be there in the following months, either to offer consumer services or to pay for products or services bought.

There is no doubt that it is beneficial for a company to have satisfied stakeholders. However, one must not underestimate the importance of having good workers and managers, or human capital. Some stakeholders, such as workers and managers, may have the great majority of their human capital tied up in a given company. Therefore, Boye and Delvalux-Derome (2002) argue that it becomes essential for such companies to offer insurance as a way of attracting and retaining the best workers and managers. Having the best human capital can yield a great competitive advantage for a company.

For listed companies, there is an agency relationship between the directors and shareholders. This agency relationship concerns the relationship between an agent – the person who decides – and a principal – the person on whose behalf the decision is made (Douma & Schreuder, 2017). In the principal-agent relationship between shareholders and directors, there is a separation of ownership and control in the listed company (Otto & Weterings, 2019). This separation occurs because of widely distributed share ownership. The agency relationship creates information asymmetry and conflict of interest between the parties. A director may not always act in the best interest of a shareholder, even though it is important for the shareholders that the directors represent their interest in the best way possible. Such agency problems may be one of many reasons for why shareholders file a lawsuit against the board of directors. Hence, D&O insurance may have become more popular because lawsuits against the management are becoming more frequent (Boyer, 2007).

Since the D&O insurance is meant to give protection in the case of a lawsuit, the level of litigation risk will affect the demand for such protection as well (Core, 1997). Core states that once the litigation risk becomes sufficiently large, the net benefits of purchasing D&O insurance increase with increases in litigation risk. Thus, Core finds that companies with higher litigation risk are more likely to purchase D&O insurance. In accordance, he further finds that companies with higher distress probabilities are more likely to purchase the insurance in order to minimize bankruptcy costs.

## 2.3 Merton Model

In 1974 Merton proposed a model for assessing the credit risk of a company by modelling the company's equity as a call option on its assets. Merton clarified and extended the Black-Scholes model which was first introduced in 1973 (Black & Scholes, 1973). Black and Sholes gives the following definition of an option:

*An option is a security giving the right to buy or sell an asset, subject to certain conditions, within a specified period of time.*

The simplest kind of option is the one that gives the right to buy a single share of common stock, known as a "call option". A call option will have a greater value the higher the stock price, and when the stock price exceeds the exercise price the option is likely to be exercised. To exercise a call option means using the right to buy the underlying stock at the predetermined price. Black and Scholes also discussed equity as a call option in their paper. A single share of stock can be viewed as a call option on the asset of the company, with an exercise price equal to the value of the debt outstanding. If the value of the firm's assets exceeds the required debt payment, the equity holders will receive the value remaining after the debt is repaid. Otherwise, the firm is bankrupt, and the equity is worthless. Thus, the payoff for the equity holders is equivalent to a call option on the company's assets.

To develop the Black-Scholes-type pricing model, Merton makes the following assumptions (Merton, 1974, p. 450):

***Table 2****: Assumptions of the Merton Model*

| | |
|---|---|
| **1** | No transaction costs, taxes, or problems with indivisibilities of assets |
| **2** | There are a sufficient number of investors with comparable wealth levels so that each investor believes that he can buy and sell as much of an asset as he wants at the market price |
| **3** | There exists an exchange market for borrowing and lending at the same rate of interest |
| **4** | Short-sales of all assets, with full use of the proceeds, are allowed |
| **5** | Trading in assets take place continuously in time |
| **6** | The Modigliani-Miller theorem that the value of the firm is invariant to its capital structure obtains |
| **7** | The Term-Structure is "flat" and known with certainty. i.e., the price of a riskless discount bond which promises a payment of one dollar at time $\tau$ in the future is $P(\tau)=\exp[-r\tau]$ where r is the (instantaneous) riskless rate of interest, the same for all time |
| **8** | The dynamics process of the firm value is a Geometric Brownian Motion, i.e., the value of the firm, $V_t$, is log-normally distributed. |

In his paper, Merton derives a formula that values the equity, E, in function of the value of assets corrected for the value of debt, D. Additional parameters required are the risk-free rate, *r*, the volatility of assets, $\sigma_A$, and the time to maturity, *T*. The formula can be written as

$$E = AN(d_1) - e^{-rT}DN(d_2), \quad (3)$$

where

$$d_1 = \frac{\ln\left(\frac{A}{D}\right) + (r + 0.5\sigma_A^2)T}{\sigma_A\sqrt{T}}, \quad (4)$$

and

$$d_2 = d_1 - \sigma_A\sqrt{T}. \quad (5)$$

The Merton Model recognizes that neither the underlying value of the firm, A, nor the volatility, $\sigma_A$, is directly observable, but under the model's assumptions both can be inferred from the value and volatility of equity, together with the other observable variables (Bharath & Shumway, 2008). The following equation shows that $\sigma_E$ and $\sigma_A$ are related, which makes it possible to estimate the value of A and $\sigma_A$,

$$\sigma_E = \left(\frac{A}{E}\right) N(d_1)\sigma_A. \quad (6)$$

The value of A and $\sigma_A$ can be estimated by solving a minimization problem using Equation 3 and Equation 6. The minimization problem is solved by inserting values for A and $\sigma_A$ that leads to the minimum differences between estimated and true values for E and $\sigma_E$. When this difference is minimized, the model gives estimated values for A and $\sigma_A$ that further can be used to estimate the distance to default and the probability of default. The distance to default is denoted $d_2$ from Equation 5 and can be interpreted as the distance between expected asset value and the default point. Further, the risk neutral probability of default is calculated as

$$P(Default) = N(-d_2). \quad (7)$$

The probability of default can be used for credit risk management purposes, as when insurance companies are determining the premium to be paid by the insured company.

# 3. Proxies for Litigation Risk Factors

In this section we highlight how various risk factors can be proxies for litigation risk and how they can affect the pricing of D&O insurance. As mentioned in Section 2.2.2, the net benefit of D&O insurance increases as the litigation risk increases. These risk factors will further be used in the analysis on the insurance premium, and a more thorough introduction to our proxies for measuring these factors is given in Chapter 4. Note that variables written in cursive represents the actual variable names used in the analysis.

## 3.1 Corporate Governance & Business Risk

Company managers enjoy a high degree of knowledge about the business activities they supervise. This can create a conflict of interest between the managers making beneficial decisions for themselves, and the company owners or shareholders. When managers use the information they possess for personal gain, the event is considered a case of managerial opportunism (Chalmers et al., 2002). According to Chalmers et al. (2002) the managerial opportunism hypothesis says that "rational managers, armed with superior information, choose to sell shares when the public valuation of the company's shares exceeds management's valuation estimate". Aside from making beneficial decisions for themselves, managers may also perform poor governance resulting in unsatisfied stakeholders. Both cases increase the risk of litigation, which should be accounted for in the D&O insurance premium.

It is a theoretically open question whether litigation risk should be positively or negatively associated with corporate governance. Romano (1991) argues that certain good corporate governance mechanisms make litigation easier. When directors and officers have a personal liability for breach of duties of care and loyalty, it helps facilitate litigation as well as aligning the interests of the managers with those of the shareholders. This implies a positive association between good governance and litigation risk. Contrary, poor corporate governance leading to ineffective disciplining of managers can imply higher litigation risk. According to Core (2000) the D&O premium decreases with the quality of a firm's governance structure, i.e., the better corporate governance structure, the less the company must pay for the insurance.

In this study, *Blockholder* and *Share Independent* are included as measures of companies' corporate governance. A further description of these variables is given in Chapter 4. Board independence can be an indicator of strong governance that in turn can reduce the D&O

insurance premium (Cao & Narayanamoorthy, 2014; Dechow et al., 1996). This is also supported by Otto & Weterings (2019), who states that good corporate governance reduces the expected risk of a liability claim against directors. However, another study by Ning and Xuesong (2018) finds that D&O insurance actually reduces the effectiveness of independent directors in corporate governance, indicating that the premium will be higher as the share of independent directors is higher. Thus, whether to expect a positive or negative relationship between board independence and D&O insurance premium is not clear, as it can be both ways. *Blockholder* is in this setting defined as the presences of a person or a company holding more than 10% of the voting rights. According to Shleifer and Vishny (1997), blockholders are assumed to be more engaged, strengthening the degree of control within the company. Thus, it is reasonable to expect a lower premium for companies where one or more blockholders are present. However, as explained by Core (2000), the presence of outside blockholders in particular might in fact increase litigation risk because they may use lawsuits as a substitute monitoring device, thus making the expectation ambiguous.

The underlying business risk of a company may also affect its litigation risk and hence the pricing of D&O insurance (Cao & Narayanamoorthy, 2014). *Equity Volatility* is used as a measure of the volatility of companies' shares, which is expected to be positively correlated with the insurance premium, as many shareholder lawsuits are triggered by poor company performance (Core, 1997). However, neither Core (2000) nor Cao and Narayanamoorthy (2014) were able to find any clear connection between volatility and premiums in their studies. As such, the expectation is primarily based on the intuition regarding lawsuits rather than previous research. In terms of a proxy for company size, this study follows Cao and Narayanamoorthy (2014) by using the natural logarithm of the market capitalization, *Ln(MarketCap).* Larger firms are more likely to be sued "due to their deeper pockets" (Cao & Narayanamoorthy, 2014; Core, 2000). Thus, premiums are expected to increase with company size. *Market Book Ratio* is used as proxy for growth. Following previous research by Egger et al. (2015) and Core (1997) it is hypothesized that high growth companies will seek higher coverage, because shareholders want to avoid underinvestment problems. Accordingly, the companies are also faced with a higher premium. The high coverage indicator, *HCI,* defines whether a company maintains higher than median coverage relative to their size. This variable is hypothesized to display a form of adverse selection, where those who seek higher coverage than expected are more likely to face litigation. Consequently, the premium for such companies is expected to be higher.

With regards to financial performance, *Profitability* is used as an independent variable that is expected to be associated with a lower premium. An important reason behind this expectation is the proposed relationship between profitability and lower risk of financial distress (Lin et al. 2013). Cao and Narayanamoorthy (2014) used an indicator variable for whether the company made a loss as an explanatory variable of the premium and found a loss in the previous year to be associated with higher premiums. Extending on this method, and drawing inspiration from Lin et al. (2013), this study quantifies whichever loss or profit was reported by companies. Further, in line with Cao and Narayanamoorthy (2014), *Leverage* is considered as another important risk factor, since it can be used as a proxy for financial distress or closeness to bankruptcy. Cao and Narayanamoorthy's findings indicate higher leverage to be informative of higher a premium. The proposed relationship between leverage and distress is also supported by Lin et al. (2013), who stated that low-leverage companies are less likely to default. In terms of *Tangibility,* the expectations are more ambiguous. On one side, Lin et al. explained how asset tangibility can increase recovery rates in default, thus implying the investments to be relatively safe. However, tangible assets are not easily liquidated and as such the variable might also proxy for illiquidity, believed to be considered risky by insurers, and thereby might increase premiums.

# 4. Data

In this chapter the data collection process will be presented and explained. The chapter is divided into two main parts, whereas the first part contains explanations of the data collection methods applied in this study. It covers which data is collected, how, and why. The second part gives a presentation of the variables generated for the analysis, in addition to a statistic summary of the variables. Unless stated otherwise, all references to dollars are to Canadian dollars.

## 4.1 Data Collection

Research within the field of D&O insurance has been limited by the lack of data on firm-level purchases of such coverage. In this study, listed Canadian companies are used because they are required by law to divulge information pertaining to their D&O insurance coverage (Boyer & Delvaux-Derome, 2002). The sample of companies consists of those listed on the S&P/TSX Composite Index as per February 26th, 2021 (tmxinfoservices, 2021). To persist a more homogenous sample all financial companies are excluded, because such companies often have high leverage without this being a signal of financial distress, dissimilar to other sectors. Additionally, GFL Environmental is excluded from the sample due to holding their IPO in March 2020, hence no proxy circulars are available for the company through SEDAR in the sampling period. Thus, the starting point of the sample consists of 193 companies.

The companies are further categorized by the sector they operate in. Figure 1 gives a visual representation of the distribution of the ten sectors in the data set. Basic materials is the largest one, accounting for approximately 25% of the sample. The sector includes mining, forestry, and chemical production. In addition, industrials, energy, and real estate are also quite large at approximately 12-14% of the total.

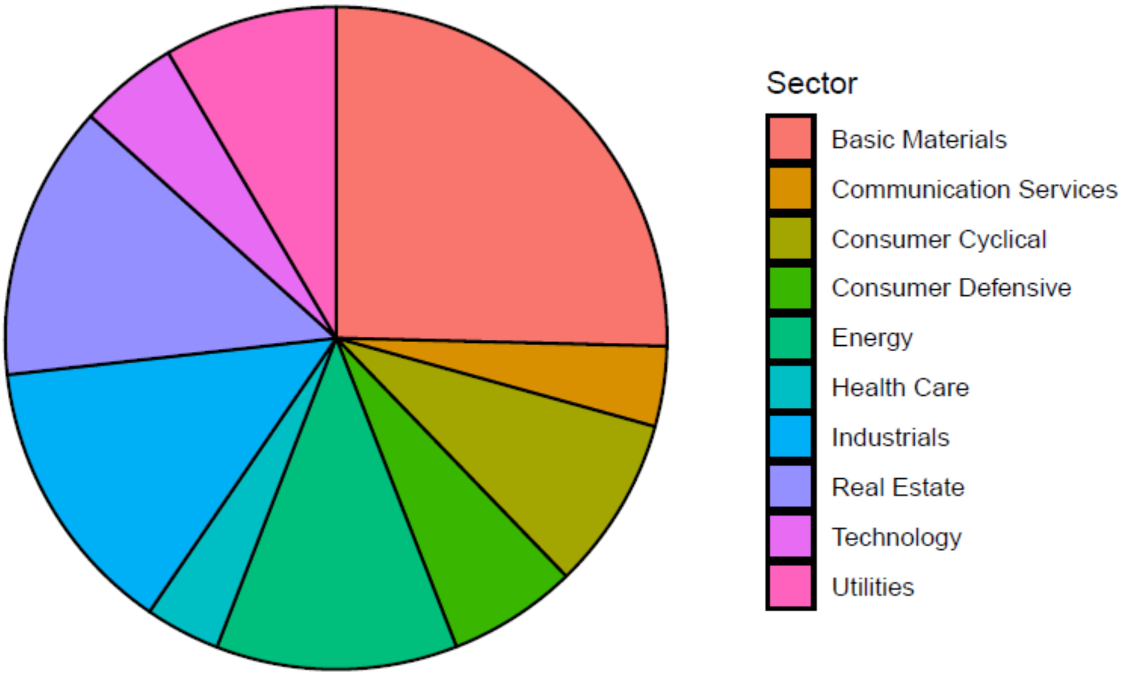


***Figure 1:*** *Pie chart of sectors showing the distribution of the then sectors in the data set.*

### 4.1.1 **D&O Insurance Data**

The basis for this thesis is data on companies' D&O insurance policies. This data is collected by replicating the method used in prior studies, such as Boyer (2007), Lin et al. (2011), and Egger et al. (2015). Insurance information is manually collected for each company from proxy circulars in the System for Electronic Document Analysis and Retrieval (SEDAR, https://www.sedar.com/). The sample is limited to all reports published within the period from 2010 to 2020, a total of 11 circulars for each company, conditional on circulars having been published annually throughout the period. The insurance data collected includes coverage limits, premiums, and deductibles for each year, supplemented with information on the currency in which insurance numbers are stated. Despite limiting this sample to only Canadian firms, many companies still use United States dollars for reporting purposes. One particular challenge faced in the data collection process concerns the quality of company reporting. In approximately 25% of all circulars where companies claimed to have an active D&O insurance policy, neither the coverage limit nor the premium paid were stated. These observations are therefore removed, reducing the sample to 860 observations of companies reporting on both limit and premium, which is considered to be efficient for the purpose of this study.

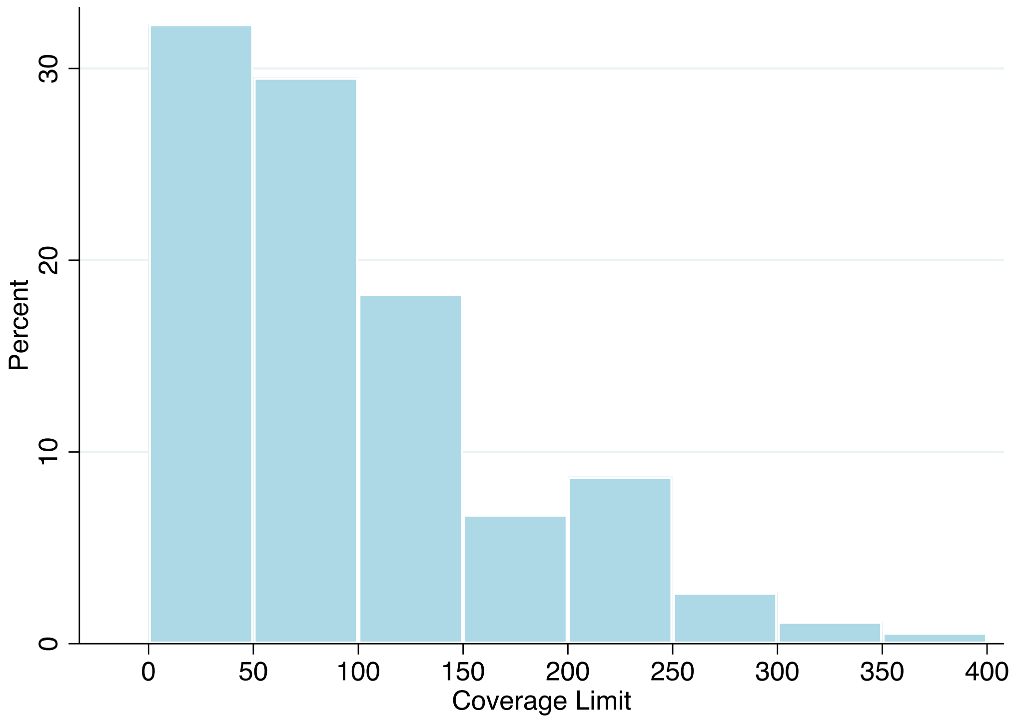


***Figure 2****: Coverage limit for all 860 observations in the sample, after converting into common currency. All amounts are stated in million Canadian dollars, and observations are presented in stages of 50 million dollars.*

Figure 2 presents the coverage limit for all 860 observations in the sample and gives a brief introduction to some of the data to be analyzed throughout this thesis. As illustrated by the figure, there is a great dispersion in the size of coverage acquired by the companies whereby the smallest coverage limit is only 5 million, while the largest recorded limit is 400 million dollars. The largest group in Figure 2 is the group which maintains less than 50 million dollars in coverage, accounting for approximately 32% of the sample. Figure 3 presents the annual premiums paid by the companies as a percentage of the coverage limit provided under the policy. Specifically, this is considered the price paid for every dollar worth of protection. Approximately 90% of our sample pay less than 1% in premiums, but as can be observed from Panel B of Figure 3, there are some identified outliers whereby the largest one recorded paid 21,4%. The three most extreme observations illustrated in Panel B are excluded in the final specifications of the models in Chapter 6. A more thorough presentation of relevant variables for the analysis will be given in Section 4.2.

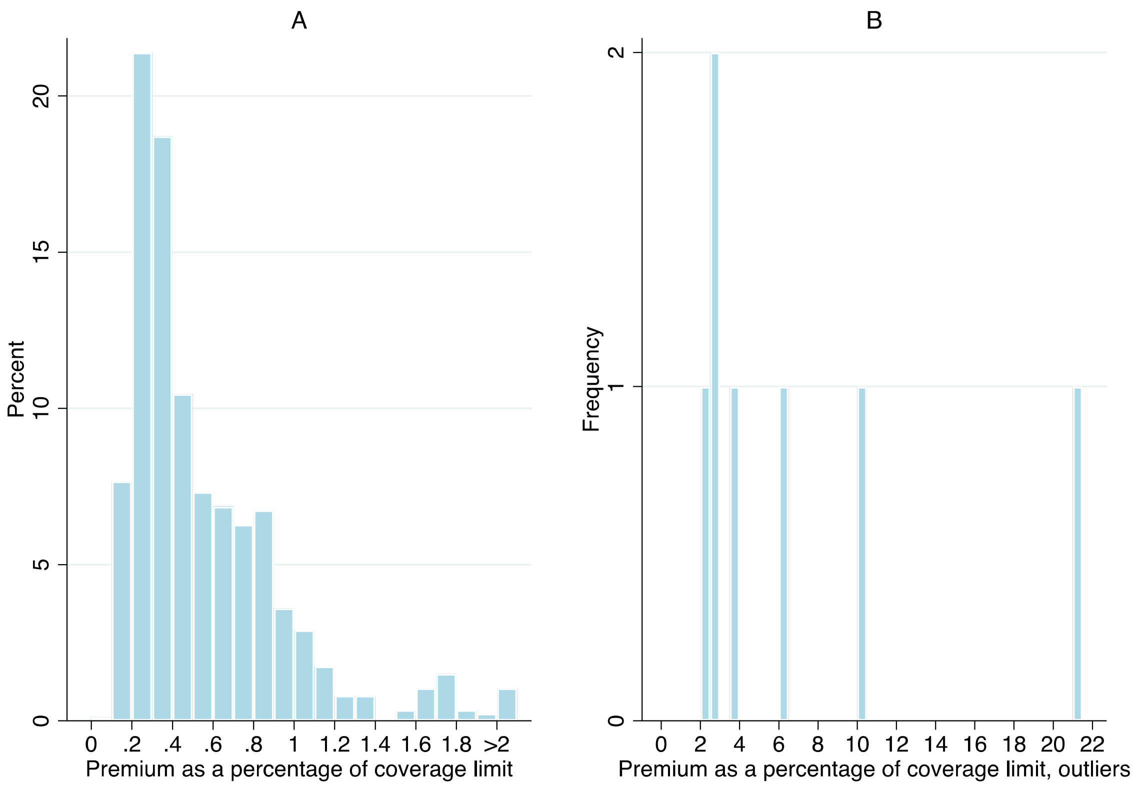


***Figure 3****: The premium as a percentage of the limit, i.e., the price paid for each dollar of coverage stated in percent. Panel A shows all 860 observations of the variable Insurance Price. The last bar of Panel A displays all observations in which companies pay 2% or more in premiums. The seven observations of companies paying more than 2% are presented more precisely in Panel B. Please note that the y-axis of Panel A is percentages while the y-axis of Panel B is frequency.*

### 4.1.2 Accounting Data

In order to supplement the analysis on the D&O insurance, accounting data for all companies are collected for a period extending two years prior to the first proxy circular. This includes book values on measures such as total assets, total liabilities, and company earnings. Accounting data is further used to compute key figures to be utilized as risk measures in the analysis of the insurance policies. All key figures and other relevant data collected is presented thoroughly in both Table 3 and Table 4. Accounting data is collected on an annual basis for each fiscal year of the companies using the database Thomson Reuters *Datastream*.

### 4.1.3 **Market Data**

One of the prime purposes of this thesis is to examine to what extent market risk is incorporated in the pricing of D&O insurance. Daily stock prices for all companies are collected for the time period January 1$^{st}$, 2008, to December 31$^{st}$, 2019. The data is further used to compute daily returns of each stock and estimate the standard deviation of returns for each fiscal year. Standard deviations are annualized and will serve as a measure for market risk.

Additionally, information on the market value of equity at the end of each fiscal year is collected. This is defined as the share price at the end of the fiscal year multiplied by the number of shares outstanding. Considering that all companies in the sample are listed on the S&P/TSX Composite Index, all market data have been available from the Toronto Stock Exchange, and data have been extracted using the database *Datastream*.

### 4.1.4 **Other Data**

The data set is extended with variables that can be used as controls for corporate governance. Information on the share of directors being classified as independent, by the standard of National Instrument 58-101 – *Disclosure of Corporate Governance Practices* and Multilateral Instrument 52-110 – *Audit Committees*[2], are manually collected from proxy circulars. Independent directors are not employees of the company, and they have no business affiliations with it (Cao, Narayanamoorthy, 2014). Further, information on the presence of majority shareholders is gathered from the same proxy circulars. Inspired by Lin et al. (2013), a blockholder is defined as any person or company holding shares representing more than 10% of the votes to be casted at the annual meeting.

To estimate the volatility of assets, the yields of 1-year Canadian treasury bills serve as proxies for the risk-free rate. This data is retrieved from *Datastream*.

[2] https://www.canlii.org/en/ca/laws/stat/rsc-1985-c-c-44/latest/rsc-1985-c-c-44.html

## 4.2 Variable Presentation

Table 3 presents the variables used in this thesis and how they are calculated. They are categorized by D&O insurance information, firm characteristic, and governance variables.

***Table 3:*** *Variable definitions*

| | |
|---|---|
| *D&O insurance information* | |
| Coverage Amount | The coverage limit under the insurance policy, stated in millions of Canadian dollars. |
| Equity Coverage Ratio | The coverage limit of the policy as a percentage of the market value of equity at the end of the last completed fiscal year prior to the purchase. |
| Asset Coverage Ratio | The coverage limit of the policy as a percentage of the book value of assets at the end of the last completed fiscal year prior to the purchase. |
| Premiums | The price paid for the insurance coverage, stated in thousands of Canadian dollars. |
| Insurance Price | Premiums as a percentage of the corresponding coverage limit. |
| *Firm characteristics* | |
| Market Capitalization | Market value of equity at the end of fiscal year. |
| Market to Book Ratio | The sum of market value of equity and book value of liabilities divided by book value of assets at end of fiscal year. |
| Profitability | Earnings before interest and taxes, divided by total assets. |
| Leverage | The sum of long-term debt and current liabilities, divided by total assets. |
| Tangibility | Net property, plant and equipment, divided by total assets. |
| Equity Volatility | The annualized standard deviation of daily stock returns over the fiscal year. |
| *Governance variables* | |
| Blockholder | Indicator variable equal to 1 if any single person or company controls shares representing more than 10% of the votes. |
| Share Independent | The share of directors proposed for the board being classified as independent |

***Table 4**: Summary Statistics*

| | Mean | Std. Dev. | min | p25 | Median | p75 | max | N |
|---|---|---|---|---|---|---|---|---|
| Coverage Amount | 91.13 | 73.04 | 5 | 35 | 65 | 123 | 400 | 860 |
| Ln(Limit) | 18.005 | .848 | 15.425 | 17.371 | 17.99 | 18.628 | 19.807 | 860 |
| Equity Coverage Ratio | 5.617 | 12.793 | .054 | 1.245 | 2.713 | 5.142 | 222.519 | 828 |
| Asset Coverage Ratio | 4.483 | 10.843 | .167 | .894 | 1.775 | 4.088 | 163.074 | 831 |
| Premiums | 555.64 | 716.98 | 10.89 | 130.32 | 265.48 | 711.43 | 7890.75 | 860 |
| Ln(Premium) | 12.614 | 1.115 | 9.296 | 11.778 | 12.489 | 13.475 | 15.881 | 860 |
| Insurance Price | .594 | .897 | .037 | .273 | .42 | .749 | 21.429 | 860 |
| Ln(MarketCap) | 21.613 | 1.545 | 14.625 | 20.75 | 21.573 | 22.66 | 25.054 | 828 |
| Market Book Ratio | 1.478 | .77 | .378 | 1.029 | 1.23 | 1.673 | 6.347 | 824 |
| Profitability | .055 | .111 | -1.047 | .038 | .062 | .097 | .426 | 830 |
| Leverage | .426 | .173 | .009 | .301 | .459 | .534 | 1.185 | 753 |
| Tangibility | .441 | .326 | -.166 | .127 | .424 | .704 | 1.949 | 795 |
| Blockholder | .621 | .485 | 0 | 0 | 1 | 1 | 1 | 837 |
| Share Independent | .769 | .125 | .091 | .667 | .8 | .875 | 1 | 842 |
| Equity Volatility | .346 | .207 | .097 | .201 | .283 | .414 | 1.406 | 802 |

Table 4 presents the summary statistics of central variables. All observations where the insurance data is incomplete, i.e., lacking information on either premium, limit, or both, are excluded. Thus, the maximum number of observations for any variable in Table 4 is 860. The 860 observations are collected from 104 different companies. The average value of *Coverage Amount* is approximately 91 million dollars, but as shown by the standard deviation and the highest observation of this variable, there is a significant dispersion. On average, the annual premium is just under 556 thousand dollars. It is reasonable to expect premiums and limits to be positively correlated. The variables *Ln(Limit)* and *Ln(Premium)* are the natural logarithms of the limit and premium respectfully. It is important to note that these are computed from the exact dollar amounts, and not from the scaled down figures of *Coverage Amount* and *Premiums*.

The average company purchases insurance with a coverage equivalent to 5,6% of their market capitalization, or 4,5% of the book value of their assets. However, these number also comes with significant dispersions. In particular, companies with strong growth over the last period may have much higher equity- and asset coverage ratios than otherwise similar companies. The variable *Asset Coverage Ratio* is presented graphically in Figure 4, and the tail of the distribution, as well as the outliers, must be emphasized. As Table 4 shows, the maximum value of this variable is 163%. This indicates that the company maintains coverage of a substantially higher value than the value of the company itself. *Insurance Price* sets the premium as a percentage of the limit, and the average company is found to pay 0,6% for their insurance coverage. This variable is presented graphically in Figure 3, which shows a significant dispersion. Further, 62,1% of the companies report on a single person or company holding more than 10% of the votes associated with their outstanding equity capital. Additionally, this sample documents the average board to consist of 76,9% independent directors. Lastly, *Equity Volatility* measures the annualized volatility of the stock returns in and the average value is 34,6%.

Some interesting characteristics regarding the variables *Leverage* and *Tangibility* are must be devoted some attention. First, for *Leverage,* one observation is identified where the maximum value exceeds 1. This implies that the value of liabilities exceeds the value of assets. However, given that the book value of equity in this observation is in fact negative, it is not considered to be overly problematic. Next, for *Tangibility,* 11 observations are identified in which the values of the variable exceed 1. If the variable displayed gross values of plant, property and equipment (PPE), this might have been problematic considering it would imply negative assets. However, as the variable is defined by net PPE, i.e., added capital expenditure and subtracted depreciation from the gross value, the accumulated values are considered to be within a reasonable range.

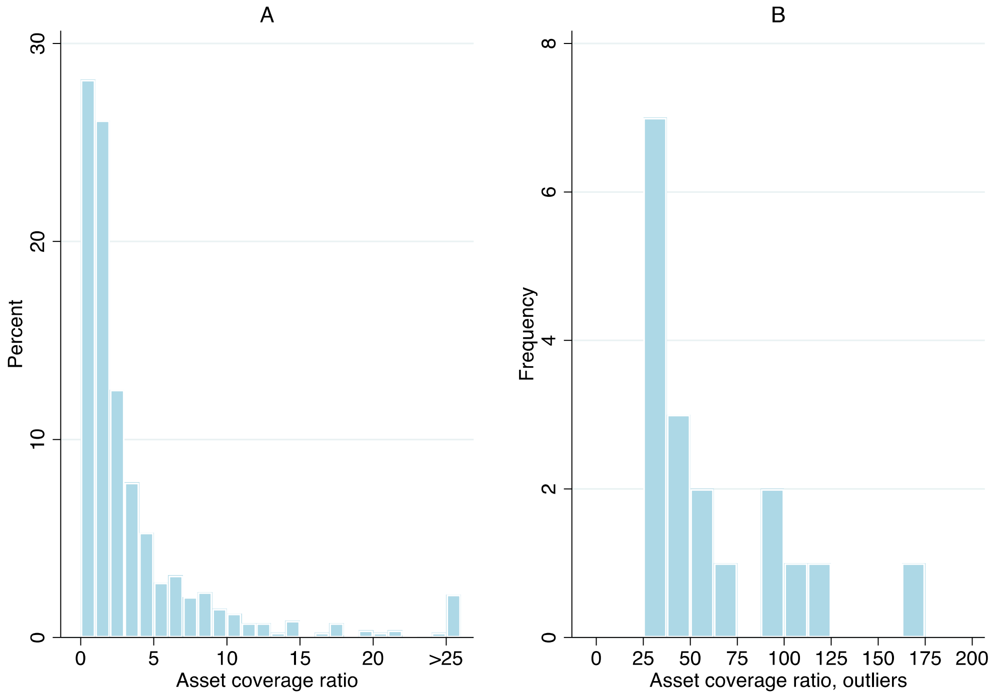


***Figure 4**: The insurance coverage maintained by the companies in the sample as a percentage of the total assets reported at the end of the last fiscal year prior to the purchase. Panel A show the 831 observations of the variable Asset Coverage Ratio. The last bar of Panel A displays all observations exceeding 25% and these 18 observations are presented more precisely in Panel B. Please note that the y-axis of Panel A is percentages while the y-axis of Panel B is frequency.*

# 5. Methodology

This chapter will present the methodology applied in the data analysis in Chapter 6. A complete data set that combines the insurance data with the other data correctly with regards to the time period is needed to conduct the analysis. Since all data on D&O insurance, as well as governance variables, are collected manually, whilst the remaining data are raw data retrieved from *Datastream*, several assumptions are made to construct a reasonable complete data set.

First, data preparation is explained, along with which assumptions are made and which exclusion criteria are set. Further, a thorough description of the calculation of asset volatility is given, as this involves using the Merton model (1974). Last, the methodology for the statistical analysis will be described, including the procedure of controlling for how risk factors affect the choice of coverage limit.

## 5.1 Preparing the Data

The data have been collected from a range of different sources, including documents released by companies, *Datastream* and TMX Datalinx. As mentioned above, all data regarding the insurance policies were collected manually and certain assumptions were made in the process of preparing the data. Firstly, for companies reporting both primary and excess coverage purchases we decide to merge these two coverages to a total coverage limit. This is done due to the lack of of information regarding how much was actually paid for the separate coverages. Secondly, all insurance data denominated in United States dollars are converted into Canadian dollars using a fixed exchange rate as of 1 January 2010 (ExchangeRates, 2021). Insurance policies are assumed to be renewed without extensive reviews of the companies. Under this process of renewal, currency fluctuations are not expected to affect insurance pricing. Finally, finding a correct exchange rate is problematic since information on the exact time the insurance was purchased is often lacking. Therefore, a fixed rate is used in order to dampen the effect of currency fluctuations in the data set.

Accounting data is collected for each fiscal year of the companies, and fiscal year end dates are used in estimating annualized volatility of stock returns. For the purposes of connecting insurance data to all supplementary data, a fiscal year is defined by the calendar year in which the fiscal period ends. For the majority of the observations, this is in line with the end of a calendar year, meaning the fiscal year ends December 31st every year. However, an issue regarding the definition arises when fiscal year end dates are not fixed for every year. This can be due to either no specified date being set, or a company changing its reporting period. The latter would imply that the company makes a permanent change in reporting period, e.g., changing fiscal years ending in March to ending in December every year. In the former case, no specified date being set could imply that end dates might fluctuate between two calendar years. Ending a fiscal year at the last day of the last week in a calendar year, is one example where the fiscal year could end in both December and January. Both these two cases can lead to two different fiscal years ending in the same calendar year. For the total of 9 times in the data set where this is an issue, the observations from January are excluded.

Information on the start and end date of the insurance policy is not available for the majority of the collected insurance data. Therefore, an assumption is made regarding what information can be expected to be available for the insurance company at the time the insurance contract was written. Proxy circulars give information on either which policy is active at the time it was issued, or which policy was active at the end of the last fiscal year. In either case, it is perceived to be unlikely that accounting data from the last completed fiscal year prior to the proxy release date are available when the insurance policy is priced. Proxy circulars are released approximately 3 months after the end of a fiscal year. Keeping this in mind, the last annual financial statements assumed to be made available prior to the insurance purchase, are for the fiscal year ending 1 year and 3 months prior to the proxy release.

Further, the market data is collected for each fiscal period. Firstly, the market value of equity is collected for the end of each fiscal year. Secondly, when estimating the volatility of stock returns, fiscal year end dates are utilized, and standard deviations of returns are computed for each fiscal year. Most observations contain fiscal years with 250 to 252 trading days. However, as some companies do not end the fiscal periods on the same date each year, the range of trading days are expanded somewhat when estimating standard deviations of returns. Thus, fiscal years are allowed to be in between 240 and 260 trading days. Additionally, this secures enough trading volume within the companies' shares so that the volatility measure is sensible. Annualization is conducted as a standardized process where the mode of 250 days is used to compute the annualized standard deviation for all observations.

Information on the nominees for the board of directors and the presence of majority shareholders are also collected from proxy circulars. For these variables to have any effect on the pricing of an insurance policy, the variables are lagged by one year and thereby it is assumed that the information is available at the time the insurance contract is written.

## 5.2 Asset Value and Volatility

To strengthen the analysis, the market value and volatility of company assets are estimated. Following the procedure set out by Merton (1974), Equation 3 and Equation 6 are solved for the estimated values of asset value, A, and asset volatility, $\sigma_A$. In solving these two equations for the two unknowns, the market value of equity, E, the annualized volatility of stock returns, $\sigma_E$, the book value of total liabilities, D, and the yield on one-year Canadian treasury bills, r, are used as input parameters. For simplicity, maturity is assumed to be one year. Finally, as the true values of E and $\sigma_E$ are known, the equations are solved simultaneously by writing a minimization problem that can be used across all observations. This allows for setting the estimated value of E and $\sigma_E$ as close as possible to the true value, by changing the values of A and $\sigma_A$.

The final solutions are incorporated in the data set to be used in estimating the effect on the pricing of D&O insurance policies. Both the Merton Model and the Black-Scholes model rely on several underlying assumptions, presented in Table 2, and how well they perform in forecasting depend on how realistic these assumptions are. In a review of Merton's model, Sundaresan (2013) states that the assumptions 1-4 of a perfect capital market can easily be relaxed, while the assumptions 5-8 are more critical for the model's performance. Since the model infers the market value of assets and asset volatility, it requires companies to be publicly listed. In this study this is unproblematic due to using publicly listed companies on the TSX Composite Index. Additionally, several input parameters in the model are not directly observable, for example the risk-free rate. The yields of one-year Canadian Treasury Bills are used as proxies for the risk-free rate.

Merton's (1974) measure of the risk-neutral probability of default is calculated using Equation 7 from Section 2.3. The variable is denoted *P(Default)* and it is used as an independent variable proxying for company risk. At last, the variables *HCI* and *Market Book Ratio* are re-estimated by using the estimated value of asset, to be used in the asset models presented in Section 6.3. These re-estimated variables are named *HCI_A* and *M/B-Ratio. HCI_A,* is defined as an indicator variable equal to 1 if the ratio of limit to estimated asset value is above the median value. *M/B-Ratio* presents the estimated market value of assets, divided by book value of assets.

## 5.3 Multiple Linear Regression Model

To address the research questions, the analysis involves several regressions. Written in a general form, a multiple regression model can be expressed as

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_i x_i + u, \qquad (8)$$

where $y$ is the dependent variable, $\beta_0$ and $\beta_1, \beta_2, \beta_i,$ are coefficients of the explanatory variables $x_i$, while $u$ is an error term consisting of unobserved factors. In this study, *Ln(Premium)* is used as the dependent variable. A set of different variables listed in Table 3 are used as explanatory variables. Following the notation of Core (2000) and Cao & Narayanamoorthy (2014), the regression model can be written as

$$Ln(Premium) = a_0 + a_1 litigation\, risk\, factors + a_2 Ln(Limit) + err, \qquad (9)$$

where *Premium* is the amount of D&O insurance premium a company pays for a specific coverage limit. *Litigation risk factors* represents the factors assumed to contribute to litigation risk and *Limit* is the coverage chosen by the company. In both Sections 6.2 and 6.3, four regressions named *Model 1, Model 2, Model 3, and Model 4*, are presented collectively in a table for comparison reasons. The purpose of this division is to isolate effects from certain variables, as well as increasing the goodness of fit of the estimates. *Model 1* is the base specification which only includes the volatility measure and residual limit[3] as explanatory variables. *Model 2* is an extension which also incorporates a set of potential risk factors expected to affect the price of insurance. *Model 3* controls for the categorical variable *sector,* which specifies which sector each company are operating in. Finally, *Model 4* is equal to *Model 3* except from three outliers being removed.

In the analysis, a multiple linear regression model is used, which is a linear regression model with more than one independent variable (Wooldridge, 2020). The main motivation for using a multiple regression model is to control for several factors to maintain more reliable estimates.

[3] See Section 5.4 for explanation of the residual limit.

Adding more independent variables to the regression model can explain more of the variation in insurance premium. This is an important reason for why a set of different variables is included. A potential weakness of the analysis can relate to an insufficient number of independent variables, i.e., that even more variables potentially affecting the D&O insurance premium should have been included. This issue can result in omitted variable bias, meaning that bias will occur in the results due to omitting one or more variables that actually belongs in the model. However, adding many variables who somehow are correlated to each other might lead to multicollinearity, which can undermine the statistical significance of an independent variable (Wooldridge, 2020). Thus, there is a trade-off between precision and bias. As the data sample contains variables within different categories, the sample is believed to be valid for the purpose of this analysis. With several variables from market data, accounting data, and governance data, the complete data set is considered to be comprehensive and thereby valid for the study.

### 5.3.1 Influential Observations and Outliers

Another potential source of error in regressions are associated with influential observations and outliers. An observation is an influential observation if dropping it from the analysis changes the estimates by a practically "large" amount (Wooldridge, 2020). Outliers can arise when one or several observations are very different in some relevant aspect from the rest of the observations. The decision to keep or drop such observations in a regression analysis can be difficult, since the decision will affect the minimization of squared residuals and hence the interpretation of the results. When operating with such observations, the results should probably be reported both with and without the outlying observations in cases where one or several data points substantially change the results. Within the sample, three outliers are identified and addressed. The three outliers are three different companies that all pay a large premium in respect to their coverage limit. These companies are Aurora Cannabis Inc. (ACB) in 2019, Aphria Inc. (APHA) in 2020, and TransAlta Corporation (TA) in 2020. These are identified in Figure 3 as the three most extreme observations of Panel B. Running separate regressions excluding these outliers yield substantially different results. For comparison reasons, both regressions with and without these outliers are presented in Chapter 6.

### 5.3.2 **Dummy Variables**

In the regression analysis, dummy variables are applied for *Sector, Blockholder, HCI,* and *HCI_A*. The dummy variable for *Blockholder* takes the value 1 in the case where there is a blockholder, 0 otherwise. As for *HCI* and *HCI_A*, the variables take the value 1 if the equity coverage ratio exceeds the median value. Regarding sector, dummy variables are made for each one. Since all the dummy variables for sector describe a given number of groups, the so-called dummy variable trap must be considered (Wooldridge, 2020). To avoid this trap, one sector dummy is omitted when running the regressions.

## 5.4 Estimating the Residual Limit

In his research on the topic of corporate demand for D&O insurance, Core (1997) found evidence that companies with higher litigation risk are more likely to purchase D&O insurance and carry higher limits. These findings were utilized by both Core (2000) and Cao & Narayanamoorthy (2014) when researching how various risk factors effect premiums. Following the notation of the latter, and as a continuation of Equation 9 in Section 5.3, the natural logarithm of the coverage limit is estimated as

$$Ln(Limit) = b_0 + b_1 litigation\, risk\, factors + xlimit. \tag{10}$$

The term $xlimit$ is the residual term of the regression, the residual limit, that captures the part of the limit not explained by the litigation risk factors. By substituting Equation 10 in Equation 9, the original regression model is rewritten as

$$Ln(Premium) = a_0 + b_0 a_2 + (a_1 + b_1 a_2) litigation\, risk\, factors + a_2 xlimit + err. \tag{11}$$

Equation 11 is further rewritten in a reduced form. It will then be the general expression for the regression model in the next section, written as

$$Ln(Premium) = c_0 + c_1 litigation\, risk\, factors + c_2 xlimit + err. \tag{12}$$

Equation 11 and 12 demonstrates how the litigation risk factors influence the premium. By viewing the third term of Equation 11, $a1$ is identified as the direct effect which is also found in Equation 9. Additionally, $b1a2$ is the indirect effect, the effect of litigation risk factors on the premium through the choice of limit. The analysis will focus on the total effect, as presented by the coefficient *c1* in Equation 12. For this purpose, the residual limit[4] is included in the regression to control for the effect of any limit not explained by the litigation risk factors. The same set of independent variables used in analysing the premium are included when estimating the residual limit, apart from the variable *HCI* in the equity models, and *HCI_A* in the asset models. An assumption is made that the limit is chosen by the company, and subsequently the premium is set by the insurer based on the limit and the perceived risk. To include a variable based on the coverage limit would imply interpretation of the type; "if the company choose a higher coverage limit, the company will choose a higher coverage limit". Thus, it is not considered reasonable to include this variable in the limit regressions presented in Chapter 6. However, as the assumptions might be relaxed, additional regressions are presented in Appendix C: Optional Approach: Estimation of Residuals. In this case the variables *HCI* and *HCI_A* are included as determinants of the limit, and the new estimations of the effects on premium are also presented. Throughout all estimations of the residual limit, the same observations are utilized as in the analysis of the premium. Thus, any observation where the premium is unavailable is excluded.

[4] The residual limit is denoted ResLimE and ResLimE2 in the models of Section 6.2, and ResLimA and ResLimA2 in the models of Section 6.3. ResLimE2 and ResLimA2 are qualitatively similar to ResLimE and ResLimA apart from the three outliers being excluded.

# 6. Analysis and Results

## 6.1 Estimating the Residual Limit

Table 5 presents the output from two regressions on the D&O coverage limit. From these regressions, the residuals used in the analysis of the premium are computed. The sample utilized for this estimation is the exact same as is used when analysing the premium in Sections 6.2 and 6.3. Two additional regression models are estimated where the three outliers are excluded, making sure all inputs are based on the same sample[5]. These additional models are qualitatively very similar to the ones presented in Table 5, with minor deviations in the size of the coefficients. All signs and significance levels are the same. For presentation purposes we do not find it useful to present them given that the main focus of this thesis is the analysis of the premium, and that they only differ from the presented models in the exclusion of the three observations.

Several of the proxied litigation risk factors are found to have a significant impact on the limit chosen by the companies. The size measures in Table 5, *Ln(MarketCap)* for the equity model and *Ln(Asset Value)* for the asset model, are both significant at the 1% level, with positive coefficients of 0,3984 and 0,4042 respectfully. For both models, the estimations imply a 1% increase in size to be associated with approximately 0,4% increase in coverage limit. The growth proxies, *Market Book Ratio* and *M/B-Ratio*, are both negatively significant at the 1% level. In the equity model, the estimated coefficient of -0,2939 indicates that any 10-percentage point increase in the ratio is associated with a 2,9% lower limit. The coefficient in the asset model displays a value of -0,2002. No significant relationship is found between the volatility measure and the companies' chosen limit in any of the models. However, note that both signs are positive. Further, the estimated probability of default in the asset model is not found to have a significant impact on the limit.

[5] See Appendix B for the regression analysis.

*Table 5*: *Regression of D&O coverage limit for estimation of residuals.*

| | (1)<br>Estimation for equity model | (2)<br>Estimation for asset model |
|---|---|---|
| Equity Volatility | .1278 | |
| | (.1323) | |
| Market Book Ratio | -.2939*** | |
| | (.0292) | |
| Ln(MarketCap) | .3984*** | |
| | (.0157) | |
| Asset Volatility | | .1077 |
| | | (.1909) |
| M/B-Ratio | | -.2002*** |
| | | (.0299) |
| Ln(Asset Value) | | .4042*** |
| | | (.0154) |
| P(Default) | | -.1893 |
| | | (.6788) |
| Profitability | -.2095 | -.0956 |
| | (.2866) | (.2816) |
| Leverage | .3814*** | -.0787 |
| | (.14) | (.1513) |
| Tangibility | .0311 | .0209 |
| | (.0786) | (.0769) |
| Blockholder | .0954** | .0802* |
| | (.0416) | (.0414) |
| Share Independent | 1.443*** | 1.4962*** |
| | (.1607) | (.1582) |
| Intercept | 8.6201*** | 8.2616*** |
| | (.3962) | (.3897) |
| Observations | 693 | 693 |
| R-squared | .6826 | .6917 |
| Adj $R^2$ | .6746 | .6834 |
| Sector Dummy | YES | YES |

*Standard errors are in parentheses*
**** p<.01, ** p<.05, * p<.1*

Evaluating the independent variables used across both models, the governance variables display significant impact on the limit in both the equity and asset model. Firstly, the variable controlling for the share of independent directors on the board is significant at the 1% level in both models, with coefficients of 1,443 and 1,4962 respectfully. In the equity model the coefficient is interpreted as a 10-percentage point increase in the share of independent directors being associated with a 15,5% increase in coverage limit, all else equal. Secondly, the indicator variable representing the presence of a blockholder is positively significant in both models. In the equity model, the estimated coefficient of 0,0954 is significant at the 5% level. This implies the presence of a blockholder to be associated with 10% higher coverage limits. The coefficient in the asset model of 0,0802 is significant at the 10% level.

The coefficient of *Leverage* is significantly positive in the equity model, and non-significant in the asset model. This is not surprising considering how the asset model, which is based on the Merton Model, controls for leverage in both size and volatility. It is reasonable to believe that the effect of leverage is captured by these two variables, yielding the leverage variable to display no additional significant information regarding the coverage limit. In the equity model, the coefficient of *Leverage* is informative of how high leverage companies purchase more coverage to protect themselves from litigation risk. No significant impact from *Profitability* or *Tangibility* on the limit chosen by the companies is found in these models.

Both estimated models are found to make reasonable estimations based on our expectations. The explanatory power of the models is roughly similar, with the asset model being slightly stronger measured by both R-squared and the adjusted R-squared. Based on these models, and the two additional models excluding the above-mentioned outliers, residuals for all observations are computed in order to control for the residual limit in the analysis of the premium.

## 6.2 Regressions on Premiums Using Volatility of Equity

Table 6 presents the results from four regressions of D&O insurance premium. The dependent variable in each case is the natural logarithm of the premium, and each model incorporates a set of explanatory variables expected to influence the cost of D&O insurance. A core determinant of the insurance price is the coverage limit under the insurance policy. As shown in the above section, the coverage limit depends to a large extent on the set of litigation risk factors that also influence the cost of coverage. However, as these risk factors are not able to explain all the variation in the limit, residuals from the regression are included as controls. The residuals are represented by the variables *ResLimE* for the three first models, and *ResLimE2* for the fourth model where the outliers are excluded. By doing so, we expect to see a strong positive relationship between the premium and the residuals, as the residuals represent excess limit that the litigation risk factors are unable to explain. Across all four models, the coefficients on the residual variables are significantly positive at the 1% level, confirming that any excess limit is priced in the insurance policy.

The first model shows a significantly positive relationship between the volatility of a company's stock and the insurance premium. The coefficient of 0,6432 is significant at the 1% level and is interpreted as a 10-percentage point increase in volatility leading to a 6,6% increase in the premium. This result is in line with our expectations regarding both sign and significance. The coefficient on *ResLimE* in Model 1 is 0,849. A 1% increase in residual limit is associated with a 0,849% increase in the premium. In this simple model, the premium is expected to increase relatively less than the residual limit, making the relationship disproportionate. The intercept in this model displays a significantly positive coefficient of 12,4631. Setting values of both residuals and volatility to zero, the model estimates the cost of coverage to be approximately 259 000 dollars. However, having zero volatility is not realistic. As viewed from the explanatory power of the base model, represented by R-squared and the adjusted R-squared, several important explanatory variables are missing from this simple regression model.

In Model 2 the analysis is extended to include a set of business- and litigation risk variables. All these variables are expected to have an influence on the cost of insurance. The relationship between volatility and premium is found to remain strong with a positive coefficient of 1,9223, significant at the 1% level. The model now estimates a 10-percentage point increase in stock volatility to be associated with a 21,2% increase in the premium, all else equal. This is notably higher than the estimations of Model 1. However, the extended model includes a wider range of controls expected to both increase and decrease the premium, thus reducing the omitted variable bias picked up by volatility in Model 1.

Moving from Model 1 to Model 2, the coefficient of *ResLimE* is reduced from 0,849 to 0,7513. As stated above, a coefficient of less than 1 is informative of the resiudal limit increasing relatively more than the premium. Specifically, Model 2 estimates a 1% increase in the residuals to be associated with a 0,7513% increase in the insurance price. Another interesting implication is how the coefficient in fact varies across the different specifications. Given its nature, if the premium was estimated based no other variables than those used in estimating the residuals, plus the variable representing the residuals, the same coefficient on *ResLimE* would be found across the first three models. However, as the indicator for above median coverage ratio, *HCI,* is included as control, this feature is not present in the presented models[6]. In previous sections, the company size was presented as an influential variable causing both the limit and premium to increase. In the extension presented in Model 2, *Ln(MarketCap)*, the natural logarithm of the market value of equity, is included as a proxy for company size. The variable displays a coefficient of 0,6528, significant at the 1% level. As such, larger companies are expected to pay a higher premium. This finding coincides with previous findings by Johnson et al. (2007) as the scholars found the premium to be higher for larger companies due to their greater risk of being sued.

Maintaining an above median coverage ratio is associated with a higher premium, as shown by the significant coefficient of *HCI.* Model 2 estimates how companies with an above median coverage ratio on average is expected to pay a 33,1% higher premium, all else equal. Further, the coefficient of *Market Book Ratio* is found to be significantly negative at the 1% level. Indicative of companies with a higher ratio paying a lower premium. This variable was difficult to predict in advance, considering how it could proxy for both growth opportunities, and as such risk shifting activities, and additional value in the company. Considering that the coefficient of *Market Book Ratio* is negative, we claim that the effect comes from additional value outweighing the risk, thereby explaining why the premium is lower for companies with higher ratios The findings further show that *Profitability* reduces the premium. These results confirm our intuitive expectation that profitable companies are less likely to face litigation. The relationship between *Profitability* and *Ln(Premium)* are significant at the 1% level, and the coefficient is interpreted as a 10-percentage point increase in profitability leading to a 13,8% decrease in the premium, all else equal.

The variable *Leverage* is not found to be significant, implying that leverage does not have an effect on the premium. Given the proximity between leverage and risk, we expected to find leverage to be associated with a higher premium. However, keeping in mind that the sample only consists of listed companies on the S&P/TSX Composite Index, the majority of companies are very large throughout the period examined. Hence, relatively safe loans and well-structured funding may influence the results and partly explain why no significant relationship is found. Furthermore, the coefficient of *Tangibility* is found to be positive at the

[6] In Appendix C, HCI is included as determinant of the limit. Thus, the coefficients of ResLimE is unaffected by the inclusion of risk factors in Model 2 and Model 3.

10% level. This variable might proxy for both illiquidity and the share of relatively safe investments. Safe investments are expected to be consistent with a lower premium, while illiquidity can be a sign of litigation risk, thus making the expectations regarding the variable ambiguous. The findings indicate that the premium is increasing in *Tangibility*, suggesting the illiquidity effect is dominating. The coefficient of 0,1269 is interpreted as a 10-percentage point increase in tangibility being associated with a 1,3% higher premium.

Model 2 also includes two variables as controls for corporate governance, namely the variables *Blockholder* and *Share Independent*. No significant impact on the premium is found from the indicator variable *Blockholder.* The variable representing the share of independent directors on the board, *Share Independent,* is significantly positive at the 1% level with a coefficient of 1,4212. This indicates that possible governance benefits stemming from a higher share of outsiders are outweighed by the increased risk of having a larger number of independent directors on the board. However, the share of independent directors is a strong determinant of the insurance limit, implying an alternative explanation that a large part of this effect is a result of the higher coverage limit preferred by independent directors. Any 10-percentage point increase in the share of independent directors is associated with a 15,3% increase in the premium.

In Model 2 the regression is based on the same 693 observations as in Model 1. As expected, the variation in the data is to a larger degree explained in Model 2, represented by a higher R-squared, in comparison to Model 1. 77,49% is explained through Model 2, a considerable increase compared to the 14% in Model 1. It is reasonable to believe that the strongest determinant of all variables is the size, but as both models have shown, several factors influence the cost of insurance coverage.

***Table 6:*** *Regression of D&O premium on equity volatility and other economic determinants*

| | (1)<br>Model 1 | (2)<br>Model 2 | (3)<br>Model 3 | (4)<br>Model 4 |
|---|---|---|---|---|
| Equity Volatility | .6432*** | 1.9223*** | 1.2265*** | 1.1761*** |
| | (.1956) | (.1323) | (.1339) | (.1293) |
| ResLimE | .849*** | .7513*** | .81*** | |
| | (.0843) | (.0483) | (.044) | |
| ResLimE2 | | | | .8258*** |
| | | | | (.042) |
| HCI | | .2862*** | .1144* | .1137** |
| | | (.062) | (.0603) | (.0573) |
| Market Book Ratio | | -.2279*** | -.3891*** | -.3722*** |
| | | (.0283) | (.03) | (.029) |
| Profitability | | -1.484*** | -.386 | -.6656** |
| | | (.2485) | (.2911) | (.2935) |
| Leverage | | .1303 | .6678*** | .6879*** |
| | | (.1348) | (.1424) | (.1355) |
| Tangibility | | .1269* | .1077 | .1172 |
| | | (.0698) | (.0797) | (.0759) |
| Ln(MarketCap) | | .6528*** | .605*** | .6002*** |
| | | (.022) | (.0214) | (.0204) |
| Blockholder | | .0282 | -.0041 | -.0106 |
| | | (.0437) | (.0422) | (.0402) |
| Share Independent | | 1.4212*** | 1.5141*** | 1.4557*** |
| | | (.1784) | (.165) | (.1572) |
| Intercept | 12.4631*** | -3.1075*** | -1.4962*** | -1.3322*** |
| | (.0778) | (.5174) | (.5179) | (.4944) |
| Observations | 693 | 693 | 693 | 690 |
| R-squared | .14 | .7749 | .8208 | .8334 |
| Adj $R^2$ | .1375 | .7716 | .8157 | .8287 |
| Sector Dummy | NO | NO | YES | YES |

*Standard errors are in parentheses*
**** p<.01, ** p<.05, * p<.1*

In Model 3 of Table 6, dummy variables are included for the ten different sectors as an extension of the previous models. Controlling for sector is a reasonable approach to the estimation, as some sectors are considered riskier than others. Taking a wider stance, controlling for sector allows controlling for the similarities within each sector while at the same time as breaking down the differences between them. For example, capital intensive sectors such as energy and utilities will usually have a higher tangibility due to their operations. Therefore, higher tangibility is a common feature for companies within these sectors, despite there always being some individual differences. Such characteristics can be found for any sector.

The dummy variable for the largest sector in the sample, basic materials, is omitted in Model 3. In comparing the findings from Model 3 to the ones from Model 2, the variables *Leverage, Profitability,* and *Tangibility* are highly affected by including the indicator variables for operating sectors. Model 2 did not find any significant relationship between the leverage of a company and the cost of insurance. However, the variable *Leverage* becomes significant at the 1% level with the inclusion of sector variables. This implies that the sector variables are highly informative of the vital differences in leverage between the sectors in the sample. In Model 3, *Leverage* displays a positive coefficient of 0,6678, thereby higher leverage is associated with a higher premium. Considering the riskiness of high leverage companies, this finding is in line with our initial expectation. As presented in Section 6.1, this effect is partially due to the choice of coverage limit. Alongside *Leverage* becoming significant, the coefficient of *Equity Volatility* has dropped considerably with the inclusion of sector variables. Considering that both variables are measures of risk, and that the equity market prices the risk associated with leverage, it is likely that *Equity Volatility* displays some of the variation in the premium stemming from the leverage in Model 2.

In Model 3, there is no longer a significant relationship between the variable *Tangibility* and the premium. As the expectations regarding this variable were ambiguous, finding definitive results is challenging. Furthermore, Model 3 does not find the significant relationship between *Profitability* and *Ln(Premium)* as found in Model 2. The coefficient remains negative in Model 3. However, as the standard error is larger, the effect is far more uncertain than we expected in advance.

Inconclusive results concerning at least one of the control variables motivates the inclusion of Model 4 where the three outliers are excluded. Due to this exclusion, Model 4 is estimated based on 690 observations. The R-squared and adjusted R-squared are both somewhat higher than in the previous models. In this final specification of the equity models, both *Profitability* and *Leverage* are found to have significant coefficients. Additionally, the new variable for residual limit, *ResLimE2,* is found to have a significantly positive effect on the premium at the 1% level. The coefficient is roughly similar to the coefficient of *ResLimE* in all three previous models.

## 6.3 Regressions Using the Estimated Volatility of Assets

This section analyses the results presented in Table 7. Here, the premium is estimated based on the asset value and volatility calculated using the Merton Model (1974), along with a set of independent variables similar to those used in Section 6.2. In this section the variables for high coverage ratio and market-book ratio are redefined in accordance with the procedure set out in Section 5.2. These variables are named *HCI_A* and *M/B Ratio.* Additionally, the risk-neutral probability of default, as defined by Merton (1974) and denoted *P(Default)*, is included as an explanatory variable in the regression models. Apart from this, the models presented in Table 7 are similar to the ones presented in Table 6 in the previous section.

Model 1 presented in Table 7 is the base model for the following new series of regression models. Residual limit is again found to be a significant determinant of the premium across all model specifications. In Model 1, *ResLimA* displays a positive coefficient of 0,811, significant at the 1% level. This is interpreted as a 0,81% increase in premium for each 1% increase in the residual limit. The coefficient of *Asset Volatility* is significantly positive at the 5% level, with a value of 0,517. Holding everything else equal, any 10-percentage point increase in the volatility of assets is associated with a 5,3% increase in the premium.

Moving from Model 1 to Model 2, the findings coincide with the previous findings for Model 2 in Table 6. *Asset Volatility, ResLimA,* and *Ln(Asset Value)* are all found to display positive coefficients significant at the 1% level. A higher value of any of these variables are therefore associated with a higher premium. Further, positive coefficients are also found for the variables *HCI_A*, *Tangibility*, *Share Independent,* and *P(Default).* Again, the positive coefficient of *Tangibility* indicates that the illiquidity effect is dominating, thus causing the premium to increase in this variable. Addressing the risk-neutral probability of default, the positive coefficient indicates that the premium will increase as the probability of default increases. This is reasonable, as lawsuits tend to follow weak performance, or in the worst case, default. The findings from Model 2 suggests that a 10-percentage point increase in the probability of default is associated with a 37,1% increase in the premium.

Three independent variables display negative coefficients in Model 2. The first two, namely *M/B-Ratio* and *Profitability,* are in line with our previous findings from Section 6.2. However, fining a significantly negative coefficient of *Leverage* is surprising, considering volatility and size were expected to indirectly control for leverage in these model specifications. To find the premium to be decreasing in the leverage of a company does not seem intuitive. Higher leverage tends to be associated with higher financial distress and thereby increased risk of litigation.

As previously explained, Model 3 expands the specifications of Model 2 by including indicator variables for each sector. Firstly, the coefficient of the *Asset Volatility* is reduced to 0,9717, indicating that the premium grows close to proportionate to the volatility of the assets. The model estimates that a 10-percentage point increase in volatility is associated with a 10,2% increase in the premium. Secondly, the coefficients of the variables *ResLimA* and *Ln(Asset Value)* are found to display the same attributes as in Model 2. Additionally, similar to the findings from Table 6 in Section 6.2, the coefficient of *Profitability* is found to be non-significant in Model 3 of Table 7. Hence, the interpretation of these variables remains unchanged.

Unlike the findings for *Tangibility* in Section 6.2, the coefficient in Table 7, Model 3, is found to remain significant after including indicator variables for each sector. With a coefficient of 0,1429 a 10-percentage point increase in *Tangibility* is expected to increase the premium by 1,4%, all else equal. Furthermore, the coefficients of the governance variables display similar features as found in all previous models. The share of independent directors on the board have an increasing effect on the premium, whilst no significant relationship is found between the presence of a blockholder and the premium. Regarding the probability of default, the coefficient of 2,1333 is significant at the 1% level. Hence, the relationship found in Model 2 persists, though with a lower impact as demonstrated by the reduced coefficient.

***Table 7:*** *Regression of D&O premium on estimated asset volatility and other economic determinants*

| | (1)<br>Model 1 | (2)<br>Model 2 | (3)<br>Model 3 | (4)<br>Model 4 |
|---|---|---|---|---|
| Asset Volatility | .517** | 1.8793*** | .9717*** | .9098*** |
| | (.2504) | (.2095) | (.196) | (.1893) |
| ResLimA | .811*** | .6743*** | .7444*** | |
| | (.0866) | (.0524) | (.0468) | |
| ResLimA2 | | | | .7727*** |
| | | | | (.0448) |
| HCI_A | | .3272*** | .1594*** | .1418** |
| | | (.0635) | (.06) | (.0574) |
| M/B-Ratio | | -.1723*** | -.2984*** | -.2807*** |
| | | (.0319) | (.0312) | (.0304) |
| Profitability | | -1.5305*** | -.3765 | -.6555** |
| | | (.2602) | (.29) | (.2941) |
| Leverage | | -.3387** | .1158 | .1307 |
| | | (.157) | (.1558) | (.1489) |
| Tangibility | | .1537** | .1429* | .1512** |
| | | (.0709) | (.079) | (.0754) |
| Ln(Asset Value) | | .6521*** | .614*** | .6034*** |
| | | (.0222) | (.0209) | (.02) |
| Blockholder | | .0032 | -.0378 | -.0416 |
| | | (.0454) | (.0427) | (.0408) |
| Share Independent | | 1.2869*** | 1.474*** | 1.4362*** |
| | | (.1875) | (.1699) | (.1625) |
| P(Default) | | 3.1578*** | 2.1333*** | 1.984*** |
| | | (.7881) | (.6971) | (.6704) |
| Intercept | 12.5788*** | -3.03*** | -1.7287*** | -1.4446*** |
| | (.0646) | (.5214) | (.4993) | (.4788) |
| Observations | 693 | 693 | 693 | 690 |
| R-squared | .1176 | .7631 | .821 | .8322 |
| Adj $R^2$ | .1151 | .7593 | .8156 | .8272 |
| Sector Dummy | NO | NO | YES | YES |

*Standard errors are in parentheses*
**** p<.01, ** p<.05, * p<.1*

Model 4 is equivalent to Model 3 apart from 3 outliers being excluded, reducing the number of observations to 690. The most prominent difference is found in the coefficient of *Profitability*, which in this final specification is significant at the 1%-level. Several of the coefficients in Model 4 change remarkably upon the exclusion of these observations. This is informative of the biased estimates caused by these extreme observations. In addition to *Profitability*, the volatility coefficient is notably reduced.

# 7. Discussion

In this chapter from the analysis in Chapter 6 will be discussed, focusing on how various company-related risk factors affect the premium in a D&O insurance contract. Firstly, the findings from Table 5 regarding the coverage limit will be discussed in Section 7.1. Secondly, in Section 7.2 the majority of the independent variables and their effect on the premium will be discussed. The basis for this discussion is Model 3 and Model 4 of both Table 6 and Table 7. Lastly, a comparison of the findings from the equity and the asset models will be given in Section 7.3, whereby the volatility and size measures are of special importance.

## 7.1 Determinants of Coverage Limit

The main purpose of the specific regressions presented in Table 5 is to clarify how litigation risk factors affect the premium, both directly and indirectly through the choice of coverage limit. While both the perceived risk and the choice of coverage limit are assumed to affect the pricing of insurance, this study also shows how the risk factors influence the chosen coverage limit. Thereby, to estimate the effect of any risk factor on the premium, the indirect effect must also be considered.

Starting with the variables measuring size, *Ln(MarketCap)* and *Ln(Asset Value),* both are found to be significantly positive, indicating that larger companies purchase higher limits. This seems intuitive and is also supported by the findings of Cao and Narayanamoorthy (2014) and Core (1997; 2000), even though the latter applied book value of assets as measure of size. As for the measures of growth, *Market Book Ratio* and *M/B-Ratio*, a significantly negative relationship to the limit is found, implying that companies with higher growth purchase a lower amount of limit. A higher market-book ratio implies that investors are willing to pay more for a company than what its net assets are worth. This may be indicative of healthy future profit projections that investors are willing to pay a premium for. As Lin et al. (2013) states, the ratio can be a proxy for additional value, supporting this argument. One can further argue that such companies will have less use of a large amount of coverage in case of a lawsuit, perhaps because the probability of a lawsuit is considered to be lower. On the other side, companies with high growth may be relatively small and therefore in a development phase, implying that the board might be less aware of the need and/or the importance of a D&O insurance policy. Additionally, as is also stated by Lin et al. (2013), high growth can be indicative of risk shifting activities, and such the need for coverage may be considered lower as the higher risk is already considered by investors.

Of the two models presented in Table 5, *Leverage* is only found to have a significant coefficient in model 1, the equity model. It is reasonable to believe that the missing significance in the asset model is due to the adoption of the Merton Model, whereby leverage is controlled for within the measurements for value and volatility. The positive coefficient for *Leverage* indicates that companies that are highly financed with debt tend to purchase a higher coverage limit. Several reasons can explain this relationship. For instance, higher debt is often associated with higher risk, as defaulting debt payments may lead to financial distress (Cao & Narayanamoorthy, 2014). Additionally, increasing the debt ratio is a form of gearing in the sense that the company shares will react stronger to any news, increasing the risk of litigation in the event of bad news being released. With an increased litigation risk, it is sensible to assume a higher demand for coverage limit follows.

Both governance variables display a significantly positive relationship to the limit in the regressions. In line with the findings of Cao and Narayanamoorthy (2014), a higher share of independent directors is found to be informative of higher coverage limits. A plausible explanation could be the necessity of the coverage to attract and retain experienced outside directors to serve on the board (Boyer & Tennyson, 2015). Outsiders, and professional directors in particular, may be especially aware of the risk faced as board members, therefore demanding to be either compensated or covered from any litigation risk. A weak positive relationship between the presence of a blockholder and the coverage limit acquired by the company is found. Core (2000) explains how blockholders use lawsuits as a substitute monitoring device. Higher coverage limits may for such investors seem attractive as it reduces their need to keep a close eye on the operation, given that they may recover more of their potential losses. This may explain the positive relationship between the presence of blockholders and the insurance premium. However, another potential reason might be that the board feels more at risk while being monitored by major shareholders, thus demanding better protection.

## 7.2 Explanatory Power of Independent Variables

The tables presented in the previous chapter display some variables as highly significant. This strongly indicates that there are various elements related to a company that affects the premium. We allow us to focus mainly on Model 3 and Model 4, as they are considered the most comprehensive ones due to the higher number of independent variables included. We examine if, and what, effect the chosen independent variables have on the insurance premium. The findings from Section 6.2 and Section 6.3 are discussed in light of our expectations and previous research.

The main difference between Table 6 and Table 7 is the choice of volatility measure and size measure; equity volatility versus asset volatility, and market capitalization versus the estimated asset value derived using the Merton Model. There are merely marginal differences in the coefficients of the majority of the significant variables across all the models. As expected, the findings indicate a positive relationship between the residual limit and premium. This is in line with the findings of Core (2000), where the residual limit is found to have an increasing effect on the premium. Additionally, this is also in compliance with general insurance theory as presented in Section 2.1, where the premium is a function of, among others, the payout in case of a loss (Berk & DeMarzo, 2017). These findings suggest that any residual limit is priced by the insurer. Our analysis finds that the limit has a greater influence on the premium than that found by Core (2000). A possible explanation can be that the article was written before the Enron scandal, the dotcom bubble, and the financial crisis. Furthermore, as Bailey (2005) states, the number of lawsuits against board members have increased. Hence, it is reasonable to believe that the price of D&O insurance has increased due to both the named events and the increased frequency of lawsuits.

Regarding financial variables used in the analysis, both *Profitability* and *Leverage* are found to be significant. *Profitability* is indicative of lower premiums as shown by the negative coefficient in the regression models. However, for both Table 6 and Table 7 the variable is only found to be significant in Model 4. The negative relation is expected since a higher profitability indicates a lower risk of financial distress and, potentially, bankruptcy. The study by Lin et al. (2013) supports this argument, as they state that profitable firms are less likely to default. Conversely, Cao and Narayanamoorthy (2014) use an indicator variable for loss when studying accounting and litigation risk associated with the insurance premium. Cao and Narayanamoorthy find a positive relationship, indicating that a loss in the last fiscal year prior to the effective date of the insurance policy increases the insurance premium. This substantiates our findings. As for *Leverage*, we expected to find higher premiums with higher leverage, as it may increase the probability of financial distress and bankruptcy (Lin et al., 2013). This independent variable is significant in both Model 3 and Model 4 of Table 6, suggesting that companies with higher debt and current liabilities relative to total assets are paying a higher insurance premium. Cao and Narayanamoorthy (2014) find a significantly positive relationship between leverage and premium, thereby supporting our findings. Contrary to this, Boyer and Stern (2012) do not find any significant relationship between leverage and premium in their analysis. Boyer and Stern further explain how the debtholder monitoring hypothesis implies a negative relationship between leverage and the potential cost of litigation, as debtholders monitor management. Due to the diverse findings regarding leverage in these previous studies, our findings must be interpreted with caution.

A third financial ratio devoted attention to in our models is *Tangibility*, which is found to have a significant increasing effect on the premium in Table 7. Given the positive coefficient of the variable, we suspect that it functions as a proxy for illiquidity risk that will increase the premium. As tangible assets are not easily liquidated, a high share of tangible assets could be associated with a higher payout risk for the company. In times of distress, difficulties to make expected payments, such as dividends, could be amplified by high shares of tangible assets. Thus, the variable can be positively associated with premiums as a measure of payout risk. However, as the relationship is not found to be significant in any of the models in Table 6, there is a possibility that the estimated effect is spurious and only visible due to the specification of any other variables in the asset models.

In the literature, Egger et al. (2015) and Core (1997) both proxy the market-to-book ratio for growth potential of the company. Core (1997) states that a higher value implies higher coverage and subsequently a higher premium, as the shareholders want to avoid underinvestment problems. To exploit these growth opportunities, managers are expected to take on higher risk, explaining the need for higher coverage, and as such a higher premium. On the other hand, Lin et al. (2013) states that the market-to-book ratio can also proxy for additional value over liquidation that is left for creditors in distress. This argument was presented in the study where Lin et al. (2013) examined the effect of D&O insurance on the cost of debt. A further extension of this argument could help explain our negative coefficients of *Market Book Ratio* and *M/B-Ratio*, where the additional value is associated with a lower premium. This result is found for Model 3 and Model 4 in both Table 6 and Table 7, giving us a reason to believe that the measure is risk-reducing when also controlling for the size of the company.

The high-coverage indicators, *HCI* and *HCI_A*, define whether companies maintain above median coverage relative to their size as measured by market capitalization or estimated asset value. The measures are found to have a significantly positive relationship with the premium in all model specifications presented. When a company maintains a higher level of protection than what could be expected based on their size, this is found to be priced by the insurer. This is interpreted in the light of asymmetric information, where those who buy extensive protection are more likely to receive a payout in the future due to less rigid incentives to act with due care (Weterings, 2015). Thus, the high-coverage group is considered riskier, explaining the higher premium for such companies.

Regarding the two governance variables included, only the share of independent directors are found to be significant across all models. However, some attention is still devoted to the blockholder-indicator. Initially, we expected to find the presence of a blockholder to be associated with lower premiums due to the monitoring capacity of these shareholders. As our models look at the total effect, finding no significant relationship may be partly due to the direct and indirect effect moving in different directions. As shown in Table 5, the indirect effect on the premium, through the choice of coverage limit, is positive in the presence of a blockholder. As no significant impact of *Blockholder* on the premium is detected, we believe this may be attributed to ambiguous effects. Despite this, we acknowledge that the total effect is non-significant, indicating that any potential benefit from monitoring is lost through the higher limits.

From the variable *Share Independent,* premium is found to be increasing in the share of independent directors. This is contrary to our expectations and the findings of both Cao and Narayanamoorthy (2014) and Otto and Weterings (2019). They both argue that a higher share of independent directors is indicative of a strong corporate governance, which in turn reduces the premium. However, as demonstrated by Ning and Xuesong (2018), the presence of D&O insurance can also decrease the effectiveness of independent directors, and hence increase the premium. Both sides make reasonable arguments regarding the effect of governance variables, therefore the effect seems to be ambiguous. Nonetheless, our findings indicate that the effectiveness reduction set out by Ning and Xuesong (2018) is dominating, thereby causing the premium to be increasing with the share of independents.

## 7.3 Equity Versus Asset Apporach

In this section, we compare our two different approaches to the models presented in Chapter 6. That is, the results presented in Table 6 using equity volatility and value, and the results presented in Table 7 using the estimated asset volatility and value. Considering how a lawsuit directed against the directors and officers of a company can come from any stakeholder, we assert that asset volatility should be a better measure of the riskiness of a company and hence of the premium. However, seen in the belief that most D&O related claims come from shareholders of the company, the importance of the equity volatility should not be underestimated. This leaves the question more open to which volatility measure is preferable.

Before assessing the volatility measures in our models, some attention is devoted to the two different size measures utilized in the regressions. The natural logarithm of market capitalization used as size measure in Table 6 is, by definition, always smaller than the natural logarithm of assets used in Table 7, as equity can never account for more than 100% of financing. All else equal, we would expect to find a higher coefficient on the former. Company size, proxied by the natural logarithm of market capitalization, is used to explain the premium in Cao and Narayanamoorthy (2014). Additionally, Core (2000) uses book value of assets as size measure and shows how larger firms are more likely to be sued due to their deeper pockets. Our estimation of the market value of assets based on the Merton Model (1974) is simply a crossing of these two common approaches; we control for leverage but still use estimates for market values. Across all our model specifications, in line with the existing research, company size is found to be a significant determinant of the insurance premium. Larger firms are expected to pay a higher premium when considering both the effect coming from choice of coverage limit and the risk associated with company size.

Further, the estimated risk-neutral probability of default is found to be positively associated with the premium. A similar measure was utilized by Core (1997) in examining the demand for D&O insurance and coverage limit. Our research examines how a given probability of default affects the insurance premium. Companies closer to defaulting, measured by *P(Default)*, are presumed to face higher litigation risk due to unsatisfied stakeholders. Along with poor financial performance in general, default can be a triggering factor for a lawsuit against directors and officers. This explains the proposed relationship where high-risk companies pay a larger premium, all else equal. Unlike Core (1997), we do not find the measure to influence the chosen coverage limit. We do acknowledge that our variable definition is not fully equal to that of Core, but we find similarities that we believe make them close replacements and thus comparable.

Volatility is found to be a significant determinant of the premium in all model specifications, when controlling for all other business and litigation risk factors. Stock volatility is a common measure of risk, especially in modern portfolio theory (Berk & DeMarzo, 2017). Finding a positive relationship between volatility and the premium is interesting for several reasons. Firstly, we acknowledge the fact that historic performance is no guarantee of future performance. There may be a variety of reasons causing stock volatility to be high in one year without yielding relevant information regarding future volatility. Secondly, neither Core (2000) nor Cao and Narayanamoorthy (2014) find a definite significant relationship between stock volatility and the D&O insurance premium. Although Cao and Narayanamoorthy (2014) find their independent variable to be significant in some of their model specifications, this relationship vanishes when extending their set of independent variables. As such, previous research has not been able to find any clear connection between market risk and the premium, contrary to our findings.

Addressing why our findings differ from previous renowned studies, one plausible reason may be related to the period the samples were extracted from. Core (2000) extracted his sample from fiscal years ending between June 1st, 1993, and May 31st, 1994, while Cao and Narayanamoorthy (2014) used data from the Tillinghast Survey in the period 2001 to 2004. Our sample consist of insurance data collected for the period 2010 to 2020. As such, at least 6 years separate the samples whereby major events such as the financial crisis occurred. Additionally, the Enron collapse in 2001 and the dotcom bubble in the late 90s are, as previously stated, considered important events in the history of D&O insurance. The effects of these events were not present in the study by Core (2000). It is unclear to what extent the effect was captured in the study by Cao and Narayanamoorthy (2014), as the sampling period coincides with some of the events. As demonstrated by Bailey (2005), the Enron collapse caused a tremendous change in the market for D&O insurance, and in the years that followed, premiums skyrocketed (Taub, 2004). Even though the main focus in Enron was governance practices, a more complex view of risk must have been undertaken by insurers.

Yet another point at which our study stands out from those of Core (2000) and Cao & Narayanamoorthy (2014) is the length of the sample period. While these previous studies use only one and four years respectfully, our sample consists of up to 11 years per company. This leaves us with a data set that is larger than any of these previous studies. The larger sample might make it easier to detect variation in volatility after controlling for a variety of different risk factors. Considering how stock volatility is also affected by market volatility, we believe a longer sample period is advantageous for the purpose of this study. In this way, the analysis will be less sensitive to large fluctuations in market volatility. As shown, our findings regarding volatility differ from those of Core (2000) and Cao and Narayanamoorthy (2014). This might indicate that the market is maturing, in the sense that the insurers have increased their understanding and incorporation of risk over the last decades.

A potential weakness in our specifications is that the volatility measure might pick up effect coming from unknown omitted variables, causing an omitted variable bias in the analysis. However, as the analysis controls for risk stemming from a variety of sources, including market value, ratios computed from financial statements, governance quality, and the obtained coverage, we believe our estimations to be representative for the purpose of this study. Our findings suggests that the asset approach and the equity approach are equally good in estimating the premium. The models display relatively similar explanatory power measured by R-squared, in addition to making reasonable estimates regarding the effect of the independent variables.

# 8. Conclusion

In this thesis, we examine how various company-related factors affect the D&O insurance premium using a sample of Canadian companies in the from 2010 to 2020. D&O insurance have existed for a very long time, and previous literature deals with several different aspects of the policy. Examples include D&O insurance and loan spreads (Lin et al., 2013), how financial reporting concerns are priced in the insurance (Cao & Narayanamoorthy, 2014), D&O insurance and corporate governance (Otto & Weterings, 2019), among many others. Yet, few studies on the relationship between the premium and financial risk factors are found. This is the motivating factor for our study, and our goal is to answer the following research question:

*How are different company-related risk factors incorporated in the premium of Director's and Officer's Liability insurance?*

Given the historical development of the D&O insurance, in addition to the increased frequency of lawsuits against directors and officers, we believe that correct pricing is essential for all parties of the insurance contract. The insurance company will naturally set the right price on their product to receive the desired profit, the insured company on their side are interesting in paying a fair price, and the third party is interested in receiving a fair amount in the case of a payout.

Our results suggests that several company-related factors in fact affect the price Canadian companies must pay for a D&O insurance. In accordance with basic insurance theory, the insurance premium should be set as a function of the coverage limit provided (Berk & DeMarzo, 2017). Our findings suggests that this holds in the real world as well, considering that we found a significant relationship between the premium and the coverage limit. According to our findings, insurance companies providing D&O insurance will incorporate information about companies' leverage, profitability, market to book value, market capitalization, and other factors, in the preparation of insurance contracts.

With regards to our findings using the Merton Model, we do not find the asset approach to yield a better fit than the equity approach. Hence, the choice of volatility measurement is not found to be critical when estimating the effects on the premium. Our findings suggest that both approaches perform equally good, since several independent variables are found to have significant effects with reasonable coefficients regarding both sign and magnitude. We therefore conclude that the volatility of a company is considered in the pricing of the D&O insurance, along with several other risk factors.

Working with this thesis has revealed a spectre of interesting problems. We believe there are many issues yet to be addressed within the field of D&O insurance, either seen from the insurance company's point of view, or from that of the insured company. With this thesis, we hope to have contributed in a way that inspires future research on D&O insurance and litigation risk. Since our study, among many others, deals with Canadian companies, we believe a similar study for European and/or Nordic countries would be interesting, as the markets highly differ from the ones in North America regarding regulations and the litigation culture. Because D&O insurance data generally are not publicly available for most European countries, this problem is not assessed, leaving it open for further research.

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# Appendices

## Appendix A: List of Companies

Appendix A presents the complete list of companies listed on the S&P/TSX Composite Index as of February 26th 2021, including their belonging sector stated to the right.

| | |
|---|---|
| Aecon Group Inc.,ARE | industrials |
| Agnico Eagle Mines Limited,AEM | basic materials |
| Air Canada Voting and Variable Voting Shares,AC | industrials |
| Alamos Gold Inc.,AGI | basic materials |
| Algonquin Power & Utilities Corp.,AQN | utilities |
| Alimentation Couche-Tard Inc. Class B Subordinate Voting Shares,ATD.B | consumer defensive |
| Allied Properties Real Estate Investment Trust,AP.UN | real estate |
| AltaGas Ltd.,ALA | utilities |
| Altus Group Limited,AIF | real estate |
| Aphria Inc.,APHA | health care |
| ARC Resources Ltd.,ARX | energy |
| Aritzia Inc. Subordinate Voting Shares,ATZ | consumer cyclical |
| Artis Real Estate Investment Trust,AX.UN | real estate |
| ATCO Ltd. Class I Non-voting Shares,ACO.X | utilities |
| ATS Automation Tooling Systems Inc.,ATA | industrials |
| Aurinia Pharmaceuticals Inc.,AUP | health care |
| Aurora Cannabis Inc.,ACB | health care |
| B2Gold Corp.,BTO | basic materials |
| Badger Daylighting Ltd.,BAD | industrials |
| Ballard Power Systems Inc.,BLDP | industrials |
| Bank of Montreal,BMO | financial services |
| Bank of Nova Scotia (The),BNS | financial services |
| Barrick Gold Corporation,ABX | basic materials |
| Bausch Health Companies Inc.,BHC | health care |
| BCE Inc.,BCE | communication services |
| BlackBerry Limited,BB | technology |
| Boardwalk Real Estate Investment Trust,BEI.UN | real estate |
| Boralex Inc. Class A Shares,BLX | utilities |
| Boyd Group Services Inc.,BYD | consumer cyclical |
| Brookfield Asset Management Inc. Class A Limited Voting Shares,BAM.A | financial services |
| Brookfield Business Partners L.P.,BBU.UN | industrials |
| Brookfield Infrastructure Partners L.P.,BIP.UN | utilities |
| Brookfield Property Partners L.P.,BPY.UN | real estate |
| Brookfield Renewable Partners L.P.,BEP.UN | utilities |
| BRP Inc. Subordinate Voting Shares,DOO | consumer cyclical |

| | |
|---|---|
| CAE Inc.,CAE | industrials |
| Cameco Corporation,CCO | energy |
| Canada Goose Holdings Inc. Subordinate Voting Shares,GOOS | consumer cyclical |
| Canadian Apartment Properties Real Estate Investment Trust,CAR.UN | real estate |
| Canadian Imperial Bank Of Commerce,CM | financial services |
| Canadian National Railway Company,CNR | industrials |
| Canadian Natural Resources Limited,CNQ | energy |
| Canadian Pacific Railway Limited,CP | industrials |
| Canadian Tire Corporation Limited Class A Non-Voting Shares,CTC.A | consumer cyclical |
| Canadian Utilities Limited Class A Non-Voting Shares,CU | utilities |
| Canadian Western Bank,CWB | financial services |
| Canfor Corporation,CFP | basic materials |
| Canopy Growth Corporation,WEED | health care |
| Capital Power Corporation,CPX | utilities |
| Cargojet Inc. Common and Variable Voting Shares,CJT | industrials |
| Cascades Inc.,CAS | basic materials |
| CCL Industries Inc. Unlimited Class B Non-Voting Shares,CCL.B | consumer cyclical |
| Celestica Inc. Subordinate Voting Shares,CLS | technology |
| Cenovus Energy Inc.,CVE | energy |
| Centerra Gold Inc.,CG | basic materials |
| CGI Inc. Class A Subordinate Voting Shares,GIB.A | technology |
| Chartwell Retirement Residences,CSH.UN | real estate |
| Choice Properties Real Estate Investment Trust,CHP.UN | real estate |
| CI Financial Corp.,CIX | financial services |
| Cogeco Communications Inc. Subordinate Voting Shares,CCA | communication services |
| Colliers International Group Inc. Subordinate Voting Shares,CIGI | real estate |
| Cominar Real Estate Investment Trust,CUF.UN | real estate |
| Constellation Software Inc.,CSU | technology |
| Corus Entertainment Inc. Class B Non-Voting Shares,CJR.B | communication services |
| Crescent Point Energy Corp.,CPG | energy |
| Crombie Real Estate Investment Trust,CRR.UN | real estate |
| Cronos Group Inc.,CRON | health care |
| CT Real Estate Investment Trust,CRT.UN | real estate |
| Descartes Systems Group Inc. (The),DSG | technology |
| Dollarama Inc.,DOL | consumer defensive |
| Dream Industrial Real Estate Investment Trust,DIR.UN | real estate |
| Dream Office Real Estate Investment Trust,D.UN | real estate |
| Dundee Precious Metals Inc.,DPM | basic materials |
| ECN Capital Corp.,ECN | financial services |
| Eldorado Gold Corporation,ELD | basic materials |
| Element Fleet Management Corp.,EFN | industrials |
| Emera Incorporated,EMA | utilities |
| Empire Company Limited Non-Voting Class A Shares,EMP.A | consumer defensive |
| Enbridge Inc.,ENB | energy |
| Endeavour Mining Corporation,EDV | basic materials |
| Enerplus Corporation,ERF | energy |
| Enghouse Systems Limited,ENGH | technology |

| | |
|---|---|
| Equinox Gold Corp.,EQX | basic materials |
| Equitable Group Inc.,EQB | financial services |
| Ero Copper Corp.,ERO | basic materials |
| Exchange Income Corporation,EIF | industrials |
| Fairfax Financial Holdings Limited Subordinate Voting Shares,FFH | financial services |
| Finning International Inc.,FTT | industrials |
| First Capital Real Estate Investment Trust,FCR.UN | real estate |
| First Majestic Silver Corp.,FR | basic materials |
| First Quantum Minerals Ltd.,FM | basic materials |
| FirstService Corporation,FSV | real estate |
| Fortis Inc.,FTS | utilities |
| Fortuna Silver Mines Inc.,FVI | basic materials |
| Franco-Nevada Corporation,FNV | basic materials |
| Genworth MI Canada Inc.,MIC | financial services |
| George Weston Limited,WN | consumer defensive |
| GFL Environmental Inc. subordinate voting shares,GFL | industrials |
| Gibson Energy Inc.,GEI | energy |
| Gildan Activewear Inc.,GIL | consumer cyclical |
| Granite Real Estate Investment Trust,GRT.UN | real estate |
| Great Canadian Gaming Corporation,GC | consumer cyclical |
| Great-West Lifeco Inc.,GWO | financial services |
| H&R Real Estate Investment Trust,HR.UN | real estate |
| Home Capital Group Inc.,HCG | financial services |
| Hudbay Minerals Inc.,HBM | basic materials |
| Hydro One Limited,H | utilities |
| iA Financial Corporation Inc.,IAG | financial services |
| IAMGOLD Corporation,IMG | basic materials |
| IGM Financial Inc.,IGM | financial services |
| Imperial Oil Limited,IMO | energy |
| Innergex Renewable Energy Inc.,INE | utilities |
| Intact Financial Corporation,IFC | financial services |
| Inter Pipeline Ltd.,IPL | energy |
| Interfor Corporation,IFP | basic materials |
| InterRent Real Estate Investment Trust,IIP.UN | real estate |
| Intertape Polymer Group Inc.,ITP | consumer cyclical |
| Ivanhoe Mines Ltd.,IVN | basic materials |
| Jamieson Wellness Inc.,JWEL | consumer defensive |
| Keyera Corp.,KEY | energy |
| Killam Apartment Real Estate Investment Trust,KMP.UN | real estate |
| Kinaxis Inc.,KXS | technology |
| Kinross Gold Corporation,K | basic materials |
| Kirkland Lake Gold Ltd.,KL | basic materials |
| Labrador Iron Ore Royalty Corporation,LIF | basic materials |
| Laurentian Bank of Canada,LB | financial services |
| Lightspeed POS Inc. Subordinate Voting Shares,LSPD | technology |
| Linamar Corporation,LNR | consumer cyclical |
| Loblaw Companies Limited,L | consumer defensive |
| Lundin Gold Inc.,LUG | basic materials |

| | |
|---|---|
| Lundin Mining Corporation,LUN | basic materials |
| MAG Silver Corp.,MAG | basic materials |
| Magna International Inc.,MG | consumer cyclical |
| Manulife Financial Corporation,MFC | financial services |
| Maple Leaf Foods Inc.,MFI | consumer defensive |
| Martinrea International Inc.,MRE | consumer cyclical |
| MEG Energy Corp.,MEG | energy |
| Methanex Corporation,MX | basic materials |
| Metro Inc.,MRU | consumer defensive |
| Morneau Shepell Inc.,MSI | industrials |
| Mullen Group Ltd.,MTL | energy |
| National Bank of Canada,NA | financial services |
| New Gold Inc.,NGD | basic materials |
| NFI Group Inc.,NFI | consumer cyclical |
| North West Company Inc. (The),NWC | consumer defensive |
| Northland Power Inc.,NPI | utilities |
| NorthWest Healthcare Properties Real Estate Investment Trust,NWH.UN | real estate |
| NovaGold Resources Inc.,NG | basic materials |
| Nutrien Ltd.,NTR | basic materials |
| OceanaGold Corporation,OGC | basic materials |
| ONEX Corporation Subordinate Voting Shares,ONEX | financial services |
| Open Text Corporation,OTEX | technology |
| Osisko Gold Royalties Ltd,OR | basic materials |
| Osisko Mining Inc.,OSK | basic materials |
| Pan American Silver Corp.,PAAS | basic materials |
| Parex Resources Inc.,PXT | energy |
| Parkland Corporation,PKI | energy |
| Pembina Pipeline Corporation,PPL | energy |
| Power Corporation of Canada Subordinate Voting Shares,POW | financial services |
| PrairieSky Royalty Ltd.,PSK | energy |
| Premium Brands Holdings Corporation,PBH | consumer defensive |
| Pretium Resources Inc.,PVG | basic materials |
| Primo Water Corporation,PRMW | consumer defensive |
| Quebecor Inc. Class B Subordinate Voting Shares,QBR.B | communication services |
| Real Matters Inc.,REAL | technology |
| Restaurant Brands International Inc.,QSR | consumer cyclical |
| Richelieu Hardware Ltd.,RCH | consumer cyclical |
| RioCan Real Estate Investment Trust,REI.UN | real estate |
| Ritchie Bros. Auctioneers Incorporated,RBA | industrials |
| Rogers Communications Inc. Class B Non-voting Shares,RCI.B | communication services |
| Royal Bank of Canada,RY | financial services |
| Russel Metals Inc.,RUS | industrials |
| Sandstorm Gold Ltd.,SSL | basic materials |
| Saputo Inc.,SAP | consumer defensive |
| Seabridge Gold Inc.,SEA | basic materials |
| Seven Generations Energy Ltd. class A,VII | energy |

| | |
|---|---|
| Shaw Communications Inc. Class B Non-voting Shares,SJR.B | communication services |
| Shopify Inc. Class A Subordinate Voting Shares,SHOP | technology |
| Sienna Senior Living Inc.,SIA | health care |
| Silvercorp Metals Inc.,SVM | basic materials |
| SilverCrest Metals Inc.,SIL | basic materials |
| Sleep Country Canada Holdings Inc.,ZZZ | consumer cyclical |
| SmartCentres Real Estate Investment Trust,SRU.UN | real estate |
| SNC-Lavalin Group Inc.,SNC | industrials |
| Spin Master Corp. Subordinate Voting Shares,TOY | consumer cyclical |
| Sprott Inc.,SII | financial services |
| SSR Mining Inc.,SSRM | basic materials |
| Stantec Inc.,STN | industrials |
| Stella-Jones Inc.,SJ | basic materials |
| Summit Industrial Income REIT,SMU.UN | real estate |
| Sun Life Financial Inc.,SLF | financial services |
| Suncor Energy Inc.,SU | energy |
| Superior Plus Corp.,SPB | utilities |
| TC Energy Corporation,TRP | energy |
| Teck Resources Limited Class B Subordinate Voting Shares,TECK.B | basic materials |
| TELUS Corporation,T | communication services |
| TFI International Inc.,TFII | industrials |
| Thomson Reuters Corporation,TRI | industrials |
| TMX Group Limited,X | financial services |
| Torex Gold Resources Inc.,TXG | basic materials |
| Toromont Industries Ltd.,TIH | industrials |
| Toronto-Dominion Bank (The),TD | financial services |
| Tourmaline Oil Corp.,TOU | energy |
| TransAlta Corporation,TA | utilities |
| TransAlta Renewables Inc.,RNW | utilities |
| Transcontinental Inc. Class A Subordinate Voting Shares,TCL.A | industrials |
| Tricon Residential Inc.,TCN | real estate |
| Trillium Therapeutics Inc.,TRIL | health care |
| Vermilion Energy Inc.,VET | energy |
| Waste Connections Inc.,WCN | industrials |
| Wesdome Gold Mines Ltd.,WDO | basic materials |
| West Fraser Timber Co. Ltd.,WFG | basic materials |
| Westshore Terminals Investment Corporation,WTE | industrials |
| Wheaton Precious Metals Corp.,WPM | basic materials |
| Whitecap Resources Inc.,WCP | energy |
| Winpak Ltd.,WPK | consumer cyclical |
| WPT Industrial Real Estate Investment Trust,WIR.UN | real estate |
| WSP Global Inc.,WSP | industrials |
| Yamana Gold Inc.,YRI | basic materials |

# Appendix B: Regression on Ln(Limit) Excluding Outliers

Appendix B shows the regressions on *Ln(Limit)* when excluding the outliers. Residuals are used as explanatory variables in model 4 of Table 5 and Table 6.

| | (1)<br>Estimation for equity model | (2)<br>Estimation for asset model |
|---|---|---|
| Equity Volatility | .1745 | |
| | (.1342) | |
| Market Book Ratio | -.3055*** | |
| | (.0296) | |
| Ln(MarketCap) | .4031*** | |
| | (.0159) | |
| Asset Volatility | | .1635 |
| | | (.1928) |
| M/B-Ratio | | -.2134*** |
| | | (.0305) |
| Ln(Asset Value) | | .409*** |
| | | (.0156) |
| P(Default) | | -.027 |
| | | (.683) |
| Profitability | -.0142 | .109 |
| | (.3032) | (.2983) |
| Leverage | .388*** | -.0698 |
| | (.1399) | (.1512) |
| Tangibility | .0262 | .0165 |
| | (.0786) | (.0769) |
| Blockholder | .0915** | .0768* |
| | (.0417) | (.0415) |
| Share Independent | 1.4561*** | 1.5118*** |
| | (.1608) | (.1583) |
| Intercept | 8.4913*** | 8.1302*** |
| | (.4014) | (.3946) |
| Observations | 690 | 690 |
| R-squared | .6844 | .6936 |
| Adj $R^2$ | .6764 | .6854 |
| Sector Dummy | YES | YES |

*Standard errors are in parentheses*
**** p<.01, ** p<.05, * p<.1*

# Appendix C: Optional Approach: Estimation of Residuals

Regressions on *Ln(Limit)* where we include *HCI* or *HCI_A* as determinants. Model 1 and 3 are estimated from the complete sample, while Model 2 and 4 are estimated from the reduced sample in which the 3 outliers are removed.

Table: Regressions of D&O coverage limit for estimation of residuals

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Estimations for equity model | | Estimations for asset model | |
| Equity Volatility | .1698 | .2008* | | |
| | (.1171) | (.1189) | | |
| HCI | .6392*** | .6349*** | | |
| | (.0466) | (.0467) | | |
| Market Book Ratio | -.2376*** | -.2459*** | | |
| | (.0261) | (.0266) | | |
| Ln(MarketCap) | .5503*** | .5524*** | | |
| | (.0178) | (.0179) | | |
| Asset Volatility | | | .0323 | .0658 |
| | | | (.1614) | (.1631) |
| HCI_A | | | .687*** | .6849*** |
| | | | (.0417) | (.0418) |
| M/B-Ratio | | | -.1389*** | -.1477*** |
| | | | (.0255) | (.0261) |
| Ln(Asset Value) | | | .5611*** | .5635*** |
| | | | (.0161) | (.0162) |
| P(Default) | | | .154 | .253 |
| | | | (.5739) | (.5777) |
| Profitability | -.4795* | -.3453 | -.3759 | -.2453 |
| | (.2544) | (.2697) | (.2385) | (.2531) |
| Leverage | .2268* | .2316* | -.2277* | -.2245* |
| | (.1244) | (.1245) | (.1282) | (.1282) |
| Tangibility | .0869 | .0832 | .0462 | .0429 |
| | (.0697) | (.0698) | (.065) | (.065) |
| Blockholder | .069* | .0669* | .0327 | .0321 |
| | (.0369) | (.037) | (.0351) | (.0352) |
| Share Independent | 1.144*** | 1.1561*** | .9245*** | .941*** |
| | (.1439) | (.1442) | (.1381) | (.1383) |
| Intercept | 5.1426*** | 5.0797*** | 4.8388*** | 4.7653*** |
| | (.4327) | (.4353) | (.3894) | (.3917) |
| Observations | 693 | 690 | 693 | 690 |
| R-squared | .7518 | .7525 | .7802 | .7813 |
| Adj $R^2$ | .7452 | .7459 | .774 | .7751 |
| Sector Dummy | YES | YES | YES | YES |

*Standard errors are in parentheses*
**** p<.01, ** p<.05, * p<.1*

Regressions on *Ln(Premium)* where *ResLimE* and *ResLimE2* where estimated from regressions on *Ln(Limit)* that included the indicator variable *HCI* as determinant. Model 1 is base specification, Model 2 includes business and litigation risk factors, Model 3 extends our specification by including dummy variables for sector, and Model 4 removes the 3 identified outliers.

Table: Regressions of D&O premium on equity volatility and other economic determinants

| | (1) Model 1 | (2) Model 2 | (3) Model 3 | (4) Model 4 |
|---|---|---|---|---|
| Equity Volatility | .6432*** | 1.9053*** | 1.2605*** | 1.1977*** |
| | (.1997) | (.1293) | (.1339) | (.1293) |
| ResLimE | .81*** | .81*** | .81*** | |
| | (.0973) | (.0479) | (.044) | |
| ResLimE2 | | | | .8258*** |
| | | | | (.042) |
| HCI | | .7099*** | .6321*** | .638*** |
| | | (.0545) | (.0533) | (.0508) |
| Market Book Ratio | | -.2003*** | -.3435*** | -.323*** |
| | | (.0276) | (.0299) | (.0289) |
| Profitability | | -1.6618*** | -.6047** | -.9391*** |
| | | (.2426) | (.2909) | (.2932) |
| Leverage | | .0863 | .5426*** | .5588*** |
| | | (.1318) | (.1423) | (.1354) |
| Tangibility | | .0845 | .1529* | .1642** |
| | | (.0682) | (.0797) | (.0758) |
| Ln(MarketCap) | | .7512*** | .728*** | .7235*** |
| | | (.0206) | (.0204) | (.0195) |
| Blockholder | | .0096 | -.0255 | -.0309 |
| | | (.0427) | (.0422) | (.0402) |
| Share Independent | | 1.2077*** | 1.272*** | 1.208*** |
| | | (.1739) | (.1645) | (.1567) |
| Intercept | 12.4631*** | -5.2609*** | -4.3127*** | -4.1493*** |
| | (.0794) | (.4873) | (.4948) | (.4732) |
| Observations | 693 | 693 | 693 | 690 |
| R-squared | .1035 | .7849 | .8208 | .8334 |
| Adj $R^2$ | .1009 | .7817 | .8157 | .8287 |
| Sector Dummy | NO | NO | YES | YES |

*Standard errors are in parentheses*
**** p<.01, ** p<.05, * p<.1*

Regressions on *Ln(Premium)* where *ResLimA* and *ResLimA2* where estimated from regressions on *Ln(Limit)* that included the indicator variable *HCI_A* as determinant. Model 1 is base specification, Model 2 includes business and litigation risk factors, Model 3 extends our specification by including dummy variables for sector, and Model 4 removes the 3 identified outliers.

Table: Regressions on D&O premium on estimated asset volatility and other economic determinants

| | (1) Model 1 | (2) Model 2 | (3) Model 3 | (4) Model 4 |
|---|---|---|---|---|
| Asset Volatility | .517** | 1.8091*** | .9155*** | .8343*** |
| | (.2567) | (.2051) | (.1959) | (.1892) |
| ResLimA | .7444*** | .7444*** | .7444*** | |
| | (.1051) | (.0524) | (.0468) | |
| ResLimA2 | | | | .7727*** |
| | | | | (.0448) |
| HCI_A | | .7412*** | .6708*** | .671*** |
| | | (.0536) | (.0507) | (.0485) |
| M/B-Ratio | | -.146*** | -.2527*** | -.2299*** |
| | | (.0312) | (.031) | (.0302) |
| Profitability | | -1.7691*** | -.5852** | -.9294*** |
| | | (.2542) | (.2897) | (.2937) |
| Leverage | | -.3794** | .0049 | .0111 |
| | | (.1537) | (.1556) | (.1487) |
| Tangibility | | .1094 | .1617** | .1716** |
| | | (.0693) | (.079) | (.0754) |
| Ln(Asset Value) | | .7453*** | .7307*** | .7228*** |
| | | (.0205) | (.0196) | (.0188) |
| Blockholder | | -.0292 | -.0732* | -.0762* |
| | | (.0444) | (.0426) | (.0408) |
| Share Independent | | .9432*** | 1.0484*** | .9951*** |
| | | (.1817) | (.1677) | (.1604) |
| P(Default) | | 3.2212*** | 2.3888*** | 2.2004*** |
| | | (.7718) | (.697) | (.6703) |
| Intercept | 12.5788*** | -4.9985*** | -4.2768*** | -4.0449*** |
| | (.0662) | (.4881) | (.4729) | (.4544) |
| Observations | 693 | 693 | 693 | 690 |
| R-squared | .0728 | .7728 | .821 | .8322 |
| Adj $R^2$ | .0701 | .7691 | .8156 | .8272 |
| Sector Dummy | NO | NO | YES | YES |

*Standard errors are in parentheses*
**** p<.01, ** p<.05, * p<.1*