CEO STOCK OPTION WEALTH AND STRATEGIC RISK-TAKING

A BEHAVIOURAL AGENCY PERSPECTIVE

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CEO Stock Option Wealth and Strategic Risk-taking: A Behavioural Agency Perspective

Abstract:

This study builds on the behavioural agency model to investigate the relationship between CEO stock option wealth and managerial strategic risk taking. This study reveals that stock options may both positively and negatively influence CEO's strategic risk taking, depending on whether they are exercisable or unexercisable, and depending on how much the accumulated cash value and prospective value is. Also, the relationship is partially moderated by bankruptcy risk of the company. Using panel data from manufacturing industries and composite measurements on CEO's ex ante strategic risk-taking, our findings suggest that current wealth of exercisable options discourages CEO's risk-taking, which is weakened by bankruptcy likelihood of the company. While on the other hand, current wealth of unexercisable options and prospective option wealth encourage risk-taking.

Keywords:

CEO stock option wealth, Behavioural agency model, Managerial strategic risk-taking, Bankruptcy likelihood

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1. Introduction

The relationship between CEO stock options and managerial risk-taking decisions has long been a topic of interest in strategic management studies. Engaging in risk taking is fundamental for a company to survive and gain competitive advantages (Shapira, 1995). Companies must be willing to act amidst uncertainty (Knight, 1921) due to its critical role in generating shareholder value (Datta, Iskandar-Datta, & Raman, 2001). In the meantime, we witness the broad use of CEO stock options in US companies during the last several decades. As indicated in Hall and Murphy (2000), stock options accounted for about 40% of CEOs' total compensation in S&P 500 companies. Therefore, the study on this particular topic has great implications to real business.

In addition to the importance and commonality of risk-taking and CEO stock options, previous research yields conflicting empirical results and forms different theoretical perspectives on this topic, which lead to the continuous debate among researchers and practitioners with regard to whether stock options encourage or discourage CEOs' risk-taking. Agency theory (Jensen & Meckling, 1976) takes the view that stock options are effective ways to align the risk preference of CEOs with that of shareholders, by providing unlimited potential gains and limited downside losses (Sanders, 2001). While some other research shows that CEO stock options create less risk-taking, which is in accordance with behavioural agency model (BAM) proposed by Wiseman and Gomez-Mejia (1998).

As an effort to advance understanding of the effect of stock option wealth on managerial risk taking and to continue the research on the previous inconclusive results, this study intends to mainly build on the behavioural agency model to answer two important questions: (1) How does CEO stock option wealth influence managerial strategic risk-taking? (2) How does the contextual factor such as bankruptcy risk of company moderate their linkage? Our research attempts to provide a more comprehensive explanation about the influence of CEO stock option wealth by dividing it into different categories and examining the corresponding influence respectively. Furthermore, we make an effort to include the contingency factor of company bankruptcy risk into the behavioural agency model to examine its moderating effect.

The behavioural agency model has served as a useful theoretical framework to explain the relationship between CEOs' compensation and their risk taking from a contingent view (Wiseman & Gomez-Mejia, 1998). According to the framework, the CEOs' risk taking is a function of their problem framing and risk bearing, which is dependent on the contingent contexts including types of incentives, monitoring mechanisms and other company characteristics. Martin, Gomez-Mejia and Wiseman (2013) argued that

agency theory focuses only on positive influence of CEO's stock option wealth (e.g. the potential future increase) while original BAM addresses only the negative effect of stock option wealth (e.g. intrinsic value). As a modification to original BAM, it is proposed that CEOs are actually facing a gambling situation of both possible gains and possible losses from their holding of stock options, thus it is necessary to take into consideration both effect from prospective option wealth and current option wealth. Our study draws from the above argument to apply BAM to examine the effect of different option wealth, while at the same time to address the important effect of contingent factor such as company bankruptcy risk. We intend to check CEO stock option wealth's different influence on managerial risk-taking within specific company contexts of lower or higher bankruptcy risk, to reveal their possible interactions, as an effort to present a more complete behavioural agency perspective.

Previous empirical research on stock options suggests that exercisable options and unexercisable options may exhibit different characteristics on how they influence risk-taking (Devers, McNamara, Wiseman, & Arrfelt, 2008; Souder & Shaver, 2010). Inspired by their insights, we further extend BAM by differentiate CEO stock option wealth as current wealth from exercisable options, current wealth from unexercisable options and prospective option wealth, to search for a more comprehensive understanding of the influence of stock option on managerial risk taking.

Also, we integrate the prospect theories of risk-taking into the behavioural agency model. Prospect theorists use value function to explain why individuals exhibit different risk preferences in gain problem framing and in loss problem framing, and claims that the value function for gains is normally concave (Kahneman & Tversky, 1979). Integrating the argument of concave value function of gains, we propose to modify the behavioural agency model to reflect a diminishing marginal effect of prospective option wealth.

We contribute to previous research in several aspects. First, we made theoretical development to behavioural agency model by 1) integrating with prospect theory, 2) differentiating between exercisable and unexercisable options, 3) adding bankruptcy risk of company as contingent factor. Our research confirms that current option wealth from exercisable options discourages managerial risk-taking, while the current wealth from unexercisable options has exactly the opposite effect. It is also supported that the positive incentives provided by prospective option wealth have diminishing marginal effect. Although only part of the moderating effect of bankruptcy risk is confirmed by our empirics, it still presents researchers and practitioners with a more comprehensive context to understand the influence of CEOs' stock option wealth on their risk-taking.

Second, in the design of our test, we propose to measure managerial strategic risk taking as a composite index considering both strategic investment intensity and the existing business volatility. We define higher managerial strategic risk-taking as making larger strategic investment in a more volatile business environment. To the best of our knowledge, this study is the first thesis that uses such composite risk measurements on the study of the relationship between stock option wealth and managerial risk taking. As claimed by Ruefli, Collins and Lacugna (1999), single measures that are mathematically simple may not be possible to capture all the perspectives of risks, and it is encouraged to explore different measures to address the notion of risks in a different setting. Therefore, our study may contribute to the previous literature about behavioural agency model, by testing it with new conceptualized risk measurements.

Lastly, this study implements an empirical testing with longer periods in comparison to previous research, which has implications to boards of directors and other company stakeholders. On one hand, the larger size of samples may reduce potential random effects and verify the behavioural agency model through different times. On the other hand, it also sheds light on the understanding of CEO stock option wealth's influence in real business context. As is suggested by our research, the influence of CEO stock options is a complicated mix of both current option wealth and prospective option wealth. The influence not only depends on whether CEOs hold exercisable or unexercisable options, but also affected by bankruptcy risk of companies. Bankruptcy risk is a relevant contingent factor in real business settings. Especially during the time of COVID-19 epidemics, we may expect more companies facing the threats of bankruptcy. Therefore, our research provides implications for practitioners by improving their understanding of the effect of bankruptcy risk when they design the stock option packages for CEOs under economic downturn when there are material bankruptcy risks.

This thesis has seven main sections. Section 2 summaries the related theories on which we make the integration and development, followed by our testing hypothesis. Section 3 introduces our research method and test design. Section 4 shows our empirical data collection, followed by quality analysis, descriptive statistics and correlations. Section 5 presents the regression results and our discussion on the interpretation of results. We also discuss the contribution and limitations of our study. Section 6 is a summary of additional tests we performed, with the discussion of the robustness of our empirical findings. And the last section presents the overall concluding remarks.

2. Literature and hypothesis

2.1. Literature survey

Several main theories are developed in the research domain of executive compensation and risk-taking, trying to explain managers' risk-taking behaviour from different perspectives.

2.1.1. Agency theory about managerial risk-taking

The underlying premise of agency theory is that principals and agents have different risk preferences, since principals are able to diversify their investment while agents are facing undiversified employment risk. Thus, agents are more risk averse (Jensen & Meckling, 1976; Eisenhardt, 1989). When executives make decisions, they will seek higher monetary rewards on the higher residual risks they take, or will make less risky decisions which may formulate less desirable corporate strategies (Hoskisson, Castleton, & Withers, 2009).

Agency theory focuses on studying mechanisms to overcome the problem of agent's risk aversion, such as providing ex ante equity-based compensations to align the interest and risk preference of executives and shareholders. Positive agency scholarship takes the view that equity-based compensation is an effective way to encourage CEO risk-taking, which is supported by some empirical studies (e.g. Carpenter, Pollock, & Leary, 2003; Sanders & Hambrick, 2007). However, normative stream of agency theory proposes that stock-based compensation on one hand may align the interests, while on the other hand may also create excessive risk bearing (which is defined as the perceived risk that one is exposed to when there is a threat to executive wealth), thus exacerbating the risk aversion of agents. (Harris & Raviv, 1979; Holmstrom, 1979; Shavell, 1979; Coles, Daniel, & Naveen, 2006; Low, 2009). Therefore, the effectiveness of equity-based compensation is within certain boundaries. In supporting the idea, Devers et al. (2008), Hoskisson, Hitt and Hill (1993) find that certain types of equity-based compensation such as restricted stock options and short-term incentives actually reduce managerial risk taking.

2.1.2. Prospect theory about managerial risk-taking

Different from agency theorist's assumption that agents are always risk averse, prospect theory proposes the notion of loss aversion — they find "the displeasure of losses is greater than the pleasure of equivalent magnitude gains" (Holmes, Bromiley, Devers, Holcomb, & McGuire, 2011). Therefore, people are inclined to minimize losses relative

to a reference point (Kahneman & Tversky, 1979). When an individual is below the reference point, the condition is loss-framed and he or she will engage in risk-taking behaviour to pursue higher expected return. While if he or she is above the reference point, the condition is gain-framed and thus risk-aversion will be dominant. According to prospect theory, aspirations, expectations, norms and social comparison are all influential factors that shape the reference point (Holmes et al., 2011), which ultimately determine the risk-taking level of executives.

Prospect theorists have long been interested in the various factors which affect the forming of the manager's reference point, and thus determining loss-framed or gain-framed conditions in relation to the reference point. For example, a manager's previous experience with a certain type of action may influence how he or she frames the condition and encourage greater level of that action (Garbuio, King, & Lovallo, 2011; Shimizu, 2007). The degree of ambiguity with regard to the outcome of risk-taking behaviour (Shimizu, 2007) and manager's ability to shift blame (Hayward & Shimizu, 2006) influence their risk framing. And external analysts play an important role in shaping manager's reference frames as well (Mishina, Dykes, Block, & Pollock, 2010).

2.1.3. Behavioural agency model about managerial risk-taking

Wiseman and Gomez-Mejia (1998) proposed the behavioural agency model, integrating both concepts of risk-bearing from agency theory and different problem domain from prospect theory, to explain the risk-taking (or risk-aversion) behaviour of managers. It is argued that the risk-taking (or not) behaviour is primarily determined by how managers frame the problem, either as gain-context or as loss context. And in addition to the problem framing, risk-bearing which is the perceived wealth-at-risk, moderates the relationship between problem-framing and risk-taking. The illustration of BAM is shown in Figure 1.

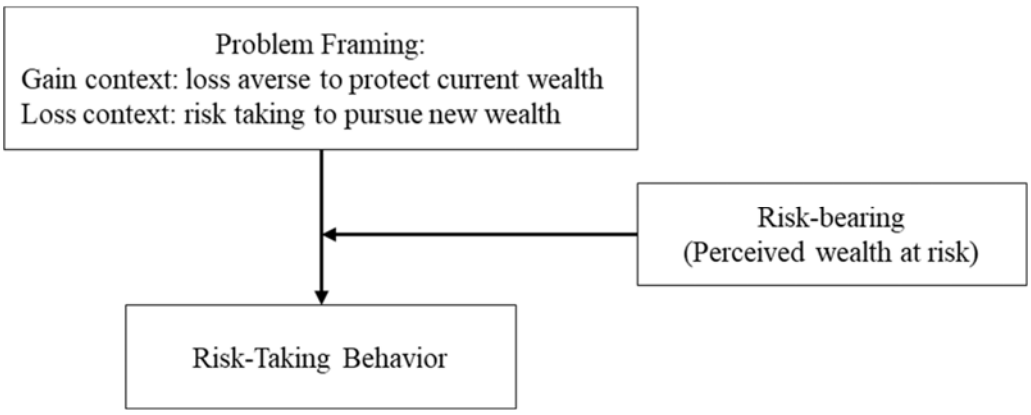

Figure 1. Illustration of behavioural agency model

Integrating manager's compensation plans into the model, behavioural agency theory explains their influence on problem-framing and risk-bearing, and demonstrates their interactions which ultimately drive the risk-taking or risk-aversion behaviour. On one hand, a manager's compensation plan directly creates a reference point that determines his or her perceived gain or loss situation. While on the other hand, individuals endow the anticipated future wealth into current wealth calculation. And to the extent that the perceived current wealth is tied to firm performance, risk-bearing is created and thus discourages managerial risk taking.

BAM provides a dynamic framework for researchers to study executive compensation and risk taking while exploring important contingent factors. For example, researchers found that CEOs are inclined to protect perceived wealth (e.g. derived from in-the-money unexercised stock options) by taking fewer risks but are also possible to take on more risks when there's higher employment risk (Larraza-Kintana, Wiseman, Gomez-Mejia, & Welbourne, 2007). CEOs endow restricted stock value into their perceived current wealth, thus creating risk aversion, while is contingent on company slack, board actions and stock price volatility (Latham & Braun, 2008; Devers, Wiseman, & Holmes, 2007).

2.1.4. Empirical research on managerial risk-taking and stock options

Stock options are used widely in US companies. Therefore, it attracts the attention of researchers. Multiple empirical studies have researched on how stock options influence managerial risk-taking, however they yielded conflicting results. Sanders (2001) argued that stock options are different from stock ownership, which has a limited downside exposure and thus encourages CEOs to engage in risky strategies. His empirical testing shows that CEO stock options are positively related to the numbers of firm's acquisition and divestiture activities. While other researchers found conflicting results about stock options. For example, intrinsic value of stock options is corresponding with lower risk-taking (Larraza-Kintana et al., 2007). If managers hold high levels of exercisable stock options, companies are less likely to make long horizon investments (Souder & Shaver, 2010).

Devers et al. (2008) claims that CEO stock options significantly influence strategic risk, but the influence is more nuanced and complex than conventional treatments of executive compensation assume. It is proposed that the relationship between accumulated value of exercisable stock options and firm's strategic risk-taking is curvilinear. Sawers, Wright and Zamora (2011) show through their experimental results that in-the-money options and at-the-money options are different in providing incentives for managerial risk-taking, and have different effects in gain and loss framings. The complex impact of stock options is further explained by Martin, Gomez-

Mejia and Wiseman (2013) from a gambling perspective, arguing that stock options are not pure gain or pure loss contexts, but a combination of both simultaneously. By dividing the option wealth as current endowed and prospective, it is argued that the prospective option wealth has positive impact on managerial risk-taking, while the current endowed wealth has a negative impact.

Table 1 provides a summary for the literature about risk-taking and stock options which is mentioned in this section.

Table 1. Summary of previous research about stock options

Paper	Research findings on stock options	Data	Risk measurement	Options measurement
Sanders, 2001	CEO stock option pay encourages firm's acquisition and divestiture propensity due to the asymmetric risk properties of stock options.	Secondary data on sample from S&P 500 companies from all industries excluding highly regulated industries, from 1991 to 1995.	Numbers of acquisition and divestiture transactions completed.	Value of stock options granted during the year, measured by SEC present-value method.
Larraza-Kintana, Wiseman, Gomez-Mejia, & Welbourne, 2007	Intrinsic value of CEO stock options corresponds to lower risk taking.	Survey and archival data from a sample of IPO firms which went public in US from 1993 to 1995. Use combination of primary and secondary data.	A composite index including nine strategic actions based on survey results.	Average cash value of options held by CEOs during 1995 to 1997.
Devers, McNamara, Wiseman, & Arrfelt, 2008	The current accumulated value of exercisable stock options and the firm's strategic risk taking has a curvilinear relationship. The current accumulated value of unexercisable stock options is positively associated with the firm's strategic risk taking.	Secondary data on US public manufacturing companies from 1992 to 2005.	Factor analysis score of R&D, capital investment and long-term debt.	Cash value of exercisable options and cash value of unexercisable options.

Paper	Research findings on stock options	Data	Risk measurement	Options measurement
Souder & Shaver, 2010	Firms make long horizon investments when managers hold higher levels of unexercisable options and lower levels of exercisable options.	Operating data (secondary data) on cable television multisystem operators from 1972 to 1996.	Dollar Investment of long risk-payoff horizon and of short risk-payoff horizon.	Cash value of exercisable options and cash value of unexercisable options.
Sawers, Wright, & Zamora, 2011	Managers are more risk-taking in the loss context than in the gain context when they have at-the-money stock options, but not when have in-the-money stock options. Mangers with in-the-money stock options are less risk-taking than managers with at-the-money stock options in the loss context.[1]	Primary data of experimental results based on 108 MBA students acting as managers.	Participants are required to choose between more risky and less risky projects, in different problem framing setting, and either with in-the-money option or with at-the-money option.	In the experiment setting, it is controlled that participants are either having in-the-money options or having at-the-money options.
Martin, Gomez-Mejia, & Wiseman, 2013	Stock option wealth has a mixed-gamble effect on risk-taking. Current wealth of stock options has negative influence, prospective wealth has positive influence.	Secondary data on US public manufacturing companies from 1996 to 2009.	Factor analysis score of R&D, capital investment and long-term debt	Current wealth (cash value) of outstanding stock options and prospective wealth of outstanding stock options.

[1] Gain context refers to the experimental setting in which participants are required to choose between two projects which both would result in a gain for the firm but with varying levels of risk. Loss context refers to the setting that participants are to choose from two projects which will make loss to the firm.

We may find that previous research on one hand examined stock options from different perspectives and had progressively improved the explanation and predicting power of the theories and models, while on the other hand also left some conflicting empirical results which provide incentives for further research.

2.1.5. Bankruptcy risk and managerial risk-taking

Bankruptcy risk is an important contingent factor which may well influence manager's risk-taking behaviours. Corporate bankruptcy can impose personal costs on CEOs, ranging from forced career change to loss of labour market capital and equity value. These costs incentivize CEOs to hedge against bankruptcy risk at the expense of shareholder value, which means CEOs are incentivized to give up some investment with positive NPV and relatively higher risks. Research shows that only one-third of the incumbent CEOs maintain executive employment after bankruptcy, either at a new firm or at the restructured firm emerging from bankruptcy (Eckbo, Thorburn, & Wang, 2016). The remaining two-thirds of incumbents leave the executive labour market and most experience a reduction of salary. And prior to bankruptcy, CEOs also experienced significant equity losses (Eckbo, Thorburn, & Wang, 2016). From this perspective of personal cost, bankruptcy or at least a credible bankruptcy threat is possible to mitigate managerial risk-taking.

In addition to the fact that company bankruptcy creates direct losses to CEOs, March and Shapira (1992) also argue that people generally have multiple reference points and risk-takers' focus of attention shifts between survival focus and aspiration focus due to complicated reasons, of which probability of company bankruptcy is a profound one. When there is a high bankruptcy risk, CEOs tend to shift their attention to the "survival point" and survival is the top priority of their target. Under the circumstance, the research argues that CEOs perform in a more conservative way of evaluating and undertaking risks, thus the risk-taking behaviours are suppressed given a bankruptcy threat. Notably, research also argues that when the bankruptcy risk is low or even neglectable, CEOs focus on the development and growth of the company and they are willing to take moderate risks to increase the returns and facilitate the growth of the company.

2.2. Theoretical development and hypothesis

2.2.1. Stock options

A stock option is a contract in which managers are granted the right, but not the obligation to buy a specific number of company's stock, at a predetermined price for a finite period of time. Usually, the options are granted with a vesting period, which is

the length of time that managers must wait in order to be able to exercise the options. So, the options held by managers can be categorized as exercisable ones and unexercisable ones, based on if they are in vesting period or not. When the current stock price underlying the option is higher than the exercise price, the stock option is "in the money" with a positive cash value. After vesting, if the option is exercised, the payoff is the difference between exercise price and the market price of stock.

The above-mentioned characteristics of options are argued to create strong incentives for CEOs to reduce risk aversion, since it provides asymmetric risk — managers benefit from unlimited upside potential of stock price, while has no obligation to exercise options when stock price goes down (Sanders, 2001). However, this perspective ignores the potential role for the accumulated value of stock options over the option's lifespan. When the accumulated cash value of options is significant, the assumption of little downside risk may no longer be appropriate. Thus, to make a more complete picture, stock options actually create mixed gamble decision situations for managers (Martin, Gomez-Mejia, & Wiseman, 2013). Managers are aware that their strategic decisions may lead to: (1) loss of current accumulated value of option wealth, or (2) future additions to option wealth. And with regard to current accumulated value of option wealth, we further differentiate between unexercisable and exercisable options. The existence of vesting period prevents managers from realizing the accumulated value of unexercisable options at their discretion, thus exercisable options and unexercisable options are very likely to affect risk taking differently.

Therefore, we extend the behavioural agency model to include current option wealth from exercisable options, current option wealth from unexercisable options, and prospective option wealth, to study their effect on managerial risk taking.

2.2.1.1. Current accumulated value of option wealth from exercisable options

Prospect researchers indicate that people endow value from owned assets into perceptions of personal wealth. Extending the endowment perspective to stock options, later research suggests that when stock option holdings move into the money, CEOs could endow their personal wealth with a portion of this potential value (Devers et al., 2007). Since exercisable options are ready to be executed, CEOs are very likely to count on receiving this accumulated value and perceive it as their real wealth. Once CEOs perceive the accumulated value from exercisable options as part of their existing wealth, according to the behavioural agency model, risk bearing are created which in turn prevents CEOs from taking on more risks. Thus, we come with our first hypothesis: current accumulated value of option wealth from exercisable options will negatively affect managerial risk-taking by creating risk bearings.

H1: Current accumulated value of option wealth from exercisable options has a negative effect on managerial risk-taking.

2.2.1.2. Current accumulated value of option wealth from unexercisable options

In contrast with exercisable options, although unexercisable options have in the money value, CEOs cannot cash out the options immediately. They may wait for years to realize the value. Evidence from discounting theory finds that individuals generally value future outcomes significantly lower than immediately accessible outcomes (Rothbard, 1990; Shelley & Omer, 1996). Extending the theory to the unexercisable options, CEOs may perceive their value as being much lower than an equivalent set of exercisable options. Therefore, we expect CEOs will perceive much less value at risk from unexercisable options, which in turn lead to limited risk bearing.

In addition, we argue that CEOs are likely to see the accumulation value of unexercisable options as a signal of their previous success. Prospect theory research suggests that previous success may increase CEO confidence, or even create CEO hubris, which may shift CEO's reference point to a higher aspiration level. When CEOs have a higher reference point, the problem framing is changed from gain context to loss context, and therefore in turn switch the dominating risk preference of CEOs to risk-taking.

Combining the CEO hubris perspective and the relatively weak risk bearing effect created by unexercisable options, we therefore expect current accumulated value of option wealth from unexercisable options will positively affect managerial risk-taking.

H2: Current accumulated value of option wealth from unexercisable options has a positive effect on managerial risk-taking.

2.2.1.3. Prospective value of option wealth

Prospective option wealth is the additional wealth CEOs can realize if risk taking strategic investment is successful. According to the prospect theory (Kahneman & Tversky, 1979), when people make decisions under risk, they assign value to gains and losses, instead of using expected utility. And the value function for gains is normally concave. It indicates that higher gains bring higher value to a person, but with a diminishing marginal effect. Extending the theory to the incentives provided by option wealth, more prospective value of option wealth represents higher gains, which increases CEO's willingness to take risk. While the sensitivity decreases as the increase

of prospective wealth. That is to say, one dollar increase in prospective option wealth will have positive but decreasing influence on managerial risk-taking.

> **H3:** Prospective value of option wealth has a positive effect on managerial risk-taking, but with a diminishing sensitivity.

2.2.2. Moderating effect of bankruptcy risk

As previously mentioned, since bankruptcy risk is an important contingent factor which may affect managerial risk-taking by affecting CEOs' risk-taking behaviours, it is possible for bankruptcy risk to affect the relationship between CEO compensation and risk-taking. We would like to extend the traditional behavioural agency model by introducing bankruptcy risk as a moderating contingent factor, to study its influence on the relationship between stock option wealth and managerial strategic risk-taking.

March and Shapira (1992) proposed a model of risk preferences, arguing that people generally shift attention between multiple reference points. When the company bankruptcy risk is high, CEOs experiencing reference frames of ruinous losses may focus their attention on an alternative reference point called survival point, which is "the point at which the firm ceases to be economically viable" (Miller & Chen, 2004). There are differences between a loss in the non-ruinous domain and a loss in the ruinous domain. When CEOs frame the situation as a non-ruinous loss, they are risk seeking. While in ruinous domain, the reference point will be redirected to survival point, and CEOs thus will be more cautious about strategic risk-taking.

Extending the argument about bankruptcy risk with our hypothesis H1 and H2, we expect bankruptcy risk strengthens the negative impact of current option wealth from exercisable options, and weakens the positive impact of current option wealth from unexercisable options on managerial risk-taking. When CEOs hold significant in-the-money options, they may feel greater potential threats to the wealth which they have endowed into calculations of their personal wealth once the company faces higher bankruptcy risk. Thus, in such situations, the influence of risk bearing gets stronger, and CEOs may favour short term and low-risk solutions rather than long-term risky investment.

> **H4.1:** Bankruptcy risk strengthens the negative impact of current option wealth from exercisable options on managerial risk-taking.
>
> **H4.2:** Bankruptcy risk weakens the positive impact of current option wealth from unexercisable options on managerial risk-taking.

In contrast with current option wealth, we argue that bankruptcy risk may strengthen the positive relationship between prospective option wealth and managerial strategic risk taking. Prospective option wealth is the expected additional value CEOs can get from options if the strategic risk-taking is successful. That part of gain is not realized yet. When bankruptcy risk is high, the prospective wealth creates no risk bearing and provides proper incentives for CEOs to carry strategic risk-taking investment. Because CEOs may view these actions as necessary responses to turn around extremely poor performance of the company. As Bowman (1982) claimed, risk taking activities may help troubled firms "come out even".

H4.3: Bankruptcy risk strengthens the positive impact of prospective option wealth on managerial risk.

3. Method

3.1. Model specifications

3.1.1. Dependent variables

Miller and Bromiley (1990) argues that capital expenditures and R&D spending reflect the strategic choice of a company. Capital-intensive companies may have lower average costs than labour-intensive companies. Companies investing heavily in R&D may exhibit greater dynamic efficiency, or more flexibility than their competitors in adapting to changes in input prices and technology.

Based on the idea that R&D and capital investment are typical strategic investments, we further argue that investment amount or investment intensity alone doesn't catch the whole picture of managers' ex ante risk assessment. It is necessary to consider the existing business volatility of the company at the same time. Two companies with different existing risks on business, make the same R&D investment, of which the perceived risk-taking level by CEO should not be the same.

Hence, we propose our measurement of managerial strategic risk-taking as follows.

$$\text{Managerial strategic risk-taking(t)} = \frac{\text{R\&D Investment(t)}}{\text{Sales(t)}} \times \Delta\text{ROE(t)} \quad (1)$$

$$\text{Managerial strategic risk-taking(t)} = \frac{\text{Capital Investment(t)}}{\text{Sales(t)}} \times \Delta\text{ROE(t)} \quad (2)$$

According to the formula, we may interpret higher managerial strategic risk-taking as making larger strategic investment in a more volatile existing business environment. In the calculation, R&D investment is the annual expense in a given year on research and development, measured in millions of dollars. Capital investment is the annual spending on property, plant and equipment, measured in millions of dollars. Sales is the annual net revenue measured in millions of dollars. And we calculate ΔROE as the standard deviation of quarterly ROE in the past 3 years, to reflect the volatility level of the existing business. As a robustness test, we calculated ΔROE as quarterly deviation in the past 4 years as well (see section 6.1).

3.1.2. Independent variables

3.1.2.1. Current option wealth from exercisable options and from unexercisable options

Consistent with prior behavioural agency research (Devers et al., 2008; Larraza-Kintana et al., 2007), current option wealth is calculated as the cash value of CEO's options, which is defined as the number of options from each option grant multiplied by the corresponding spread (for in-the-money options) on the last day of the year. Since the cash value is reported in the proxy statement annually and is easily calculated by multiplying the number of options and the difference between stock price and exercise price, we argue that it is a convenient heuristic for CEOs to estimate their current wealth inherent in their options.

And we further differentiate between exercisable and unexercisable options, to compute their cash value respectively.

$$\text{Current option wealth from exercisable options} = \sum \text{cash value of exercisable options} \quad (3)$$

$$\text{Current option wealth from unexercisable options} = \sum \text{cash value of unexercisable options} \quad (4)$$

3.1.2.2. Prospective option wealth

The variable estimates the potential additional option wealth that CEO may realize through the increase of stock price, if their strategic risk taking is successful. It is an attempt to measure CEO's subjective estimation of gains to their option portfolio when they make strategic decisions with the potential to raise stock price and deliver option wealth gains. In keeping with Martin et al. (2013), we use the average increase in the Dow index which was 7% percent during the period. We increase the stock price at this rate over the remainder of the life of CEO's stock options. Therefore, we raise (1+7%) to the power of the number of years remaining (a weighted average across the options held, shown below in our equation as time). We subtract the present-day stock price so that we measure only the additional wealth CEOs may get due to stock price increases, excluding existing current wealth from our calculation. Lastly, we multiply the calculation by the number of options held, to get the total potential additional payoff. Hence, the formula is as following:

$$\text{Prospective option wealth} = \text{number of options held} \times [(1 + 7\%)^{\text{time}} \times \text{stock price} - \text{stock price}] \quad (5)$$

The number of options held is calculated as the aggregation of both unexercisable and exercisable options. Stock price is the share price reported at the end of the year. To calculate average time to expiry, we use Core and Guay's (2002) estimation technique, since detailed time to expiry is unavailable prior to 2006 (Martin et al., 2013).

Following the method, we calculate time to expiry as a weighted average across exercisable, unexercisable and newly granted options.

Since our hypothesis H3 expects that the prospective option wealth will have diminishing marginal effects on CEO's strategic risk-taking. We further take the natural logarithm transformation of prospective wealth as the independent variable in our model.

It is worth mentioning that the formula may overestimate the prospective wealth for extreme cases when CEOs hold deep out of the money options, since it overlooks the fact that if current stock price is significantly below exercise price, CEOs may expect no prospective wealth from the options at all. However, since detailed exercise prices of each grants are not available prior to 2006, we argue that for normal cases, our treatment to calculate the prospective option wealth level is still a good proxy.

3.1.3. Moderator

To measure bankruptcy rate, Ohlson score is used to predict the likelihood of bankruptcy due to its relatively high stability and predictiveness compared with other models. Ohlson (1980) revealed that previous bankruptcy prediction models suffer from overestimation. For example, the Altman Z-score model has a larger prediction error rate compared with Ohlson's model. It was also revealed that there are four basic factors that can significantly affect bankruptcy rate, which are (1) company size; (2) a measure(s) of the financial structure; (3) a measure(s) of performance; (4) a measure(s) of current liquidity. According to these four factors, Ohlson constructed a predictive model of bankruptcy rate by calculating financial indicators and synthesizing them as O-score, the following formula is used in our study to measure bankruptcy rate:

$$O - score = -0.407 \times SIZE + 6.03 \times TLTA - 1.43 \times WCTA + 0.0757 \times CLCA - 2.37 \times NITA - 1.83 \times FUTL + 0.285 \times INTWO - 1.72 \times OENEG - 0.521 \times CHIN - 1.32 \times CONST \quad (6)$$

Where SIZE =LN $\left(\frac{\text{total assets}}{\text{GNP price-level index}}\right)$, total assets are reported in dollars and the index assumes a base value of 100 for 1968; TLTA=$\frac{\text{Total liabilities}}{\text{total assets}}$; WCTA=$\frac{\text{Working capital}}{\text{current assets}}$; CLCA=$\frac{\text{Current liabilities}}{\text{current assets}}$; OENEG = One if total liabilities exceeds total assets, zero otherwise; NITA= $\frac{\text{Net income}}{\text{total assets}}$; FUTL=$\frac{\text{Funds from operations}}{\text{total liabilities}}$; INTWO= One if net income

was negative for the last two years, zero otherwise; CHIN=$\frac{NI_t - NI_{t-1}}{|NI_t| + |NI_{t-1}|}$, where NI is net income for the most recent period.

The probability of bankruptcy is defined as followed:

$$P(B) = \frac{1}{1 + e^{-O-score}} \quad (7)$$

In addition, Ohlson's model does not include any market transaction information that can potentially affect bankruptcy rate, so the effectiveness of the O-score model is slightly weakened due to this disadvantage. However, the O-score model has been proven practical and reliable by many researchers who used the O-score model in their research to calculate bankruptcy rate (Hillegeist, 2004; Xu & Zhang, 2009; Lawrence, 2015). Also, its simplicity and data accessibility contribute to its prevalence in the area of bankruptcy rate research in the US market, so using the O-score model improves comparability of our research. Considering all the factors above, the O-score model is suitable for us to apply in our study.

3.1.4. Control variables and managerial risk-taking

3.1.4.1. Upper echelons theory and control variables of CEO characteristics

Hambrick and Mason (1984) proposed a theory that the top-level management team has great influence on organizational outcomes which can be predicted by managerial background characteristics. In particular, research shows that company behaviour is aligned with CEO characteristics. It is found that companies behave consistently with how their CEOs behave personally in the context of leverage choices which can influence financial leverage and risks of companies (Cronqvist, Makhija, Shefrin, & Statman, 2012).

1) CEO age

There are conflicting results with regard to the relationship between CEO age and risk-taking behaviour. Some researchers think older CEOs tend to take on more risks since they have better ability to manage higher risks with more professional experience. Also, older CEOs usually have shorter career life left, so they are willing to take on more risks since they are less concerned with future career development and potential punishment.

Serfling (2014) however documented a negative relation between CEO age and stock return volatility. Further analyses reveal that older CEOs reduce company risk through

less risky investment policies. Specifically, older CEOs invest less in research and development, make more diversifying acquisitions, manage firms with more diversified operations, and maintain lower operating leverage. Further, company risk and the riskiness of corporate policies are lowest when both the CEO and the next most influential executive are older and highest when both of these managers are younger. Some researchers examined the moderating effect of CEO age on the relationship between CEO compensation and risk-taking behaviour, reaching a conclusion that CEO age weakens the relationship (Shammari, 2018).

2) CEO Gender

Executive gender is also likely to influence CEO risk-taking behaviour. The evidence from economic experiments and behavioural and psychological literature is consistent with the general view that women are more risk averse than men (Croson & Gneezy, 2009; Charness & Gneezy, 2012; Bertrand & Pan, 2013). Bertrand & Schoar (2003), Malmendier & Tate (2005, 2008), Malmendier & Lee (2011), Benmelech & Frydman (2015) and Cain & McKeon (2016) all found similar results in their research that firms run by female CEOs significantly have lower leverage, less volatile earnings, and a higher chance of survival than otherwise similar firms run by male CEOs. Additionally, transitions from male to female CEOs (or vice versa) are associated with economically and statistically significant reductions (increases) in corporate risk-taking.

3) CEO Tenure

Former research indicates that both stock options and restricted stock increase risk-taking, but with decreasing effect as CEO tenure increases. Both increase the likelihood of big gains for short-tenured CEOs, but again with decreasing effect as tenure increases. Stock-based incentives therefore appear to be a useful solution to the agency problem for short-tenured CEOs, but much less so for long-tenured CEOs (Hou & Lovett, 2017). Other research shows that CEO tenure indirectly influences performance through its direct influences on top management team risk-taking propensity and the firm's pursuit of entrepreneurial initiatives (Simsek, 2007). Therefore, tenure of CEOs is included in our model as a control variable.

4) Founder CEO or professional CEO

Chen (2014) and Huang (2016) provide evidence that founder CEOs of large S&P 1500 companies are more overconfident than their non-founder counterparts ("professional CEOs"). They measure overconfidence via CEO tweets, CEO statements during earnings conference calls, management earnings forecasts, and CEO option-exercise behaviour. Compared with professional CEOs, founder CEOs use more optimistic language on Twitter during earnings conference calls. In addition, founder CEOs are

more likely to issue earnings forecasts that are too high; they are also more likely to perceive their firms to be undervalued, as implied by their option-exercise behaviour. So it is reasonable to include this measure into our study.

5) CEO stock ownership

CEO ownership is used to incentivize managers to align their own and shareholders' interests. Baysinger and Hoskisson (1990) found that non-owner managerial behaviour leads to increased levels of corporate diversification, particularly into unrelated industries to reduce managerial risk. But there are also opposite conclusions drawn by other researchers that high levels of share ownership can discourage CEOs from taking risks, when external governance is taken into consideration. Besides, others argue that CEO stock ownership has an inverted-U shape relationship with R&D investment (Kim & Lu, 2011). Those research projects show conflicting but still significant results with regard to the relationship between CEO stock ownership and risk-taking behaviours. Other research studies the internal mechanism of the influence of stock ownership on managerial risk-taking and reaches conclusions that CEO stock ownership is significantly related with CEO turnover and therefore influences CEOs' risk appetite.

6) CEO duality

CEO duality occurs when the same person occupies both the CEO and board chairperson positions in a corporation (Rechner & Dalton, 1991). From the agency theory perspective, having one individual in charge of both management implementation and control is not consistent with the concept of checks and balance. However, from an organization theory perspective, CEO duality may enhance organizational efficiency in corporate leadership (Boyd, 1995). Previous research based on a sample of 290 large U.S. corporations revealed that dual positioning on both CEO and board chairperson positions at the corporate top leads to reduced company risk-taking propensity, serving managerial risk minimization preferences (Kim & Buchanan, 2011). This research is mainly based on agency theory suggesting that managers are risk-averse and shareholders are risk-neutral (Beatty & Zajac, 1994). In other words, shareholders are more likely to accept a potentially risky investment as they want to maximize their investment returns, and their risks can be easily diversified through other investments. While managers are hesitant to take the risky options because their returns and rewards (e.g., salary) from the risk-taking are limited. CEO duality is assumed to facilitate CEO risk-averse managerial decisions by enhancing power concentration on dual CEO and reducing the ineffective control of the board.

3.1.4.2. Company characteristics

In addition to CEO characteristics that can influence managerial risk-taking, some company characteristics are also statistically related to managerial risk-taking and risk appetite by affecting managerial discretion. For instance, company size has a significant influence on managerial discretion since it is an internal inertial force that can influence organizational inertia. The directions of companies that depend on discretionary choices of CEO and management executive therefore can be influenced by the company size (Li & Tang, 2010). Zahra and Pearce (1989) suggests that greater scale of the company may increase the amount of uncertainty and complexity in the firm‘s operation. Thus, previous empirical studies have suggested a positive relationship between company size and company risk (Graves, 1988; Hansen & Hill, 1991). Moreover, company performance also influences the discretion of managerial action because it determines the degree of slack organizational resources that managers may dispense (Finkelstein & Hambrick, 1990). We therefore choose ROE as the measure of company performance due to its prevalence and reliability.

We also include interest rate as one of our control variables since it is assumed to have direct and indirect influence on managerial risk-taking. Generally, interest rate reflects the cost of borrowing and it is relevant to managerial discretion about capital structure and financing strategy that are directly related to risk-taking decisions. Interest cost decreases the cash flow of the company, thus restricting the potential investment. CEOs therefore are more cautious about investment plans and passively reducing their risk-taking behaviours. Moreover, if we consider an extreme case in which the company is a so-called zombie company that completely relies on one or a series of bailouts, or is kept afloat by lenient creditors and below-market interest rates, interest rate is assumed to have significant influence on managerial risk-taking decisions. Zombie companies historically appear in the manufacturing industry more frequently compared to other industries, since too-big-to-fail is one of the important characteristics of zombie companies and manufacturing companies tend to be large and systemically important in the economy. In addition, we consider the influence of creditors on managerial risk-taking of the company. Creditors are more likely to be risk-averse and hope companies keep liquidity at a relatively high level. Taking those factors into consideration, we include company size, ROE and interest rate as our company-specific control variables.

In addition, there are many other company specific characteristics that can affect company managerial risk-taking and it is impossible for us to include them in our models since some of them are unmeasurable. Family company is one of the characteristics. Some researchers argue that the strong alignment of interests between companies and families that accompanies concentrated family ownership encourages a long-term perspective, an exploration of innovative ideas, and entrepreneurial risk

taking (Astrachan, 2003; Litz, 1995; Zahra, 2005). However, others propose that the strong overlap between family welfare and company wealth (which implies an undiversified investment position) may lead to conservatism, strategic inertia, and risk-avoiding strategies (Hall, Melin, & Nordqvist, 2001; Naldi, Nordqvist, Sjöberg, & Wiklund, 2007; Short, Payne, Brigham, Lumpkin, & Broberg, 2009; Schulze, Lubatkin, & Dino, 2002). Some research shows that CEO risk-taking is related to new product portfolio innovativeness in the organizational context, while family firm-specific characteristics have impacts on the relationship between CEO risk-taking and new product portfolio innovativeness. Specifically, the relationship between CEO risk-taking and new product portfolio innovativeness is weaker if levels of ownership by top management family members are high. Additionally, the effect of CEO risk-taking on new product portfolio innovativeness is stronger in family firms at earlier generations. This result suggests that family firm-specific characteristics can affect individual dispositions and, in turn, the behaviours of executives in the area of risk-taking (Kraiczy, Hack, & Kellermanns, 2015).

There are other company characteristics such as legal restrictions that can have impacts on our research. Since it is not realistic to include them all in our models, we use company-fixed effect models to address the potential defect of our research. As a result, family company specific characteristics are omitted in the results but its impact on our models should be addressed by the company-fixed effect model.

3.2. Estimation method

Using ordinary least squares (OLS) on panel data regression often experiences problems with heteroscedastic error terms and autocorrelation, which may result in biased and inconsistent results (Bliese, 2000; Certo & Semadeni, 2006). Thus, fixed or random effect models are typically used to estimate panel models (Certo & Semadeni, 2006; Halaby, 2004; Sanders, 2001). Fixed and random effect models have different assumptions on whether the estimated error term is uncorrelated with the independent variables (Certo & Semadeni, 2006). In choosing between fixed effect and random effect models, we mainly consider the empirical validity of the analytical techniques. We use Hausman (1978) specification tests on the regressions for each hypothesis, and the results suggest that the fixed effect model is more appropriate than the random effect model in our setting. The Hausman specification test results are presented in Appendix B.

4. Empirics

4.1. Sample selection and data collection

In order to obtain more detailed and complete data about CEO options, we choose sample companies that are listed in the US market from 1993 to 2019. We choose sample companies in the US market under restrictions of GAAP which requires companies to disclose numbers and exercise prices of options granted to management executives as part of reward packages. Since IFRS does not require companies to disclose such information, it is difficult for us to calculate the value of independent variables about CEO option wealth in the regions under restrictions of IFRS. So our samples are restricted to US companies under GAAP. In addition, we pick samples from manufacturing companies, because capital expenditure that we used to measure risk-taking has a strong industry-related characteristic. And our research seeks to build on prior research using samples from the manufacturing industry and facilitate comparison with similar behavioural agency studies (Devers et al., 2008; Martin et al., 2013). Keeping consistent with previous research, we pick firms with SIC code between 2000 and 4000.

We obtain company financial data from Standard & Poor‘s Compustat North America Daily and CEO option data from S&P Compustat Execucomp. These two databases provide comprehensive information for listed companies and are widely used by researchers in the area of business. All data from WRDS was collected in September and October 2020.

Primarily, 942 companies were selected after we had excluded some sample companies with lack of data. Then we found there are abnormal values in terms of ROE when we run the primary data description, so we further cleaned the data and deleted 69 sample companies with abnormal values. Finally, 873 companies are selected as our samples.

4.2. Data quality

A data quality test is conducted to ensure accuracy and reliability of our data. Since we exclude data with abnormal ROE, we use the ratio as our benchmarks of the quality test. We calculated ROE using fundamental financial figures which are total assets, total equity and net income of each sample company to obtain self-calculated figures and compared them with figures that we directly obtained from the database Compustat. The results show that our data is overall reliable and accurate although there are some company-year observations deviating from our self-calculated figures.

4.3. Descriptive statistics

There are two dimensions in the data we used in our regression which includes CEO data and company data. The following table 2 summarizes the descriptive statistics in the groups of CEO variables, company variables and mixed variables. Among CEO variables, CEO in board measures if the CEO is in the position of chairperson of the board of directors in the current year. If the CEO is the chairperson of the board of directors, the variable is 1. CEO gender and CEO founder are also dummy variables defined in the same way. 1 represents that CEO is male and that CEO is founder. Compared with previous research, CEO ownership has a higher standard deviation of 3.571 and a higher mean of 1.085. CEO current and prospective wealth from options also have higher values compared with previous research. Among company data, two managerial risk-taking measures show similar mean values of 0.004 and 0.006 respectively but both have higher coefficient of variation which is defined as the ratio of standard deviations to the mean compared to other measures of managerial risk-taking. Interest rate and bankruptcy rate also show increases of standard deviation compared to previous research. Overall, our data has higher volatility compared with previous research since we have a much longer time span.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CEO variables					
CEO In Board	10968	.983	.129	0	1
CEO Age	10968	56.605	7.001	30	86
CEO Gender	10968	.975	.155	0	1
CEO Tenure	10968	8.101	7.461	.085	49.03
Stock Ownership	10968	1.085	3.571	0	53.711
CEO Founder	10968	.109	.311	0	1
Current Wealth Exercisable	10968	9116.549	30816.404	0	1061256
Current Wealth Unexercisable	10968	2641.118	8798.641	0	346539
Prospective Options Wealth	10968	20165.98	38443.362	0	829923.31
Ln (Prospective Wealth)	10968	8.115	3.077	0	13.629
Company variables					
Company Size	10968	7.454	1.553	3.717	12.836
ROE	10968	.106	.203	-1.571	1.574
Interest Rate	10968	.075	.09	0	.983
$\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$	10968	.006	.032	0	1.449
$\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$	10968	.004	.009	0	.463
Moderator (Mixed company and					

Variable	Obs	Mean	Std. Dev.	Min	Max
CEO variables)					
Bankruptcy Likelihood	10968	.011	.023	0	.855
Bankruptcy Likelihood × Current Wealth Exercisable	10968	51.548	212.907	0	9044.011
Bankruptcy Likelihood × Current Wealth Unexercisable	10968	15.1	58.102	0	1493.41
Bankruptcy Likelihood × Ln (Prospective Wealth)	10968	.085	.164	0	5.019

4.4. Correlation

The correlation coefficients of control variables, dependent variables and independent variables in our regression are shown in the following table 3. Most correlation results show signs and significance that are consistent with our expectations, however there are some exceptions that need to be further verified and tested in regression analysis. We expected that CEO current wealth from exercisable options should have a negative correlation with company managerial risk-taking, $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$, but the correlation results show that they have a positive correlation at significance level of 1%. Regarding our second measure of company managerial risk-taking, $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$, although there is a positive correlation between this variable and CEO current wealth from exercisable options, the result is not significant. With regard to CEO current wealth from unexercisable options, both risk-taking measures show significantly positive correlation with them but the correlation coefficient is relatively small. This might partly confirm the complicated correlation between the two set of variables and we will further explore the relationship between them in our regression. As we expected, prospective option wealth has a significantly positive correlation with $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$, but this correlation is not confirmed when we use $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$ as our dependent variable. Although the correlation has a positive sign, the coefficient is not significant. As for our control variables, CEO tenure has different signs when different measures of managerial risk-taking are used, which is still consistent with our expectation. The reason might be that CEO tenure is perceived to have a non-linear but significant relationship with managerial risk-taking. Company size is expected to have a negative relationship with managerial risk-taking which is confirmed when $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ is used as a risk measure at

significance level of 0.01. The sign becomes positive when we use the alternative risk measure, but it is not significant.

Table 3. Correlation

	Variables	1	2	3	4	5	6	7	8
1	CEO In Board	1							
2	CEO Age	-0.011	1						
3	CEO Gender	-0.016*	0.034***	1					
4	CEO Tenure	0.011	0.455***	0.050***	1				
5	Stock Ownership	-0.021**	0.124***	-0.043***	0.349***	1			
6	CEO Founder	0.023**	0.160***	0.048***	0.618***	0.239***	1		
7	Current Wealth Exercisable	0.017*	0.065***	0.013	0.104***	0.006	0.063	1	
8	Current Wealth Unexercisable	0.005	-0.016*	0.01	0.015	0.019**	0.043	0.51	1
9	Prospective Options Wealth	0.020**	0.045***	0	0.054***	-0.037***	0.004	0.746	0.546
10	Ln (Prospective Wealth)	0.017*	-0.027***	0.046***	-0.049***	-0.114****	-0.045	0.278	0.262
11	Company Size	0.002	0.049***	-0.053***	-0.181***	-0.181***	-0.237	0.222	0.197
12	ROE	0.017*	0.033***	-0.018*	0.01	-0.025**	-0.046	0.141	0.103
13	Interest Rate	0.016*	-0.01	0.008	-0.019*	-0.051***	-0.008	-0.024	-0.007
14	$\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$	0.009	-0.057***	0.015	0.006	-0.01	0.053	0.031	0.044
15	$\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$	0.014	-0.060***	0.003	-0.020**	-0.035***	0.034	0.014	0.053
16	Bankruptcy Likelihood	0.001	-0.017*	0	-0.057***	-0.014	-0.037	-0.071	-0.071

	Variables	9	10	11	12	13	14	15	16
9	Prospective Options Wealth	1							
10	Ln (Prospective Wealth)	0.467	1						
11	Company Size	0.439	0.313	1					
12	ROE	0.197	0.114	0.21	1				
13	Interest Rate	-0.04	-0.012	-0.028	-0.013	1			
14	$\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$	0.026	0.044	-0.062	-0.176	0.001	1		
15	$\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$	0.013	0.028	0.003	-0.121	0.002	0.413	1	
16	Bankruptcy Likelihood	-0.095	-0.091	-0.058	-0.32	0.031	0.058	0.098	1

Note: *** p<.01, ** p<.05, * p<.1

5. Results and analysis

5.1. Regression results

To examine our hypotheses regarding CEO current wealth from exercisable options, CEO current wealth from unexercisable options, CEO prospective option wealth and bankruptcy rate, we conduct several regression analysis using Stata 15. The following tables present our regression results using $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ and $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$ as dependent variables separately. Table 4 presents the result of the first model when $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ is used as the dependent variable, while the second table presents the result of the second model when $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$ is used as the dependent variable.

First of all, we only include control variables in model 1-1 and 2-1 to examine whether our control variables have expected signs and relations to the dependent variable. CEO in board, also known as CEO duality factor has a positive but insignificant sign, although we expected it to be negatively related to risk-taking measure. CEO age has a positive sign when the dependent variable is $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ and a negative sign when the dependent variable is $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$, which might imply inconsistency between two risk-taking measures. Also, CEO gender has a similar result with CEO age, although we expected it to be negatively related to risk-taking given former research consistently shows a negative relationship. CEO tenure has a significantly negative relationship with managerial risk-taking measured by $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ at 0.1 significance level, however the relationship becomes not significant when managerial risk-taking is measured by $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$. CEO stock ownership has opposite signs in the two models using different measures of dependent variables, but both are not significant. It is possible that the complicated influence of stock ownership on managerial risk-taking can be explained from the perspective of the difference between R&D and capital expenditure. Whether CEOs are founders does not show a significant sign in the first model, however in the second model there is a significantly positive relationship between $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$ and this variable. Among our company-specific control variables, ROE has negative signs

in both regression models at the 0.01 and 0.1 level of significance respectively. This is aligned with our expectation that a higher ROE that represents a better company performance should lead to higher degree of discretion of resource allocation of CEO. Generally, CEOs are less likely to take risks than shareholders as agency theory suggested, so more discretion granted to CEOs leads to less risk-taking behaviour. Interest rate has opposite signs in the two models but both are not significant. Finally, company size shows both significant negative signs in the two models at 0.1 and 0.05 levels separately, which is consistent with our expectation based on organizational inertia.

Then we add our independent variables to model 1-1 and 2-1 with only control variables, which are shown in model 1-2 and 2-2. CEO tenure becomes insignificant in the first model at the 0.1 level but still with a negative sign. The significance of company size increases in both models (p-value decreases from 0.001 to 0.0005). The signs and significance of other control variables remain stable. Current wealth from exercisable options has a significant negative relationship with managerial risk-taking in the first model at the 0.1 level, but not significant in the second model. Current wealth from unexercisable options has a significant positive relationship with managerial risk-taking in both models at significance levels of 0.05 and 0.01 respectively. Ln (prospective option wealth) has a significant positive relationship with managerial risk-taking at significance levels of 0.1 and 0.05 in the two models respectively. The natural logarithm transformation significantly improves the regression results and the regression results without natural logarithm transformation can be found in appendix L&M in which prospective wealth does not have an significant relationship with managerial risk-taking.

Finally, we include moderators in our model 1-3 and 2-3. The signs and significance of control variables remain stable, except for ROE and company size factors in the second model. Although the two control variables have the same signs, their significance decreases. Signs and significance of independent variables remain stable in the first model, however in the second model, significance of current wealth from exercisable options and ln (prospective option wealth) changes. Current wealth from exercisable options becomes significant at the level of 0.05, while the ln (prospective option wealth) becomes insignificant. Among interaction terms in the first model, current wealth from unexercisable options × bankruptcy likelihood has a positive sign at significance level of 0.1, which means bankruptcy risk accentuates the positive relationship between current wealth from unexercisable and managerial risk-taking. In the second model, interaction terms, current wealth from exercisable options × bankruptcy likelihood and ln (prospective option wealth) × bankruptcy likelihood both have significant positive signs at the level of 0.1 and 0.05 respectively. So the bankruptcy risk attenuates the negative relationship between current wealth from

exercisable options and managerial risk-taking but accentuates the positive relationship between prospective option wealth and managerial risk-taking.

Table 4. Regression results of $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$

Variables	Model 1-1 Controls	Model 1-2 Main	Model 1-3 Interaction
Current Wealth Exercisable		-0.002*	-0.002*
		(-1.675)	(-1.822)
Current Wealth Unexercisable		0.002**	0.002**
		(2.057)	(2.299)
Ln (Prospective Wealth)		2.709*	1.862*
		(1.913)	(1.847)
Bankruptcy Likelihood			134.977
			(0.501)
Bankruptcy Likelihood × Current Wealth Exercisable			0.077*
			(1.877)
Bankruptcy Likelihood × Current Wealth Unxercisable			-0.092
			(-0.931)
Bankruptcy Likelihood × Ln (Prospective Wealth)			54.548
			(0.942)
CEO In Board	9.810	9.243	8.993
	(1.130)	(1.024)	(1.022)
CEO Age	0.389	0.703	0.760
	(0.531)	(0.960)	(1.035)
CEO Gender	14.932	12.767	12.490
	(0.603)	(0.513)	(0.504)
CEO Tenure	-1.518*	-0.974	-1.126
	(-1.745)	(-1.130)	(-1.339)
Stock Ownership	0.568	0.281	0.224
	(1.351)	(0.724)	(0.584)
ROE	-142.328***	-129.928***	-107.755***
	(-3.252)	(-3.675)	(-3.372)
Interest Rate	35.088	33.078	34.763
	(0.689)	(0.630)	(0.667)
CEO Founder	7.219	2.235	5.089
	(0.476)	(0.138)	(0.317)
Company Size	-18.570*	-12.631**	-11.277**
	(-1.782)	(-2.222)	(-2.014)
_cons	17.854*	100.990	85.705
	(1.729)	(1.631)	(1.375)
Observations	10,968	10,968	10,968
Within Adjusted R-squared	0.0123	0.0312	0.0351

*Note: 1) Coefficient are displayed as multiplied by 10,000; 2) Absolute values of t-statistics based on cluster robust standard errors are reported in parentheses; 3) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Table 5. Regression results of $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$

Variables	Model 2-1 Controls	Model 2-2 Main	Model 2-3 Interaction
Current Wealth Exercisable		-0.000	-0.000**
		(-1.631)	(-2.006)
Current Wealth Unexercisable		0.001***	0.001***
		(3.246)	(3.142)
Ln (Prospective Wealth)		0.832**	0.359
		(2.436)	(0.980)
Bankruptcy Likelihood			-42.551
			(-0.446)
Bankruptcy Likelihood × Current Wealth Exercisable			0.015*
			(1.949)
Bankruptcy Likelihood × Current Wealth Unxercisable			0.007
			(0.215)
Bankruptcy Likelihood × Ln (Prospective Wealth)			35.378**
			(2.226)
CEO In Board	3.376	3.162	2.915
	(0.624)	(0.578)	(0.533)
CEO Age	-0.301	-0.259	-0.246
	(-1.136)	(-0.982)	(-0.919)
CEO Gender	-2.553	-3.298	-3.503
	(-0.338)	(-0.438)	(-0.478)
CEO Tenure	-0.596	-0.555	-0.578
	(-1.484)	(-1.382)	(-1.424)
Stock Ownership	-0.123	-0.222	-0.217
	(-0.477)	(-0.882)	(-0.870)
ROE	-4.051**	-3.773**	-3.382*
	(-2.080)	(-2.076)	(-1.863)
Interest Rate	-16.109*	-16.346*	-7.213
	(-1.673)	(-1.751)	(-0.659)
CEO Founder	-11.989	-11.654	-11.017
	(-1.028)	(-1.001)	(-0.941)
Company Size	-4.051**	-3.773**	-3.382*
	(-2.080)	(-2.076)	(-1.863)
_cons	86.787***	76.055***	72.704***
	(4.063)	(3.875)	(3.603)
Observations	10,968	10,968	10,968
Within Adjusted R-squared	0.0062	0.0098	0.0140

*Note: 1) Coefficient are displayed as multiplied by 10,000; 2) Absolute values of t-statistics based on cluster robust standard errors are reported in parentheses; 3) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

5.2. Discussion

In the following section, we will analyse and discuss the results presented in section 5.1, by 1) comparing the empirical results with our hypothesis, and 2) integrating with previous literature to form our interpretation of the result. Following the interpretation, we further highlight our research contributions and limitations.

5.2.1. Interpretation for results

5.2.1.1. Interpretation for regression result of independent variables

In the discussion below, we aim to answer our first research question: how CEO stock option wealth influences managerial strategic risk-taking. As previously presented in section 2 and section 3, we extended the behavioural agency model to include current option wealth from exercisable options, current option wealth from unexercisable options, and prospective option wealth, to check their influence on managerial strategic risk taking respectively.

The regression result of $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ confirms a statistically significant negative relationship with current wealth from exercisable options. We argue that $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ is a risk-taking measurement on a company's strategic investment of R&D, considering both the R&D project outlay in relation to a company's sales scale, as well as the volatility of its existing business. The negative relationship suggests that when CEOs hold higher cash value of exercisable options, they are less likely to make risky strategic investment of R&D for the company. The result confirms our hypothesis H1, which provides empirical supporting to the risk-bearing argument in behavioural agency model — CEOs endow the cash value of exercisable options into their wealth calculation, and therefore it creates risk bearing since the cash value of exercisable options is perceived at risk which is closely tied to future firm performance. Risk bearing then discourages managerial risk-taking. The regression result of $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$ also shows a negative coefficient on current wealth from exercisable options. While it is not statistically significant. We interpret $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$ as a company's risk-taking level on fixed assets investment. Compared to R&D investment, fixed assets investment represents a mix of strategic investment and sometimes necessary investment to maintain current business for manufacturing companies. A company may choose to make investment on plants and equipment in consideration of adopting capital intense strategy to reduce future labour costs. While it is also possible that a company may purchase machines as a normal

upgrade of its producing equipment. So in some cases, even though CEOs holding exercisable options with high cash value have great risk bearing, they will not stop making necessary capital investment. Thus, it may provide a reasonable alternative explanation to why the negative relationship between cash value of exercisable options and managerial strategic risk-taking on fixed assets investment is not statistically significant.

With regard to current option wealth from unexercisable options, both regressions of R&D strategic investment risk and capital strategic investment risk demonstrate statistically significant positive coefficients. It is suggested that when CEOs hold unexercisable options of high cash value, they are more inclined to make risky R&D and capital strategic investment. The result confirms our hypothesis H2. We argue that the result provides support to the idea that CEOs may only endow part of the cash value of unexercisable to their current wealth, and probably with a high discount of time effect due to the vesting periods, thus creating little risk bearing. Applying the behavioural agency model, the empirical result that high cash value of unexercisable options increases managerial risk-taking also suggests that CEOs are pursuing aspiration reference points, thus creating a loss problem domain, in which risk-taking is functioning as the dominant risk preference of CEOs. Therefore, our empirics agree with the reference point shifting view of prospect theorists.

The results in table 4 and table 5 also show a statistically significant positive effect of ln (prospective option wealth) on R&D strategic investment risk and capital strategic investment risk. Therefore, our hypothesis H3 is confirmed. We interpret the positive linear relationship between ln (prospective option wealth) and managerial strategic risk-taking as following: when CEO prospective option wealth increases by 1%, the strategic risk-taking level of R&D and the strategic risk-taking level of capital investment are going to increase with a fixed amount. That is to say, as prospective option wealth gets bigger, higher additional prospective option wealth increase is needed to generate the same level of incentive increase on managerial risk-taking. Therefore, the diminishing sensitivity of prospective option wealth on managerial strategic risk-taking is supported. Based on our empiric results, we agree with the idea of prospect theory that the value function of monetary incentive is concave. And we argue to modify the behavioural agency model by integrating the diminishing positive marginal effect of prospective option wealth, to make it more fit with actuals.

5.2.1.2. Interpretation for regression result of moderator

Contrary to our hypothesis H4.1: bankruptcy risk strengthens the negative impact of current option wealth from exercisable options on managerial risk-taking, bankruptcy rate shows a significant effect of weakening the negative relationship between current option wealth from exercisable options and managerial risk-taking. Our hypothesis

based on personal cost incurred by company bankruptcy from the perspective of CEO employment and career is therefore challenged by the regression results of the two models. There are several potential explanations to the conflicting results according to former research and our analysis.

Firstly, as we mentioned in the literature, research such as March & Shapira (1992) proposed models of risk preferences, arguing that people generally shift attention between multiple reference points in which organizational slack point and survival point contribute to one of our intended explanations. When the bankruptcy rate is low, ranging from 0 to a certain point that can maintain CEOs' attention on organizational slack, CEOs tend to focus on excess resources that can be allocated due to their discretion. The allocation of excess resources increases the risk-taking behaviours such as risky investments and strategic revolution because organizational slack is seen as opportunities of increasing returns by taking more risks.

When bankruptcy rates are in a relatively low level, a small increase in the bankruptcy risk may be regarded as a sign of potential declining of the business and poses pressure on CEOs to deliver better performance. In such situations, CEOs hold high cash value of exercisable options on one hand have great risk bearing, which discourages them from taking additional risk. While, on the other hand, the pressure to deliver better performance makes CEOs more inclined to make risky investments in spite of the potential but non-ruinous loss. CEOs are likely to seek a balance among the incentives of both encouragement and discouragement on risk-taking. We made an analysis on the bankruptcy likelihood data of our sample companies (Appendix C). The average mean is 1.1%, with medium value as 0.46%. And 95% of our sample companies have bankruptcy likelihood lower than 4.3%. Taking into consideration the low bankruptcy rates in our samples, we argue that our regression results may be interpreted as CEOs seek risk-taking under the pressure of delivering better performance, when the overall bankruptcy risk is regarded as limited.

When the bankruptcy rates are high, there is a high possibility of ruinous losses, so the attention of CEOs is assumed to be directed to the survival point when bankruptcy rates significantly affect the risk appetite of CEOs during their decision process. However, in our study, our samples only have 437 observations with bankruptcy rates higher than 5%, among 10968 observations in total. So inadequate data with high bankruptcy rates might lead to ineffective confirmation of this effect in our study.

Secondly, it is also argued that high bankruptcy rates can possibly increase managerial risk-taking as Bowman (1982) claimed, risk taking activities may help troubled firms "come out even". When the company is on the verge of bankruptcy, CEOs might decide to invest in risky projects and expect success of the projects can reverse the

unfavourable situation and make the company come out even according to some psychological theories about the reactions to the plight. Sometimes such strategy and decisions are similar to gambling which has extremely high risk involved. Moreover, when a company is on the brink of bankruptcy, CEOs either with or without ownership have already suffered from a huge amount of loss, including decreased compensation and threats to their employment and future career paths. Those losses can be perceived as sunk costs when CEOs make their managerial decisions. Shareholders also suffer from a similar sunk cost, so in fact the increased risks are born by debtors instead of shareholders and management given there is an extremely high bankruptcy rate. Under the circumstance, CEOs are more likely to gamble on the risk-taking decisions and therefore high bankruptcy risk attenuates the negative relationship between current option wealth from exercisable options and managerial risk-taking.

Finally, we consider some extreme cases that might lead to the opposite results. If a company is a so-called zombie company or other kinds of companies that rely on bailouts or lenient creditors, it is possible for CEOs to invest in risky projects since the increased risks are also directly transferred to creditors. Therefore, we may interpret the higher risk-taking of CEOs even in high contingent bankruptcy risk situations, as they are taking actions favouring shareholders at the expense of creditors. These arguments are consistent with some of the agency literature (Jensen & Mecking, 1976) and provide alternative explanations, although our study suffers from the same limitation that our samples do not include adequate observations with high bankruptcy risk.

Hypothesis H4.2: bankruptcy risk weakens the positive impact of current option wealth from unexercisable options on managerial risk-taking is not supported by our regression results. Potential reasons include that there is indifferent perception of bankruptcy rates when bankruptcy rates are neglectable and that high current wealth from unexercisable options is seen as a signal of success that can create CEO hubris.

Generally, specific conceptualization and perception of bankruptcy risk might be unrealistic for CEOs during their daily management and operations, since we can not expect them to use bankruptcy prediction models such as O-score and Z-score models to calculate bankruptcy rates as one of their management routines or even include bankruptcy rates in their yearly reports. It is reasonable that CEOs only realize there is likelihood of bankruptcy when the likelihood exceeds a certain value. It is inferred that CEOs tend to consider bankruptcy risk using classification methods of which the most convenient and simplest way is to classify the bankruptcy rates of their companies into high, medium and low levels. It is possible that a bankruptcy rate of 5% is indifferent to that of 1% in the viewpoint of a CEO. Considering bankruptcy rates of our samples have a mean of 1.1%, it is possible that the indifferent perception of bankruptcy rates leads to the conflicting results.

Another potential explanation is that high current wealth from unexercisable options leads to CEO overconfidence, so that CEO insists on her or his original level of risk-taking in spite of bankruptcy risk. To be specific, when the company has a low bankruptcy rate as in our samples, the company has a higher buffer and ability to absorb higher risk, CEOs are more likely to take on more risks to increase returns. But if the CEO is overconfident and previously conducts a low-risk strategy, he or she will be less likely than other CEOs to take more risks and vice versa. When the company has a high bankruptcy rate, an overconfident CEO is also less likely to decrease her or his risk-taking as the CEO might think her or his strategy is effective enough to avoid bankruptcy of the company.

Hypothesis H4.3: bankruptcy risk strengthens the positive impact of prospective option wealth on managerial risk is supported by our regression results of the second model but not supported by results of the first model.

In the first model, the interaction term of prospective option wealth and bankruptcy risk has an insignificantly positive sign, while in the second model the interaction term has a significant positive sign. Our hypothesis is therefore partly supported. The potential explanations are consistent with those of hypothesis 4.1. Firstly, around 96% of the bankruptcy risks of our samples range from 0 to 0.05, which are relatively low compared with samples chosen in the previous study on moderating effects of bankruptcy risks. Previous study stated that when bankruptcy risk is high, the prospective wealth creates no additional risk bearing and provides proper incentives for CEOs to carry strategic risk-taking investment. Because CEOs may view these actions as necessary responses to turn around extremely poor performance of the company, which is similar to gamble on risky investments. It is also stated that high bankruptcy rates can lead CEOs to shift their attention from organization slack to survival, thus reducing risk-taking behaviours. Although our results from the second model support the former explanation, the restriction of samples might decrease its effectiveness.

While we are able to effectively support our hypothesis 4.3 in the second model given a low bankruptcy situation. In the second model, we confirm a significant moderating effect of bankruptcy rate on the relationship between managerial risk-taking and prospective option wealth. When bankruptcy risk is low or neglectable, CEOs focus on organizational slack and tend to allocate resources more efficiently in order to get higher returns. They are willing to undertake non-ruinous risks for higher return, thus increasing managerial risk-taking.

5.2.2. Contribution

5.2.2.1. Conceptualization and measurement of “managerial strategic risk taking”

Over decades, strategy management researchers are fundamentally concerned with manager's ex ante decision processes as well as their efforts to create and maintain above-average returns for their companies (Ruefli, Collins, & Lacugna, 1999). Research about executive compensation is addressing the incentive mechanism with regard to managerial risk-taking. However, among the multiple previous studies, the conceptualization of risk is somehow ambiguous or not explicitly clarified.

In general, risks are regarded as "uncertainty about outcomes or events" (Bloom & Milkovich, 1998). According to a well-known definition (Baird & Howard, 1985), strategic risk refers to "corporate strategic moves that cause return to vary, that involve venturing into the unknown, and that may result in corporate ruin". Literature on this topic has also referred to this kind of risk in terms of entrepreneurial risk or venturing risk (Zahra, 2005; Naldi et al., 2007; Huybrechts, Voordeckers, & Lybaert 2013).

We somehow may get some intuitive gut feeling from the concept, but do encounter difficulties when trying to transform it into a concrete measurement directly. The relatively abstract definition of strategic risk still leaves readers with puzzles, such as what actually do researchers mean by saying that a manager is taking a higher risk?

Previous studies using multiple risk measurements have well echoed the problem. Agent theory argues that agents are generally risk averse due to their relatively undiversifiable risks with regard to the company, and should be incentivized or monitored to join shareholders to take on more risks (Meyer, Milgrom, & Roberts, 1992). When agent theorists advocate that managers should take on more risks, they sometimes refer to the importance of making larger outlays of strategic investment. For example, Larcker (1983) takes the capital investment intensity as risk measurement in the study of the relationship between performance plan compensation and risk-taking. Sanders (2001) takes the number of acquisitions done in the year as risk measurement. Wu and Tu (2007) takes R&D investment intensity as proxy measurement of risk-taking. While, in other instances, researchers refer to the importance of making investments that will have more extreme possible outcomes. Hayward and Hambrick (1997) focus on the acquisitions with higher premiums. Baixauli-soler, Belda-ruiz and Sanchez-marin (2015) takes stock return volatility as risk measurement. Miller and Chen (2004) researches firm-risk as measured by volatility of ROA.

The volatility of company performance, either market-based stock return or accounting based ratio of ROA and ROE, provides a good fit to the definition of risk. However, they are criticized to be imperfectly fit with key concerns of strategic management research, since ex post measures are decidedly different from managers' ex ante risk assessment (Ruefli, Collins, & Lacugna, 1999). Using ex post realized risk mix the

intended risk-taking of managers together with other exogenous industrial factors, which may blur the situation.

Given the multifaceted and ubiquitous nature of risk, it is advocated that a single measure that is mathematically simple may not be possible to capture all the perspectives of risks. And it is encouraged to research on different measures to address the notion in a different setting or from a different perspective (Ruefli, Collins, & Lacugna, 1999).

We therefore compute the two dependent variables in our model, as an effort to research new measurements of risks. We argue that the two dependent variables in our model are good proxies of ex ante assessment of managerial strategic risk taking by CEOs, as they reflect the composite risk level CEOs may be aware of when integrating the strategic investment with the contingencies of the company's existing business volatility. The trial on the new measurement of risks provides refreshing empiric data to test and analyse the validity of the behavioural agency model.

5.2.2.2. Extension of behavioural agency model on option wealth

Most of the previous research on the relationship between stock options and company risk-taking tries to explain the influence of stock options as a whole. For example, classical agency theorists predict that stock options encourage CEOs to take more risks in the expectation that risk positively affects the value of their option wealth in a firm (Jensen & Meckling, 1976). They focus on the effect of stock options at the time of granted, and argue that CEOs perceive stock options as a gamble providing only gain outcomes. While Wiseman and Gomez-Mejia (1998) addressed in the original BAM formulation that the accumulated value of stock options create negative influence on risk taking through risk bearing, which focus only on the potential loss outcomes. Related empirical research has studied the effect of newly granted stock options during the year (Sanders, 2001), the effect of exercisable options and unexercisable options (Larraza-Kintana, Wiseman, Gomez-Mejia, & Welbourne, 2007; Souder & Shaver, 2010).

Martin, Gomez-Mejia and Wiseman (2013) modified the original BAM by arguing that it is necessary to consider the situation in which CEO make strategic decision as a mixed gambling with both possible losses and possible gains, thus introducing prospective option wealth into the behavioural agency model for the first time, in addition to current option wealth.

Based on Martin, Gomez-Mejia and Wiseman (2013), we further integrate the idea of diminishing marginal effect from prospect theory. According to Kahneman and Tversky (1979), the value function provided by monetary incentive is concave. Thus,

we modify the BAM by predicting that prospective option wealth positively influences managerial risk taking, but with decreasing marginal effect. And secondly, we integrate the BAM with previous research finding that exercisable and unexercisable options have different effects on company risk-taking. Thus, we differentiate the current wealth between the one from exercisable options and the other from unexercisable options in our model, as an extension to the model in Martin, Gomez-Mejia and Wiseman (2013).

As a summary, compared to previous research, we break down stock option wealth into detailed categories of current wealth from exercisable options, current wealth from unexercisable options and prospective wealth, to together demonstrate a whole picture of a CEO's wealth from his or her option portfolio. We are the first to make the trial to include the three categories of option wealth in one model and to demonstrate their dynamic interactions, while previous research has study focus on only one or two. The empirical testing in Martin, Gomez-Mejia and Wiseman (2013) suggests that current wealth of CEO stock option discourages managerial risk-taking. However, our study shows that only current wealth from exercisable options discourages CEO's strategic risk-taking, while current wealth from unexercisable options encourages risk-taking behavioural of CEOs. We argue that previous conflicting empirical results on the relationship between stock option wealth and risk-taking may partially be reconciled while we consider the difference between exercisable and unexercisable options. Therefore, our study make contribution by developing the traditional behavioural agency model and providing reconciliation to previous research findings.

5.2.2.3. Exploration of bankruptcy risk as a moderator

In addition to the above-mentioned modification, we further introduced bankruptcy risk of a company as a moderator to the behavioural agency model, to study its effect on the relationship between option wealth and managerial strategic risk.

Bankruptcy, also known as business failure, has significant economic effects not only on the company and shareholders but also on its creditors and employees, especially when the company is large and systemically important as some manufacturing company samples we chose in our study. The research on bankruptcy risk in the contingent context of companies therefore becomes extremely important for both academia and industry. So far research on bankruptcy risk has provided various models and explanations to the mechanism related to prediction, prevention and impacts of company bankruptcy, in which bankruptcy risk generally serves as an independent or dependent variable. However, from the perspective of the behaviour agency model, we assume bankruptcy risk should serve as a moderator that can adjust the relationship between risk-taking and CEO option wealth. This assumption is based on the conflicting results of former research on the relationship between managerial risk-

taking and bankruptcy risk. As we mentioned in section 2.1 and 2.2, former research considers bankruptcy risk as a suppression of further risk-taking, but when two scenarios of high and low bankruptcy risk are taken into consideration, the results become conflicting. So we infer bankruptcy risk does not directly affect managerial risk-taking, it might affect the relationship between risk-taking and other economically meaningful and statistically significant factors. And this assumption is partly supported by our regression results, providing evidence for the moderating effect of bankruptcy risk.

Our study and particularly the inclusion of bankruptcy risk as the moderator therefore shed some light on the understanding of the relationship between stock options and managerial risk taking with regard to the particular contingent context of companies in the research area of management behaviour, company governance and risk management.

5.2.2.4. Empirical test with longer periods

Our hypothesis test adds to the small handful empirical testing of the behavioural agency model about stock option wealth. Compared with previous research on the behavioural agency model, our study provides refreshing empirics with relatively longer periods from 1993 to 2019. The data with longer periods may help to verify the validity of the model through different times by reducing potential random effects caused by the small size of samples and the short time period.

5.2.2.5. Implications to practitioner

Our study deconstructs the influence of stock option wealth into different perspectives (e.g. current wealth vs. prospective wealth, unexercisable options vs. exercisable options). We argue that our empirical findings have practical implications to boards of directors or company stakeholders who seek to understand how the stock option incentive plan may influence the behaviour of their agents. As time passes and stock price changes, the composition of exercisable and unexercisable options in a CEO's option portfolio may change, and the current option wealth and prospective wealth value may vary as well. Thus, it is necessary to understand the incentives provided by option portfolios dynamically. Our model may provide a basic framework for practitioners to understand the impact of stock options on CEOs' risk taking as their existing stock options approaches expiry time or they are granted with new stock options. Although due to the complicated effect of stock option wealth on managerial risk-taking, it is impossible to conclude a fit for all stock option policy suggestions, our empirical findings may help practitioners to have a deeper understanding on how stock option influence the behaviour of CEOs. And it is encouraged to design the stock option incentive plan for CEOs in consideration with his or her existing holdings of options.

Moreover, it is also meaningful to analyze bankruptcy risk included in the model, since bankruptcy occurs more frequently due to Covid-19 pandemic. The increase of bankruptcy risk has become a growing concern of many CEOs and managers when they consider new investments. Understanding the effect of bankruptcy risk is beneficial for boards of directors and company stakeholders when they design the option compensation packages for CEOs under economic downturn when there is a material bankruptcy risk.

5.2.3. Limitation and future research directions

We acknowledge that our study has several limitations. First, the prospective option wealth measure is an estimate of CEOs' subjective evaluation of growth prospects for the value of their stock options. As we mentioned in section 3.1.2.2, due to the unavailability of data before 2006, we estimate the prospective option wealth as a function of the increase in stock price for all the stock options held by the CEO, without identifying and taking out the deep in-the-water options from our calculation. We are also aware of the possibility that CEOs may form their estimation of prospective option wealth on alternative benchmarks, such as the stock price movement history of their own company, or the performance of the rival companies. The limitation on the computation of prospective option wealth in our study may present opportunities for future research. We suggest future research could examine the possible determinants of prospective option wealth estimates.

Secondly, our research is based on secondary data. We compute the risk measurements using secondary accounting data. Though we regard the risk measurements in our model as a contribution to previous research, they are still inferior to primary measures which can reflect CEOs' risk-taking attitude and their reference points directly. Therefore, we suggest future studies of behavioural agency model may obtain primary data to measure CEO's risk-taking through surveys or questionnaires if possible.

Thirdly, the bankruptcy risk of our samples is relatively low, of which only 437 observations have bankruptcy rates higher than 5% among 10968 observations in total. This was not expected before data collection and became a drawback for our analysis about the moderating effect of bankruptcy risk. There might be a survival bias in our research. Although our results partly support the hypothesis, the inadequacy of high bankruptcy risk data might reduce the accuracy and effectiveness of our analysis. Also, the standard of distinguishing high bankruptcy risk from low bankruptcy risk might differ from industry to industry. We use 5% as a standard to distinguish high bankruptcy rates from low bankruptcy rates, but the standard can be lower in the banking industry for example. The standard can also vary because of models used to measure bankruptcy rates and risk appetite of CEOs. So we suggest that in the future research, researchers

take above factors into account and conduct a grouped regression that can verify the difference between effects of high and low bankruptcy risks.

Lastly, our research is based on manufacturing companies. Since companies' risk taking in strategic investment is closely related to the industrial characteristics, our empirical findings may not be ready to be extended to other industries. Instead, we suggest future research may focus on other industries to test the explanatory power of behavioural agency model and facilitate the comparisons across different industries.

6. Additional tests

6.1. Robustness tests

We conduct four more tests to analyze if our results will vary with alternative model assumptions, including changing the assumptions to compute both dependent variables and independent variables.

First, we compute the dependent variables $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ and $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$, using the deviation of quarterly ROE in the past four years instead of the past three years in our main test. We use 4-year data of quarterly ROE to measure our dependent variable while keep all independent variables, moderators and control variables unchanged in the model. The regression results are shown in Appendix D and E. In the first model, all the signs and significance of independent variables and moderators remain the same as the results shown in our main section, except for the significance of prospective wealth which increases by one star from the 10% level to 5% level. In the second model, the significance of prospective wealth also increases, while that of bankruptcy risk and prospective wealth decreases by one star.

Second, we consider alternative assumptions underlying dependent variable of prospective option wealth. In our second and third additional test, we compute the prospective option wealth with more extreme assumptions about annual stock price increase. In the second additional test, it is assumed that stock price increase 2% annually. In the third additional test, it is assumed that stock price increase 20% annually. We calculate new Ln (prospective option wealth) according to the new assumptions about stock price while keeping all the other variables in the model the same as in the main test. The regression results for second additional test are shown in Appendix F and G. The regression results for third additional test are shown in Appendix H and I. According to the results, all the signs and significance of independent variables and moderators in the first model remain the same as they are in the original regression, except for the significance of current wealth from unexercisable options, which decreases from the level of 5% to 10%. Notably, in the second model, current wealth from exercisable options becomes significant at the level of 10%. When it is assumed that stock price increase 20% annually, the significance of the interaction term of bankruptcy risk and exercisable wealth increases from the level of 10% to 5%, all the others remain unchanged.

Last, we test the assumptions of expiration time of stock options underlying prospective option wealth. According to Fu and Ligon (2010), fifty percent of executives exercise

their options within two years of vesting. So it is reasonable to expect situations that CEOs may not wait until the final expiration date to execute their options. As an alternative, we assume CEOs execute options 3 years before expiry and compute new Ln (prospective option wealth) accordingly. The regression results are presented in Appendix J and K. The prospective wealth becomes more significant in the models 1-2, 1-3 and 2-2 and the interaction term of bankruptcy risk and exercisable wealth in model 2-3 increases from significance level of 10% to 5%. All the other signs and significance of independent variables and moderators are the same as in our main test.

As a summary, the sensitivity test of the stock price, the options remaining time and the years to calculate ΔROE proves that our findings are robust, although there are slight volatility of the significance.

6.2. Endogeneity discussion

Endogeneity leads to biased and inconsistent parameter estimates. Thus it is important to address the endogeneity concerns. Generally, sources of endogeneity include measurement error bias, simultaneous causality and omitted variables (Wooldridge, 2016). We consider the possibility that our CEO stock option wealth variables are endogenous. In an effort to reduce the possibility of simultaneous causality, we use the instrument variables of lagged CEO stock option wealth in our regression. So that the R&D investment or capital investment in this year are not possible to influence CEOs' option wealth as at the end of last year. The design may reduce possible simultaneous causality to some extent. With regard to the problem of omitted variables, we are aware of the possibility since managerial risk-taking is influenced by many various factors according to previous research. And it is impossible for us to include all in our model. As an attempt to address the endogeneity problem which may be caused by omitted variables, we choose to use the company fixed effect regression model, so that we may include all the effects from company persistent characteristics, thus reducing the possibility of omitting important variables. Therefore, we argue that we have considered the problem of endogeneity for our model and taken some measures to control it. Yet in the same time we are aware that endogeneity could still arise due to possible omitted variable, which is not firm-specific or varies through time.

7. Concluding remarks

Research on stock option as part of management compensation and company risk-taking has developed many theories in strategic management studies. Among those previous theories, some yield conflicting empirical results from different perspective. For instance, agency theory (Jensen & Meckling, 1976) takes the view that stock options are effective ways to align the risk preference of CEOs with that of shareholders who are mostly risk-seekers (Sanders, 2001). While some other research shows that CEO stock options create less risk-taking, which is in accordance with behavioural agency model (BAM) proposed by Wiseman and Gomez-Mejia (1998). Moreover, contingent and contextual factors show influence on the above relations in the previous research. Bankruptcy risk is one of the highly related factors as previous research suggested. For instance, bankruptcy risk can affect the reference points of risk-takers who shift their attention on company growth and survival (Holmes et al., 2011). Also, bankruptcy risk is possible to incur personal cost to CEOs and therefore affects their risk-taking.

Our research builds on those previous results and extends the behaviour agency model by examining the relationship between CEO stock option wealth and managerial strategic risk-taking and further includes bankruptcy risk in our study as a contextual factor to examine its moderating effect. We further divided the CEO stock option wealth into exercisable and unexercisable wealth to conduct a more reasonable and specific analysis. We are inspired by the methods of dividing option wealth into different elements including exercisable option wealth and unexercisable option wealth (Devers, McNamara, Wiseman, & Arrfelt, 2008; Souder & Shaver 2010). The negative effects of exercisable wealth and positive effect of unexercisable wealth are confirmed in our analysis. Further support of relations between CEO option wealth and managerial risk-taking is provided by our study. Moreover, our hypothesis of non-linear relationship between prospective wealth and risk-taking with a diminishing effect is also confirmed, providing a more complete picture for the study. However, our hypothesis about bankruptcy risk is not confirmed and we suggest that further study can explore the effects of bankruptcy risk using high bankruptcy risk samples and/or different measures of bankruptcy risk. In conclusion, the three different parts of stock option compensation play different roles in affecting CEOs' risk-taking as discussed, and bankruptcy risk does not show expected moderating effect in our study.

We acknowledge that our study suffers from limitations about measurement of variables, samples selection and endogeneity. We suggest that further research improve credibility and reliability of measurement of variables and choose broad samples with higher bankruptcy risk. Besides, applying instrumental variables is an option to mitigate

endogeneity of the study, although it is difficult to find proper and appropriate instruments. We hope our study can shed some light on the incentive package design for company management in both academia and industry and contribute to the research in the area of strategic management studies.

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Appendices

Appendix A – Glossary

Word or phrase used in thesis	Definition
BAM	Behavioural agency model
CAPEX	Capital expenditure; capital investment
CEO	Chief executive officer
ROE	Return on equity
ROA	Return on assets
CHIN	$\frac{NI_t - NI_{t-1}}{\lvert NI_t \rvert + \lvert NI_{t-1} \rvert}$
CLCA	$\frac{\text{Current liabilities}}{\text{current assets}}$
FUTL	$\frac{\text{Funds from operations}}{\text{total liabilities}}$
INTWO	One if net income was negative for the last two years, zero otherwise
NITA	$\frac{\text{Net income}}{\text{total assets}}$
NPV	Net Present Value
OENEG	One if total liabilities exceeds total assets, zero otherwise
P(B)	Probability of bankruptcy
R&D	Research and development
ROE	Return on Equity
SIZE	$\text{LN}\left(\frac{\text{total assets}}{\text{GNP price-level index}}\right)$
TLTA	$\frac{\text{Total liabilities}}{\text{total assets}}$
WCTA	$\frac{\text{Working capital}}{\text{current assets}}$

Appendix B - Hausman test

In order to test whether it is reasonable to apply company fixed-effect model in our regression, we run Hausman Tests to compare random effect and fixed effect models. In the following two tables, test results of our two models are presented. P-value of both models is close to 0, so it is consistent and effective for our study to choose company fixed effect models.

Independent variable: $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$	(1)	(2)
Dependent variables	RE	FE
Current Wealth Exercisable	-0.002***	-0.002***
Current Wealth Unexercisable	0.002***	0.002***
Ln (Prospective Wealth)	2.743**	1.862
Bankruptcy Likelihood	38.234	134.977
Bankruptcy Likelihood × Current Wealth Exercisable	0.075***	0.077***
Bankruptcy Likelihood × Current Wealth Unexercisable	-0.057	-0.092*
Bankruptcy Likelihood × Ln (Prospective Wealth)	56.161*	54.548*
CEO InBoard	13.472	8.993
CEO Age	0.079	0.760
CEO Gender	13.395	12.490
CEO Tenure	-0.774	-1.126
Stock Ownership	-0.100	0.224
ROE	-135.194***	-107.755***
Interest Rate	27.065	34.763
CEO Founder	14.419	5.089
Company Size	-11.826***	-11.277**
Constant	120.483**	85.705
Observations	10,968	10,968
Number of CompanyID	873	873
Hausman		131.1
p-value		0.000

*Notes: *** p<0.01, ** p<0.05, * p<0.1*

Independent variable: $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$	(1)	(2)
Dependent variables	RE	FE
Current Wealth Exercisable	-0.000***	-0.000***
Current Wealth Unexercisable	0.001***	0.001***
Ln (Prospective Wealth)	0.365	0.359
Bankruptcy Likelihood	-32.330	-42.551
Bankruptcy Likelihood × Current Wealth Exercisable	0.014***	0.015***
Bankruptcy Likelihood × Current Wealth Unexercisable	0.008	0.007
Bankruptcy Likelihood × Ln (Prospective Wealth)	39.484***	35.378***
CEO In Board	4.409	2.915
CEO Age	-0.353**	-0.246
CEO Gender	-3.053	-3.503
CEO Tenure	-0.441**	-0.578***
Stock Ownership	-0.485	-0.217
ROE	-15.247***	-7.213
Interest Rate	-7.375	-11.017
CEO Founder	22.648***	28.102***
Company Size	-1.567	-3.382**
Constant	65.530***	72.704***
Observations	10,968	10,968
R-squared		0.015
Number of Company ID	873	873
Hausman		101
p-value		0.000

*Notes: *** p<0.01, ** p<0.05, * p<0.1*

Appendix C – Descriptive data for bankruptcy likelihood

Percentiles	Bankruptcy Likelihood
1%	0.000014
5%	0.000131
10%	0.000332
25%	0.001356
50%	0.0046085
75%	0.0118675
90%	0.026686
95%	0.043274
99%	0.109003
Obs	10,968
Mean	0.0112616
Std. Dev.	0.0233405

Appendix D – Additional test: regression of $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ (ΔROE in the last four years)

Variables	Model 1-2		Model 1-3	
	coefficient	t-statistics	coefficient	t-statistics
Current Wealth Exercisable	-0.002*	(-1.712)	-0.002*	(-1.841)
Current Wealth Unexercisable	0.002**	(2.15)	0.003**	(2.41)
Ln (Prospective Wealth)	3.267**	(2.25)	2.662**	(2.44)
Bankruptcy likelihood			151.877	(0.60)
Bankruptcy Likelihood × Current Wealth Exercisable			0.072*	(1.76)
Bankruptcy Likelihood × Current Wealth Unexercisable			-0.122	(-1.066)
Bankruptcy Likelihood × Ln (Prospective Wealth)			38.381	(0.76)
CEO In Board	13.755	(1.41)	13.697	(1.42)
CEO Age	0.88	(1.06)	0.93	(1.12)
CEO Gender	14.723	(0.57)	14.632	(0.57)
CEO Tenure	-1.4	(-1.435)	-1.545	(-1.618)
Stock Ownership	0.506	(1.21)	0.441	(1.07)
Company Size	-13.776***	(-2.661)	-12.567**	(-2.484)
ROE	-124.900***	(-3.583)	-107.551***	(-3.216)
Interest Rate	31.126	(0.64)	32.323	(0.67)
CEO Founder	1.535	(0.08)	4.412	(0.24)
_cons	101.56	(1.64)	87.525	(1.41)
Observations	10,968		10,968	
Within Adjusted R-squared	0.0286		0.0312	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix E – Additional test: regression of $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta\text{ROE}$ (in four years)

Variables	Model 2-2		Model 2-3	
	coefficient	t-statistics	coefficient	t-statistics
Current Wealth Exercisable	-0.000	(-1.625)	-0.000**	(-2.098)
Current Wealth Unexercisable	0.001***	(2.701)	0.001***	(2.910)
Ln (Prospective Wealth)	1.059***	(2.861)	0.613*	(1.673)
Bankruptcy likelihood			-99.547	(-0.703)
Bankruptcy Likelihood × Current Wealth Exercisable			0.015**	(2.123)
Bankruptcy Likelihood × Current Wealth Unexercisable			-0.001	(-0.018)
Bankruptcy Likelihood × Ln (Prospective Wealth)			33.085*	(1.958)
CEO In Board	8.744	(1.217)	8.438	(1.170)
CEO Age	-0.381	(-1.113)	-0.378	(-1.068)
CEO Gender	-2.874	(-0.353)	-3.073	(-0.385)
CEO Tenure	-0.496	(-0.854)	-0.514	(-0.873)
Stock Ownership	-0.191	(-0.565)	-0.181	(-0.548)
Company Size	-6.091***	(-3.310)	-5.856***	(-3.174)
ROE	-6.008	(-0.605)	-0.293	(-0.023)
Interest Rate	-16.169	(-1.040)	-15.714	(-0.999)
CEO Founder	28.392**	(2.484)	28.639**	(2.499)
_cons	97.057***	(4.107)	96.445***	(3.762)
Observations	10,968		10,968	
Within Adjusted R-squared	0.0045		0.0054	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix F – Additional test: regression of $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ with assumption of 2% stock price increase

Variables	Model 1-2		Model 1-3	
	coefficient	t-statistics	coefficient	t-statistics
Current Wealth Exercisable	-0.002*	(-1.679)	-0.002*	(-1.825)
Current Wealth Unexercisable	-0.002*	(-2.055)	-0.002*	(-2.296)
Ln (Prospective Wealth) – 2% annual increase in stock price	3.430*	(-1.939)	2.321*	(-1.886)
Bankruptcy likelihood			107.369	(-0.389)
Bankruptcy Likelihood × Current Wealth Exercisable			0.076*	(-1.874)
Bankruptcy Likelihood × Current Wealth Unexercisable			-0.096	(-0.961)
Bankruptcy Likelihood × Ln (Prospective Wealth) -2% annual increase in stock price			73.384	(-0.993)
CEO In Board	9.199	(-1.019)	8.902	(-1.012)
CEO Age	0.71	(-0.97)	0.765	(-1.042)
CEO Gender	12.701	(-0.51)	12.418	(-0.501)
CEO Tenure	-0.993	(-1.156)	-1.138	(-1.357)
Stock Ownership	0.266	(-0.683)	0.215	(-0.558)
Company Size	-130.276***	(-3.677)	-107.748***	(-3.377)
ROE	33.255	(-0.634)	34.953	(-0.671)
Interest Rate	2.437	(-0.151)	5.168	(-0.322)
CEO Founder	-12.882**	(-2.250)	-11.481**	(-2.042)
_cons	101.335	(-1.64)	86.236	(-1.386)
Observations	10,968		10,968	
Within Adjusted R-squared	0.0313		0.0352	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix G – Additional test: regression of $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta ROE$ with assumption of 2% stock price increase

Variables	Model 2-2		Model 2-3	
	coefficient	t-statistics	coefficient	t-statistics
Current Wealth Exercisable	-0.000*	(-1.647)	-0.000**	(-2.003)
Current Wealth Unexercisable	0.001***	(3.244)	0.001***	(3.153)
Ln (Prospective Wealth) – 2% annual increase in stock price	1.003**	(2.493)	0.413	(0.953)
Bankruptcy likelihood			-49.937	(-0.532)
Bankruptcy Likelihood × Current Wealth Exercisable			0.014*	(1.908)
Bankruptcy Likelihood × Current Wealth Unexercisable			0.005	(0.168)
Bankruptcy Likelihood × Ln (Prospective Wealth) -2% annual increase in stock price			44.905**	(2.314)
CEO In Board	3.167	(0.579)	2.896	(0.529)
CEO Age	-0.258	(-0.977)	-0.245	(-0.915)
CEO Gender	-3.309	(-0.440)	-3.520	(-0.481)
CEO Tenure	-0.559	(-1.389)	-0.579	(-1.426)
Stock Ownership	-0.226	(-0.896)	-0.219	(-0.877)
Company Size	-3.844**	(-2.104)	-3.435*	(-1.883)
ROE	-16.439*	(-1.761)	-7.241	(-0.659)
Interest Rate	-11.621	(-0.997)	-10.956	(-0.936)
CEO Founder	27.837***	(2.817)	28.086***	(2.841)
_cons	76.479***	(3.882)	73.114***	(3.609)
Observations	10,968		10,968	
Within Adjusted R-squared	0.0099		0.0141	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix H – Additional test: regression of $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ with assumption of 20% stock price increase

Variables	Model 1-2		Model 1-3	
	coefficient	t-statistics	coefficient	t-statistics
Current Wealth Exercisable	-0.002*	(-1.671)	-0.002*	(-1.820)
Current Wealth Unexercisable	0.002**	(-2.057)	0.002**	(-2.3)
Ln (Prospective Wealth) – 20% annual increase in stock price	2.185*	(-1.913)	1.525*	(-1.833)
Bankruptcy likelihood			156.313	(-0.591)
Bankruptcy Likelihood × Current Wealth Exercisable			0.078*	(-1.878)
Bankruptcy Likelihood × Current Wealth Unexercisable			-0.09	(-0.911)
Bankruptcy Likelihood × Ln (Prospective Wealth) -20% annual increase in stock price			42.273	(-0.899)
CEO In Board	9.269	(-1.028)	9.049	(-1.028)
CEO Age	0.698	(-0.951)	0.756	(-1.028)
CEO Gender	12.826	(-0.515)	12.553	(-0.506)
CEO Tenure	-0.957	(-1.106)	-1.116	(-1.323)
Stock Ownership	0.292	(-0.756)	0.232	(-0.604)
Company Size	-129.687***	(-3.673)	-107.813***	(-3.369)
ROE	32.916	(-0.626)	34.618	(-0.664)
Interest Rate	2.015	(-0.124)	4.98	(-0.309)
CEO Founder	-12.454**	(-2.201)	-11.135**	(-1.993)
_cons	101.105	(-1.625)	85.521	(-1.367)
Observations	10,968		10,968	
Within Adjusted R-squared	0.0311		0.035	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix I – Additional test: regression of $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta ROE$ with assumption of 20% stock price increase

Variables	Model 2-2		Model 2-3	
	coefficient	t-statistics	coefficient	t-statistics
Current Wealth Exercisable	-0.000	(-1.615)	-0.000**	(-2.008)
Current Wealth Unexercisable	0.001***	(3.244)	0.001***	(3.131)
Ln (Prospective Wealth) – 20% annual increase in stock price	0.703**	(2.385)	0.319	(1.013)
Bankruptcy likelihood			-34.450	(-0.359)
Bankruptcy Likelihood × Current Wealth Exercisable			0.015**	(1.983)
Bankruptcy Likelihood × Current Wealth Unexercisable			0.008	(0.250)
Bankruptcy Likelihood × Ln (Prospective Wealth) -20% annual increase in stock price			28.451**	(2.139)
CEO In Board	3.152	(0.577)	2.925	(0.536)
CEO Age	-0.259	(-0.986)	-0.246	(-0.921)
CEO Gender	-3.287	(-0.436)	-3.486	(-0.475)
CEO Tenure	-0.551	(-1.373)	-0.576	(-1.422)
Stock Ownership	-0.219	(-0.870)	-0.215	(-0.866)
Company Size	-3.719**	(-2.054)	-3.342*	(-1.847)
ROE	-16.277*	(-1.745)	-7.240	(-0.662)
Interest Rate	-11.688	(-1.004)	-11.057	(-0.945)
CEO Founder	27.771***	(2.814)	28.109***	(2.847)
_cons	75.769***	(3.873)	72.357***	(3.598)
Observations	10,968		10,968	
Within Adjusted R-squared	0.0098		0.0138	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix J – Additional test: regression of $\frac{\text{R\&D Investment}}{\text{Sales}} \times \Delta\text{ROE}$ with assumption of shorter expiration time

Variables	Model 1-2		Model 1-3	
	coefficient	t-statistics	coefficient	t-statistics
Current Wealth Exercisable	-0.002*	(-1.677)	-0.002*	(-1.826)
Current Wealth Unexercisable	0.002**	(-2.043)	0.002**	(-2.282)
Ln (Prospective Wealth) - 3 years less in expiration time	2.843**	(-2.242)	1.978**	(-2.208)
Bankruptcy likelihood			137.402	(-0.521)
Bankruptcy Likelihood × Current Wealth Exercisable			0.077*	(-1.879)
Bankruptcy Likelihood × Current Wealth Unexercisable			-0.094	(-0.944)
Bankruptcy Likelihood × Ln (Prospective Wealth) - 3 years less in expiration time			59.891	(-0.93)
CEO In Board	9.206	(-1.024)	8.923	(-1.016)
CEO Age	0.708	(-0.965)	0.764	(-1.041)
CEO Gender	13.049	(-0.524)	12.671	(-0.511)
CEO Tenure	-0.968	(-1.119)	-1.118	(-1.328)
Stock Ownership	0.275	(-0.71)	0.217	(-0.566)
Company Size	-130.210***	(-3.679)	-108.217***	(-3.380)
ROE	33.451	(-0.637)	35.097	(-0.673)
Interest Rate	2.127	(-0.131)	5.02	(-0.312)
CEO Founder	-12.826**	(-2.247)	-11.458**	(-2.042)
_cons	103.056*	(-1.652)	87.327	(-1.395)
Observations	10,968		10,968	
Within Adjusted R-squared	0.0313		0.0352	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix K – Additional test: regression of $\frac{\text{Capital Investment}}{\text{Sales}} \times \Delta ROE$ with assumption of shorter expiration time

Variables	Model 2-2		Model 2-3	
	coefficient	t-statistics	coefficient	t-statistics
Current Wealth Exercisable	-0.000	(-1.643)	-0.000**	(-2.043)
Current Wealth Unexercisable	0.001***	(3.221)	0.001***	(3.107)
Ln (Prospective Wealth) - 3 years less in expiration time	0.979***	(2.901)	0.540	(1.453)
Bankruptcy likelihood			-16.027	(-0.175)
Bankruptcy Likelihood × Current Wealth Exercisable			0.015**	(2.009)
Bankruptcy Likelihood × Current Wealth Unexercisable			0.007	(0.222)
Bankruptcy Likelihood × Ln (Prospective Wealth) - 3 years less in expiration time			33.438**	(1.975)
CEO In Board	3.104	(0.568)	2.874	(0.528)
CEO Age	-0.255	(-0.964)	-0.241	(-0.900)
CEO Gender	-3.221	(-0.428)	-3.469	(-0.474)
CEO Tenure	-0.556	(-1.381)	-0.580	(-1.429)
Stock Ownership	-0.225	(-0.895)	-0.225	(-0.899)
Company Size	-3.847**	(-2.108)	-3.456*	(-1.897)
ROE	-16.465*	(-1.767)	-7.733	(-0.705)
Interest Rate	-11.479	(-0.985)	-10.845	(-0.925)
CEO Founder	27.854***	(2.812)	28.207***	(2.848)
_cons	75.953***	(3.835)	72.144***	(3.543)
Observations	10,968		10,968	
Within Adjusted R-squared	0.0101		0.0139	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix L – Regressions without natural logarithm transformation of prospective wealth (Model 1-2)

Variables	Model 1-2	
	coefficient	t-statistics
Current Wealth Exercisable	-0.001*	(-1.792)
Current Wealth Unexercisable	0.002**	(2.006)
Prospective Wealth	-0.000	(-0.793)
CEO In Board	10.812	(1.186)
CEO Age	0.609	(0.833)
CEO Gender	13.642	(0.547)
CEO Tenure	-0.834	(-0.939)
Stock Ownership	0.321	(0.822)
Company Size	-11.134**	(-2.023)
ROE	-128.702***	(-3.695)
CEO Founder	0.019	(0.001)
Interest Rate	30.686	(0.577)
_cons	115.809*	(1.824)
Observations	10,968	
Within Adjusted R-squared	0.032	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*

Appendix M – Regressions without natural logarithm transformation of prospective wealth (Model 2-2)

Variables	Model 2-2	
	coefficient	t-statistics
Current Wealth Exercisable	-0.000*	(-1.811)
Current Wealth Unexercisable	0.001***	(3.168)
Prospective Wealth	0.000	(0.827)
CEO In Board	3.475	(0.641)
CEO Age	-0.276	(-1.042)
CEO Gender	-3.177	(-0.421)
CEO Tenure	-0.535	(-1.320)
Stock Ownership	-0.209	(-0.835)
Company Size	-3.946**	(-2.092)
ROE	-16.280*	(-1.750)
CEO Founder	27.147***	(2.727)
Interest Rate	-11.852	(-1.018)
_cons	83.977***	(4.136)
Observations	10,968	
Within Adjusted R-squared	0.0104	

*Note: 1) Coefficient are displayed as multiplied by 10,000;2) ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels respectively.*