UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Economics & Financial Economics

# The Short- and Long-Term Performance Effects of Implementing Executive Stock Option Compensation Programs

Double Bachelor's Thesis (15 Credits)
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Spring term 2023

# Abstract

This study examined the effect of implementing executive stock option compensation schemes on firm performance, specifically focusing on the US IT Sector from 2000-2022. To accomplish this, a theoretical background was first established with previous works on the subject. Then, an event study methodology and a multiple linear regression were employed to examine the causality in both the short- and long-term. The previous works pointed to a weak but positive relationship, with a cyclical component being present. The results from the event study confirmed that the market exhibits positive sentiment when presented with the implementation of an executive stock option compensation scheme. Furthermore, the multiple linear regression confirmed a relationship between the issuance of executive stock options and improved performance in the long-term, and highlighted the presence of cyclical effects. These results both confirmed and built upon previous works' conclusions. Future research was urged to delve deeper into the subject.

**Keywords:** Event study, executive compensation, performance, stock options, XSO

# Acknowledgements

We would like to take the time to extend our gratitude to our supervisor Dr. Jian Hua Zhang of the Department of Economics at the University of Gothenburg. This paper was only possible through his wisdom, guidance and unwavering patience. Thank you!

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# 1. Introduction

*In this introductory chapter, the reader will gain a deeper insight into executive compensation, stock options, and the impact an executive's risk-taking behaviour has on a firm's performance. '1.1 Background' provides an expanded rationale on the importance of this thesis. '1.2 Purpose and Problem Area' discusses the contextual landscape in which stock options exist, what the current literature has yet to define and how this thesis aims to address some of these problematic areas. '1.3 Structure of the Thesis' familiarises the reader with the two-sided analysis (short- and long-term) used to answer the research questions. '1.4 Research Questions and Expected Results' expands upon the purpose and problem area, constructing the hypothesis, and finally presenting the expected results. Finally, '1.5 Scope' clarifies the criterion used to narrow down the problem area for this study.*

## 1.1 Background

The issue of executive compensation has garnered significant attention from the media, prompting a closer examination of the matter. There have been concerns raised about the perceived excessive and unfair compensation received by executives, leading to negative portrayals of corporations and their leaders. The primary criticism is that executives receive an unwarranted share of the income, relative to the contributions of other employees, which may result in a net negative impact on the company's value[1]. However, what value do executives actually bring to the table?

An analysis is needed, to explore the value that executives bring to an organisation and how their impact on the company's performance justifies their compensation. Additionally, it is important to consider the potential impact of executive compensation on a company's bottom line. Therefore, it is necessary to explore how different forms of executive compensation may impact firm performance, of which stock options are of key interest.

Stock options as a form of compensation arose in the 1950s, and while experiencing large shifts in popularity, have risen to become one of the most widely used equity compensation schemes for

[1] David Aboody, Nicole Bastian Johnson, and Ron Kasznik, "Employee Stock Options and Future Firm Performance: Evidence from Option Repricings," *Journal of Accounting and Economics* 50, no. 1 (May 2010): pp. 74-92, https://doi.org/10.1016/j.jacceco.2009.12.003.

executives in public companies[2]. After their use peaked during the late 1990s, the Dot Com Bubble and a scandal regarding their backdating caused them to fall out of favour.[3] However, at present, stock options have made a massive comeback, with recognition as a major driving force for innovation. This could be the case within areas such as the IT sector, where knowledge of employees is an important asset, since stock options heavily promote the retention of key personnel.

## 1.2 Purpose and problem area

According to agency theory, whenever work is delegated to a party with less ownership of the consequences of said work, costs separate from compensation or other forms of monetary expenses arise. These costs may be in the form of lost income from not taking investment opportunities the principal (owner) may have taken, or from taking (to the owner) excessively risky investments. This refers to agency costs, whenever an agent agrees to act on behalf of a principal, due to the inherent differences in incentives between agents and principals.

A recognised and often used remedy is stock compensation, which in a sense may better align the agent's incentives with that of the owners'[4]. The net effect depends upon the level of risk-taking the agent will expose the firm to, as all investing entities have an optimal level of risk given their appetite and all own a portfolio of investments (some not in the conventional sense). Risk, an aspect of paramount importance for firms and owners, is perhaps where agency costs become most apparent. According to modern portfolio theory, every individual has an optimal level of risk which depends upon their preference for risk. The impact of risk on investments is often seen in the portfolio allocations of the individual. The agent must consider the risk of their financial investments and their future income. The firm, however, solely owns itself while the owners may have a diversified portfolio of investments. There is an important distinction to make here, the optimal risk level for the firm will not be the same as the optimal risk level for the principals who may own a diversified portfolio, nor for the agents who may have a much higher relative share of their portfolio invested in the company's future performance. These intricacies manifest themselves in the level of risk the agent introduces to the firm.

[2]Secfi, "The History of Employee Stock Options," Secfi (Secfi, August 19, 2021), https://secfi.com/learn/history-of-employee-stock-options.
[3]Amit Batish, "Prevalence of Options Decreases as Companies Tie Awards to Performance," The Trusted Source for Corporate Leadership Data (Equilar, Inc., August 23, 2018), https://www.equilar.com/press-releases/103-prevalence-of-options-decreases-as-companies-tie-awards-to-performance.
[4] Aboody, David, Nicole Bastian Johnson, and Ron Kasznik. "Employee Stock Options and Future Firm Performance: Evidence from Option Repricings." *Journal of Accounting and Economics* 50, no. 1 (May 2010): 74–92. https://doi.org/10.1016/j.jacceco.2009.12.003.

As indicated, stock compensation may be used to mediate the risk level of the agent, since the value (and subsequently, the level of risk) of this compensation may fluctuate after the stock award has been issued. Unlike stocks, stock options have a convex payoff structure, appreciating in value given more volatility and subsequent risk, and as such they may be used to further fine-tune the risk-taking behaviour of the agent[5].

This aspect of stock options should reflect positively on the future performance of the firm, under the assumption that the benefits outweigh the costs. According to the efficient market hypothesis, when the market receives information of a stock option compensation scheme, this should be accurately integrated into the market price. As such the positive action of the company (introducing stock options), should be reflected by an appreciation in the stock price. When this appreciation is put into relative terms, and the return is isolated from the movement of the overall market, it is called abnormal return (AR)[6].

Whilst the stage of the business cycle will inevitably have a significant impact on a company's performance, abnormal returns could specifically be impacted as the agent's personal wealth is affected by the present state of the cycle. In turn, the principal's own risk-taking preference may impact the positive effects of executive stock options (XSOs). This could lead to the agent's rational risk-taking behaviour becoming less optimal than the firm's (or principal's) optimal level of risk, thus negating the benefits of stock options.

This paper, however, still proposes that the net effect of executive stock options will be positive if used competently (combined with other forms of equity incentives to align the principal's risk-taking behaviour with that of the shareholders) in compensation structures, to influence and take account of the executive's portfolio diversification and optimal level of risk.

Previous research has highlighted the role of XSOs as a complement to that of traditional stock-based equity compensation. Yet there seems to be no consensus regarding their actual long-term impact on the incentives of the risk-taking executives nor by extension their effect on the

[5] Swee-Sum Lam and Bey-Fen Chng, "Do Executive Stock Option Grants Have Value Implications for Firm Performance?," *Review of Quantitative Finance and Accounting* 26, no. 3 (2006): pp. 249-274, https://doi.org/10.1007/s11156-006-7433-3.
[6] James M. Patell, "Corporate Forecasts of Earnings per Share and Stock Price Behavior: Empirical Test," *Journal of Accounting Research* 14, no. 2 (1976): p. 246, https://doi.org/10.2307/2490543.

performance of firms. The aim of this paper is to shed light on, and contribute to this area of research.

## 1.3 Structure of the Thesis

The underlying questions this thesis will attempt to clarify are '*How does an option's payoff affect managerial risk-taking?*' and '*How does this risk-taking by extension affect firm performance with and without regard to the business cycle?*'. The first part of the question regarding the relationship between options payoff and managerial risk-taking requires considerable data, work, assumptions and expertise in modelling both options payoff and the risk-taking behaviour of the executive. It, therefore, falls outside the primary scope of this thesis and will merely constitute a theoretical background on the subject.

The second part of the question (*how do executive stock options by extension affect firm performance with and without regard to the business cycle?*) is the main concern of this paper. In order to analyse this, the first question must be addressed. Therefore, the theoretical background of the first part will be structured and based on a literature study of other authors' works. Using their conclusions, the paper will continue with analysing the second part by adopting a short-term and long-term perspective with their own respective methodologies. It is the belief of the authors that these two perspectives will lend themselves to produce a more conclusive and coherent account of the consequences of XSOs on shareholder returns.

The short-term perspective will employ an event study methodology to find the abnormal return (or market sentiment) after the introduction of XSOs and test for statistical significance using multiple hypothesis tests. The aim here is to gauge whether or not the market exhibits a positive sentiment when introduced with an executive stock option compensation scheme, signalling a positive effect on performance.

To further bridge the gap between finance and economics, this thesis will then attempt to deduce whether a possible causality is really a correlation between stock options and performance. It is possible for stock options to be granted in times of economic expansion, without themselves directly leading to improved performance. This motivates the use of a long-term perspective, which will use a multiple linear regression (an extension of the ordinary least squares approach) to estimate both system and firm-specific coefficients where the natural log of the price-to-earnings

ratio is the dependent variable. Thus seasonal and cyclical variables as well as firm-specific variables will be added to the long-run multiple linear regression. Finally, the results will be interpreted by economic theory.

This method will offer a short-term perspective on how the market gauges the value of introducing XSOs and the long-term perspective will compare and contrast this initial reaction to the long-term effect in performance, while also gauging the effect of the business cycle on the performance effects of XSOs.

## 1.4 Research Questions and Expected Results

In order to answer the main research question of this paper; '*To what extent does executive stock option compensation affect the performance of publicly traded companies in the United State's IT sector during the period 2000-2022?'*, two sub-questions must first be identified and addressed:

1. *Do firms exhibit statistically significant short-term abnormal returns when presented with an XSO compensation scheme announcement?*

2. *Is there a statistically significant correlation present between the introduction of an XSO and performance in the long term, and is it independent of the business cycle?*

As the literature review will identify, there is evidence to support answers to both of these questions. Therefore, in line with previous research, the hypotheses are:

1. *The firm's stock price exhibits statistically significant positive abnormal returns when the implementation of an XSO compensation scheme is announced.*

It is recognised that firms may not always act in their own best interests in practice. However, the authors of this thesis believe that the behaviour predicted by economic theory is the benchmark, and not the other way around. Furthermore, they believe that the widespread usage of XSOs is indicative of their ability to increase the performance of the firm in the long term.

The short-term event study is expected to provide a positive value for the majority of average abnormal returns (AAR), and the cumulative average abnormal returns (CAAR), which will signify positive market sentiment regarding the introduction of XSOs. It is further expected that the majority of these positive AARs and CAARs will be statistically significant at the 5% significance level (Alpha = 0.05). Despite cyclical effects, the impact of stock option programme introductions is expected to result in positive values for AARs and CAARs regardless of the business cycle. Dispersal of negative ARs is expected randomly around the event horizon for some individual firms.

2. *Additionally, the business cycle will have a statistically significant effect on the magnitude of the performance effect of XSOs, but a net positive effect will be present regardless of the stage of the business cycle.*

The long-term regression analysis will highlight a statistically significant value for the system-specific factors when the natural log of the P/E ratio is the dependent variable. Given a significant result, it can be inferred that the system-specific factors have predictive value for the P/E ratio. To isolate the effect of stock options themselves, a ratio of options to total compensation, as well as options to net income, will be used. This is of paramount significance in concluding that the alignment of risk is the reason for improved performance, as opposed to simply giving executives a larger dollar value in compensation.

## 1.5 Scope

Preliminary research indicates that the IT sector is one that favours stock options as a compensation scheme. Thus, it should lend itself to a study on the effectiveness of stock options in motivating executives and by extension contributing to the performance of the firm.

It should be noted that when referring to stock options, this paper solely refers to stock options granted to the top three executives and not general stock option programs issued to all or most employees. This is based upon the managerial power theory, where, the power over a firm tends to congregate with the executives and will therefore offer the best place to observe and analyse the performance effect of stock options.

The period selected runs from the year 2000 through 2022, to incorporate various parts of the business cycle into this study; this was done in order to gauge the effect of stock options on firm performance with and without regard to the business cycle, as well as ensure appropriate data availability.

# 2. Theory and Literature Review

*In this section the reader will gain an understanding of options and options programs, as well as theories critical to the thesis. '2.1 Options and Options Programs' discusses the characteristics of options and how their impact on the risk-taking behaviour of the executive differs from that of traditional stock grants. '2.2 Theoretical Background' gives the reader basic knowledge regarding theories and their relevance to the thesis. Examples include the principal-agent theory and efficient market hypothesis.*

This paper will take into account two separate areas of research - finance and economics. To examine the initial market impact (as measured by abnormal return) and long-term market impact, the subject of finance will be most applicable. Subsequently, the field of economics will be used to determine the macroeconomic effects' impact on executive stock option programs and contribute significantly when combined with economic theory on business cycles.

This will give the thesis more value, providing a more robust understanding of stock options as a compensation scheme, and will highlight any discrepancies and variations in the two schools of thought regarding asset prices and incentive schemes. Furthermore, it will raise a discussion as to the causal effect of economic expansions and contractions on the prevalence of these stock option programs – i.e. do the programs correlate with an economic expansion and thus not truly cause increased performance, or is there causality at play?

## 2.1 Options and Options Programs

Options give the owner a contractual right, although not an obligation, to purchase or sell a set quantity of an underlying asset at a predetermined strike price. If the option is exercised, the writer is obligated to carry out the transaction at the strike price, but if left to expire, the obligation is terminated. There is a clear distinction between call options (the right to buy) and put options (the right to sell), as well as American options (which can be exercised at any point leading up to the expiration date) and European options (which can only be exercised on the expiration date).

Furthermore, there are two sides to all options trades, the buyer (receiving the contractual right) and the seller (receiving the contractual obligation)[7].

Whilst hedging might be the most common use of this financial tool, its use as a means of non-cash-based (equity) compensation for executives is not far behind. Since their introduction for executives around 100 years ago and employees shortly thereafter, stock option compensation schemes have seen their popularity both rise and fall repeatedly throughout the period[8].

After the US emerged from World War Two with incredible economic growth, the marginal tax rate for the top level of earners rose to approximately 91%.[9] The 1950s Revenue Act made taxes on stock options payable as capital gains, which amounted to a mere 25% tax. This allowed executives to reduce their effective tax rate by a massive margin; by 1951, 18% of US executives were earning stock options as a form of compensation. During the Dot Com Bubble, that number was in excess of 80%[10].

This initial spike in popularity was in part because it offered a new form of performance-based-incentive system for executives, due to the tax-favourable position executives received at the time (not present today).

Shortly after the initial introduction, the restricted stock option (which unlike its predecessor came with a vesting period) also saw a rise in popularity. As opposed to normal stock option awards where a decline in stock price could leave the holder out of the money, restricted stock options ensure the holder will receive value upon exercising the option. This is due to the nature of restricted stocks, where the executive is guaranteed a number of shares to a fair market value to be paid out at the end of the vesting period[11].

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[7] 1. James Chen, "What Are Options? Types, Spreads, Example, and Risk Metrics," Investopedia, April 25, 2023, https://www.investopedia.com/terms/o/options

[8] Andy Tsang and Joseph Bachelder, "What Has Happened to Stock Options?," The Harvard Law School Forum on Corporate Governance (Harvard Law School, October 2, 2014), https://corpgov.law.harvard.edu/2014/10/02/what-has-happened-to-stock-options/.

[9] Secfi, "The History of Employee Stock Options," Secfi (Secfi, August 19, 2021), https://secfi.com/learn/history-of-employee-stock-options.

[10] ibid.

[11] Andy Tsang and Joseph Bachelder, "What Has Happened to Stock Options?," The Harvard Law School Forum on Corporate Governance (Harvard Law School, October 2, 2014), https://corpgov.law.harvard.edu/2014/10/02/what-has-happened-to-stock-options/.

Resultant of this feature, the use of stock options is more prevalent during stock market bull runs since the definition of fair market value may be far below that of an expansion's price surge, i.e., at the end of the 1990s when approximately 75% of long-term equity awards consisted of options. In the early 2000s, a scandal regarding the backdating of options arose. A 1993 amendment to the tax code resulted in an incentive for executives and employers to work together to falsify filings to earn more money. The options' initial date of registration would be forged to fall on a day when the stock price was low, leading to instant profits on the part of the executive[12].

This coupled with the aftermath of the Dot Com Bubble saw the use of stock options phased out, until recently, when knowledge-heavy sectors have begun relying on them to retain key personnel and the assets they provide (namely knowledge).[13] The later introduction of the Dodd-Frank Act in July 2010 further influenced the prevalence of stock option-based executive compensation. In light of this act, over 50% of the equity awards given to executives were required to have a performance tie. Failure to provide sufficient evidence of such a performance linkage would result in a restructuring until the 50% threshold was reached. This introduction is hypothesised to increase the extent of the performance-enhancing effects of stock option compensation.[14]

## 2.2 Theoretical Background

### 2.2.1 Principal Agent Theory

The principal-agent problem was first conceptualised by economists Michael Jensen and William Meckling. In a 1976 paper, they presented a theory whereby principals (those entrusting others) delegate differing forms of responsibility to agents (those entrusted)[15]. Jensen and Meckling were the first to identify the costs of these arrangements, apart from obvious compensation schemes. They concluded that these costs arose from the separation of ownership and control, a third party who is assumed to be utility maximising is much less likely to act in accordance with the utility maximising behaviour of the principal. In short, principal-agent problems arise when arrangements

[12] Edmund L. Andrews, "How CEOS Reinvented the Dating Game Scandal in Stock Options," Stanford Graduate School of Business, August 29, 2018, https://www.gsb.stanford.edu/insights/how-ceos-reinvented-dating-game-scandal-stock-options.
[13] Hugo Pinto, Jorge André Guerreiro, and Manuel Fernández-Esquinas, "Sources of Knowledge in the Firm: A Review on Influential, Internal and Contextual Factors in Innovation Dynamics - SN Business & Economics," SpringerLink (Springer International Publishing, January 26, 2023), https://link.springer.com/article/10.1007/s43546-023-00430-7.
[14] Michael Jensen and William Meckling, "Theory of the Firm: Managerial Behaviour, Agency Costs, and Ownership Structure," *The Economic Nature of the Firm*, 2009, pp. 283-303, https://doi.org/10.1017/cbo9780511817410.023.
[15] ibid.

fail to incorporate and account for differences in incentives and rational decision-making. The agency costs of these arrangements are dependent on law, monitoring the alignment of incentives and human ingenuity in devising said arrangements[16]. Here, the ideas of asymmetric information and moral hazard are of crucial importance in understanding the principal-agent theory.

*Contextual Relevance (Principal-Agent Theory, Asymmetric Information, and Moral Hazard)*
Equity compensation is often defended by those receiving it as a means to better align the incentives of the agent (executive) to that of the principal (shareholders/owners). In its most common form, equity compensation is issued as stock to the executive, stock options are also issued to fine-tune the incentives of the agent in ways that traditional stock grants cannot.

In order to achieve a more realistic analysis of the hypothesis this paper will not assume that agents have the same information available to them. Therefore, it is possible that principals (shareholders) have less information than the agents (executives) as to the necessity and effect of implementing stock options programs as a form of compensation. It would further be possible for the market to possess less information than the executives. The theory of asymmetric information is relevant as a tool to balance the effect of the efficient market hypothesis on the analysis.

Despite its primary use in the insurance sector, moral hazard is of paramount importance in understanding the true benefit of XSO compensation. Moral hazard is not only about risk but also concerned with acting in good faith, it is possible that managers take more risk than would be optimal for the company as a whole, simply because the manager doesn't bear the full consequences of a poor outcome. In this sense, moral hazard can be used to explain such behaviour of executives.

### 2.2.2 The Efficient Market Hypothesis

The efficient market hypothesis (EMH) was developed independently by Paul Samuelson and Eugene Fama in the 1960s. EMH is a theory of informational efficiency, as traditionally seen in the movement of security prices. While it has been continuously refined and built upon, in its most basic form it postulates that in an idealised world with perfect informational distribution among all agents, the movement of prices will be completely random. This is due to all available information having been incorporated and traded upon at an instant of its release[17].

[16]ibid.
[17] Andrew W. Lo, "Efficient Markets Hypothesis," *The New Palgrave Dictionary of Economics, 2012 Version*, n.d., https://doi.org/10.1057/9781137336583.0483.

*Contextual Relevance*

In the 60 years since its conception, it is surprising that the efficient market hypothesis is still one of the most controversial theories surrounding the efficiency of financial markets. The main sources of critique come from the social sciences where scholars argue that its assumptions of human behaviour are contradictory, and from fund managers who, understandably, refute the idea of no one being able to beat the market consistently.

To date, there is no consensus on whether the theory holds true or false. Alas, its importance is derived not from its validity, but rather from the perspective it offers. If financial markets are truly efficient, then the introduction of an executive stock option compensation scheme should offer an informational advantage, which should be traded upon and, by extension, the price of stocks should move in the direction of the impact an XSO has on the performance of a firm (positive or negative). This gives weight to the initial analysis of the movement in stock prices immediately following an introduction of an XSO.

### 2.2.3 Modern Portfolio Theory

Harry Markowitz (1952) demonstrated how a portfolio of financial instruments was less risky than the constituents while maintaining the same return. His work has since been the standard for how money managers assemble their investment portfolios[18].

*Contextual Relevance*

While modern portfolio theory is quite mathematical in nature, the logical arguments it presents will be beneficial to the paper. Specifically, how an executive may be under-diversified for his given level of risk tolerance and, therefore, make decisions within the firm which are optimal for himself but not the firm or shareholders in general. In this thesis, this importance will be highlighted through the portfolio of compensations given to executives to align their short- and long-term wealth with the company's performance, in order to better align their utility maximising decisions.

### 2.2.4 Managerial Power Theory

Developed in the early 2000s by Lucian Bebchuk and Jesse Fried, this theory argues that executives have the power to affect their own pay and use this to extract rents in their own best interest. The

[18] Harry M. Markowitz, "Portfolio Theory: As I Still See It," *Annual Review of Financial Economics* 2, no. 1 (January 2010): pp. 1-23, https://doi.org/10.1146/annurev-financial-011110-134602.

process of executives extracting a disproportionate amount of pay may lead to 'inefficient pay arrangements' aimed at masking the rent extraction. In short, they argue that managerial power may be used to set executive wages far above what an equilibrium wage would be.

*Contextual Relevance*

This theory would explain why executives would receive payment in the form of stock options in the case of the performance impact of stock options on the company not yielding a statistically significant result. In short, executives may pressure the board into granting them stock options in excess of the value that the stock options provide through a positive impact on the incentives of the executives and, by extension, the performance of the firm.

# 3. Method and Research Design

*In '3.1 Research Method' the reader is introduced to the fundamental research method employed, '3.2 Reliability and Validity' discusses the steps taken to ensure that the thesis maintains a high level of reliability and validity as well as potential areas of improvement. Section '3.3 Qualitative' summarises contemporary research on the topic from authors such as Hall and Liebman, Yermack and Brickley, Bhagat and Lease. '3.4 Quantitative' outlines the procedure used for both the short-term event study and the long-term regression.*

## 3.1 Research Method

This paper used an empirical and fundamental analytical research method, coupled with both quantitative and qualitative approaches, opting for time series analysis over panel data- and cross-sectional analyses. Based upon a review of existing literature, a hypothesis was constructed and subjected to a hypothesis test that would either reject or corroborate the hypothesis, by using statistical tools. As such, the report had a positivistic perspective with the use of a hypothetico-deductive model. Where a hypothesis was tested, deductions were drawn from the outcome and then compared to the practical situation at hand[19].

## 3.2 Reliability and Validity

For a successful research report, the study should be reproducible with similar results, not contingent on the authors of the original study. For a quantitative approach especially, this requires that both the data and method remain reliable and not biassed or influenced by the authors. The data was sampled according to sequential sampling where the quality and quantity of data on each data point is observed, and only those reaching a predetermined set of criteria are included.

All data has been collected from secondary sources and, as such, must be reliable, suitable and adequate in quality to ensure that the reliability and validity of the paper are not compromised at the source[20]. The secondary sources used for the quantitative approach were WRDS Compustat Capital IQ and SEC EDGAR, one being a well-known financial analysis and screening tool, and the other being a government database. As such, the reliability of the data is high. When it comes to the

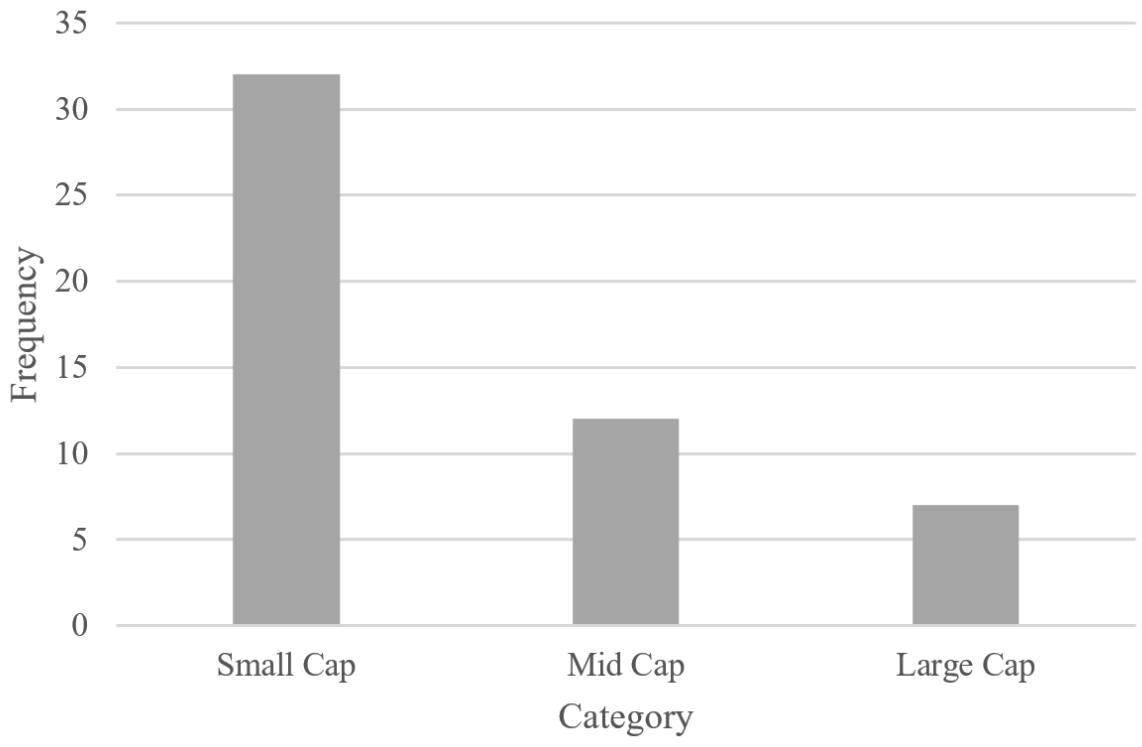
[19] C. R. Kothari, *Research Methodology Methods & Techniques* (New Delhi: New Age International (P) Ltd., Publishers, 2004).
[20] ibid.

suitability and adequacy of the data, there is some room for improvement. As this paper had no ability to thoroughly test whether or not the data is accurate, many data points that may have been of satisfactory quality might have been eliminated in the selection process. This may have led to the unintentional introduction of bias into the result, which would affect the validity and reliability of the report negatively. This question was specially raised after many of the observations were discarded due to incompleteness or contradictory data points between sources.

Additionally, the distribution of data points was significantly concentrated in the 'Small Cap' category. If there are differences in reaction to XSOs between categories, the thesis will primarily pertain to companies with small capitalisations (250-2000 USDm). Finally, it is possible that the differing effects of the other categories interfere with the analysis, which could lead to biassed or otherwise insignificant results. Illustration 1 represents the distribution of firms by market capitalisation:

Illustration 1 - Distribution of Market Capitalizations

The following chart illustrates the distribution of firms between small-, medium and large market capitalizations.

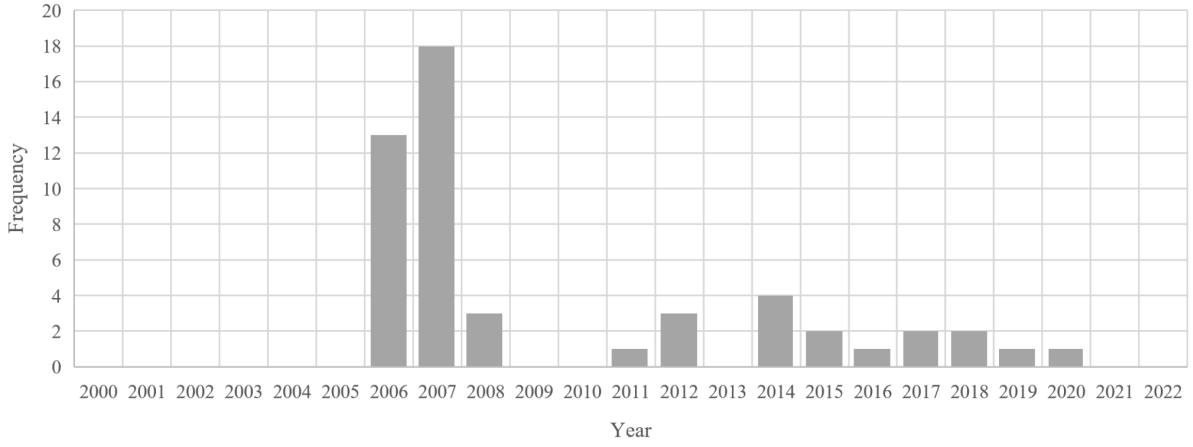



Validity was assessed through the use of previously peer-reviewed methodologies in all models, and verifying that all models meet specified assumptions or requirements. The predicaments of OLS assumptions, nonsynchronous trading, and estimation bias, have been thoroughly tested, and are available in the appendix. While a conscious decision was made to use the S-8 filing registration

date (clarified in the event study methodology below), as the event in the event study, the authors recognise that this has not been the approach used in previous studies. As such, this may lead to misleading results if interpreted in the context of other research studies, and the measurement of events outside those of interest. Additionally, the majority of event windows were concentrated around the period of 2006 and 2007 (as seen in Illustration 2), the effect of which was discussed thoroughly in the analysis. This concentration has little to do with the 2010 Dodd-Frank Act, where no evidence was found of a smaller proportion of firms using stock options after the Act was introduced. Rather, it is assumed to be due to the inherent distributional effects of the criteria used to select the data.

Illustration 2 - Distribution of Firms by Year

The following chart illustrates the distribution of firms by year, grouping the frequency of firms which issued stock options during a particular year.




Furthermore, the U variate of the Patell-Z Test (explained further in the event study methodology below) was insignificant for all days when the abnormal returns were found to be significant. This indicates that there is no bias in the Z-Statistic and, therefore, no bias towards false rejection of the null hypothesis that abnormal returns are equal to zero. Additionally, the U variate gave no significant results for the remaining event days, signifying that the data set does not exhibit increased variance during the event window, suggesting that the sample does not contain companies who experienced other significantly positive or negative news during the period[21].

[21] James M. Patell, "Corporate Forecasts of Earnings per Share and Stock Price Behavior: Empirical Test," *Journal of Accounting Research* 14, no. 2 (1976): p. 246, https://doi.org/10.2307/2490543.

## 3.3 Qualitative

### 3.3.1 A Brief Summary of Previous Research Paramount to the Topic at Hand

For the qualitative approach, a literature study provided the knowledge required on executive stock options and macroeconomic relationships, as well as constituted the pillar for the thesis' methodology regarding event studies and OLS regressions. Previous research papers pertaining to research methods and methodology, foundational finance and economics theories, and executive compensation along with stock options were discussed. These also aided in validating the conceptual and/or empirical support for the results, and in the event that the thesis' findings differ greatly from previous research, provided an opportunity to determine what went awry.

A study by Hall and Liebman (1998) found that between 1980-1994 the relationship between CEO compensation and firm performance grew by 136%. They further estimated an elasticity between CEOs and performance of 3,9. This result was very high compared to previous studies and suggests that stock options and stock holdings affect the compensation-to-performance sensitivity heavily[22].

Yermack (1995) found a weak relationship between options programs and a reduction of agency costs. Yermack's study on stock option awards examined whether stock options' performance incentives had significant associations with explanatory variables related to agency cost reduction. Further tests examined whether the mix of compensation between stock options and cash payment could be explained by corporate liquidity, tax status, or earnings management. Results indicated that few agency or financial contracting theories have explanatory power for patterns of CEO stock option awards[23]. Similarly, Brickley *et al.* (1985) found a positive market reaction in conjunction with the launch of long-term options programs for company executives[24].

Armstrong, Nicoletti, and Zhoua (2020) found that bank executives' compensation programs cause them to take actions that contribute to systemic risk… "We find that bank executives' equity portfolio vega leads to greater subsequent systemic risk that manifests during economic downturns, but not during expansions. We also find that Vega encourages bank executives to pursue specific

[22] Hall, Brian J., and Jeffrey B. Liebman. "Are CEOs Really Paid Like Bureaucrats?" The Quarterly Journal of Economics 113, no. 3 (1998): 653-691.
[23] Yermack, David. "Do corporations award CEO stock options effectively?" Journal of Financial Economics 39, no. 2-3 (1995): 237-269.
[24] Brickley, James A., Sanjai Bhagat, and Ronald C. Lease. "The impact of long-range managerial compensation plans on shareholder wealth." Journal of Accounting and Economics 7, no. 1-3 (1985): 115-129.

activities that contribute to the accretion of systemic risk, including: (i) maintaining lower Tier 1 capital ratios, (ii) investing in commercial and industrial loans, which tend to track the business cycle, and non-agency mortgage-backed securities, which are subject to greater default and liquidity risk, and (iii) greater reliance on liabilities subject to runs (i.e., short-term deposits). Collectively, our evidence suggests that bank executives' incentive-compensation contracts promote systemic risk-taking by encouraging them to adopt lending, investment, and financing policies that are highly procyclical and contagious." The study found that systemic risk only manifests during economic downturns[25].

Sanders' (2003) study examined the incentive effect of stock ownership and stock option pay by executives. This study showed that they had diametrically opposite effects on firms' acquisition and divestiture propensity. Moreover, situational characteristics moderated the risk-seeking behaviour associated with stock option pay but not the risk aversion associated with ownership. "The incentive alignment perspective suggests that executives who own large amounts of stock should be reluctant to engage in acquisitions (Amihud & Lev, 1981; Jensen & Murphy, 1990)"[26].

Lam and Chng (2006) explored stock option grants and their value implications for firm performance. "Consistent with predictions of agency theory, we find direct evidence that executive stock option grants have value implications for firm performance. This inference is drawn from the evaluation of various motivations for the use of such grants in executive compensation: value enhancement, risk-taking, tax benefit, signalling and cash conservation. As well, they signal for positive price-sensitive information… Consistent with the implications of agency theory, we find that firms grant XSOs for their value enhancement incentives to reduce agency costs and these indeed have value implications for firm performance"[27].

The thesis' source of inspiration, Lewellen et. al. (1992), found a weak positive link between compensation and performance, employing descriptive statistics for measures of stock returns, company characteristics, and executive compensation. 49 firms from the top of Fortune 500 (1964-1973) were screened, and executive compensation data was sourced via SEC 10-K filings.

[25] Armstrong, Chris S., Frank Zhou, and Allison Nicoletti. "Executive Stock Options and Systemic Risk." SSRN Electronic Journal, 2020.
[26] Sanders, Wm. Gerard. "Behavioral Responses of CEOs to Stock Ownership and Stock Option Pay." Journal of Business Research 56, no. 4 (2003): 287-296.
[27] Swee-Sum Lam and Bey-Fen Chng, "Do Executive Stock Option Grants Have Value Implications for Firm Performance?," Review of Quantitative Finance and Accounting 26, no. 3 (2006): pp. 249-274, https://doi.org/10.1007/s11156-006-7433-3.

The study found evidence for the adoption of executive stock options having a positive effect on performance, and evidence that senior executives' holdings of the company shares could impact risk-taking; the study delved deeper into these findings and explored their implications in theory and practice[28]. The concluding remarks highlighted the link between a larger dollar value in payment and performance, but drew no distinction between different forms of compensation nor was cyclicality and its inherent effects accounted for; these points were remedied in this study. Lewellen et. al. (1992) further inspired the use of naturally log-transformed variables in the regression to normalise the data across variables.

## 3.4 Quantitative

### 3.4.1 Short-Term Event Study

The methodology behind event studies was first introduced in 1969 by Fama, Fisher, Jensen and Roll, and has since become the standard method of either measuring market efficiency or, assuming market efficiency holds, determining how an event impacts security prices. In short, an event study requires a clear event date around which the event period is defined to encompass both insider trading and a lag in the information spread. Additionally, an estimation period of around 60 times the length of the event period is used to measure normal market activity, against which the returns in the event period are measured. If the event period exhibits abnormally large (positive or negative) returns in comparison to this estimation period, the event is assumed to have a significant impact, that is, the market reacts in one way or another to the event. Thus, this methodology gauges whether or not movements in the stock price during the event window can, within reason, be causally linked to the event in question[29].

More specifically, the methodology aims to find a value for the AARs and CAARs of the event period, by first finding the real return using historical stock prices. The normal return can then be calculated in several different ways, of which the market model was applied in this study. A regression is then run to find the market model parameters[30]. This is used to deduce and calculate the AARs and CAARs. Finally, a hypothesis test is conducted to check whether or not the abnormal

[28] Lewellen, Wilbur, Claudio Loderer, Kenneth Martin, and Gerald Blum. "Executive Compensation and the Performance of the Firm." Managerial and Decision Economics 13, no. 1 (1992): 65–74. http://www.jstor.org/stable/2487399.
[29] James M. Patell, "Corporate Forecasts of Earnings per Share and Stock Price Behavior: Empirical Test," *Journal of Accounting Research* 14, no. 2 (1976): p. 246, https://doi.org/10.2307/2490543.
[30] ibid.

returns in the event period differ from the estimation period, and whether or not the results can be considered statistically significant. If the null hypothesis is rejected at a statistically significant level, and the coefficients for the AARs and CAARs are positive, it can be determined that an abnormal positive return is present. This would support the original hypothesis that the market exhibits positive abnormal returns when presented with news regarding the implementation of a new XSO compensation scheme.

#### 3.4.1.1 Assumptions and Requirements for the OLS Regression

Ordinary least squares is one of the most commonly used linear regression methods due to its simplicity. Regression analyses produce estimates of population parameters from a smaller sample. These estimates should be reasonable, and, in being reasonable they must be free from bias (not systematically over nor underestimating the true population coefficients) and minimise the difference between the estimates and actual observed values. There are certain conditions which must be met in order for OLS to perform reliably and produce reasonable estimates. The assumptions are[31]:

*1. Correctly specified linear regression model with additive error term*

This assumption is essential for an OLS regression as it assumes that the relationship between the independent variables and the dependent variable is linear, and the errors are additive. The correctly specified model assumption sets up the structure of the empirical model to be used. The model must take on the form of: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_K X_K + \varepsilon$

Where $\beta_0$ is the Y-intercept of the linear model, $\beta_1$ is the coefficient for $X_1$ which is the value that $X_1$ takes on, in the data. Finally ε is the additive error term, representing the difference between the actual outcome and the outcome predicted by the estimates from the regression model.

*2. The error term's population mean is zero*

$$E(\varepsilon) = 0$$

This assumption implies that the model is correctly specified, and the sum of the errors over all observations is equal to zero. For example, if the average error is +7, this indicates that the model systematically underpredicts the observed values. In this case, if the average error is non-zero, then part of the error could be explained by adding more variables. This should be done, as it is desirable

[31] "7 Ols Regression Assumptions (with Explanations) - Indeed," Indeed.com, October 1, 2022, https://www.indeed.com/career-advice/career-development/ols-regression-assumptions.

to only have the random error left for the term. One can check for this assumption by computing the mean of the residuals and checking if it approaches zero. However, there is a trick to this - when including the constant of the regression (y-intercept), it will adjust to keep the average error term low at the expense of meaningful interpretation of the constant. If the model systematically underpredicts the data and the constant is added, it will turn positive and keep the error at a mean of 0. As such this was applied in all regressions of this thesis.

*3. All explanatory variables are uncorrelated with the error term (exogeneity)*

$$E(X_i \varepsilon_i) = 0 \; for \; all \; i$$

This assumption ensures that the independent variables are not affected by the errors in the model, which could lead to biassed coefficient estimates. If they are biassed, then one can use the variable to predict the error term, which signifies a violation of the assumption that the error term solely represents unpredictable random error (thus, becoming endogenous). This can occur due to simultaneity between independent and dependent variables, omitted variable bias or measurement error in variables. To remedy this, one must make sure to incorporate this information into the model itself. This assumption was examined on a theoretical level, as there are no simple tests to check for endo- and exogeneity due to the fact that the error term is unobservable. As such, efforts were made to include all relevant variables that may otherwise have explained the variation in the error term.

*4. The values of the error term from different observations are uncorrelated (serial- or autocorrelation)*

$$E(\varepsilon_i \varepsilon_i - 1) = 0 \; for \; all \; i \neq j$$

This assumption ensures that the errors in the model are independent of each other, and there is no pattern in the residuals. Autocorrelation occurs when the errors in a regression model are correlated with each other over time, and hence, the value of previous errors can be used to predict the value of future errors. This assumption was examined by the use of the Durbin-Watson Test for autocorrelation, which turned out insignificant, indicating no autocorrelation[32].

*5. The error term has constant variance*

$$Var(\varepsilon_i) = \sigma^2 \; for \; all \; i$$

[32] William H. Greene, *Econometric Analysis* (Harlow, England: Pearson, 2020), chapter 11.

Also known as homoscedasticity (same variance as opposed to heteroscedasticity, different variance), this assumption assumes that the variance of the errors is the same for all observations. Violation of this assumption could lead to biassed coefficient estimates and incorrect predictions. Since historical returns tend to be heteroscedastic in their raw form, despite using the natural log transformation to smooth out the variance, this assumption was thoroughly tested using residuals plotted against fitted values (where a growing cone shape is undesirable). Additionally, the White Test and the Breusch Pagan Test were conducted with no significant results[33]. These two tests complement each other well since the Breusch Pagan Test assumes normally distributed error terms, while the White Test does not. Moreover, robust standard errors, proposed by White (1980) were employed to account for potential violations of assumptions regarding the distribution of errors in the multiple linear regression[34], explicitly the HC3 specification being particularly useful when the sample size is small[35].

Once assumptions 4 and 5 have been satisfied, the error term is said to be independent and identically distributed (I.I.D.), signifying that there are no general trends. I.I.D. is important for hypothesis testing as it ensures the test is conducted with a stable effect[36].

*6. No explanatory variable is a perfect linear function of other explanatory variables*

Also known as the problem of multicollinearity, this assumption ensures that the independent variables are not too highly correlated with each other, which could lead to unstable coefficient estimates and incorrect predictions. Perfect correlation suggests that two variables are different forms of the same variable. When multicollinearity exists in a regression model, it can lead to several problems, such as unstable coefficient estimates, inflated standard errors, and incorrect predictions. In this paper, the Variance Inflation Factor (VIF) was tested, and yielded no significant results. A value of 1.5 means that the variance is 50% larger than would be expected without multicollinearity[37]. A value larger than 5 is said to indicate high correlation of which the largest found in this report was 1.705.

[33] William H. Greene, *Econometric Analysis* (Harlow, England: Pearson, 2020), chapter 9.
[34] Halbert White, "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica* 48, no. 4 (1980): p. 817, https://doi.org/10.2307/1912934.
[35] ibid.
[36] William H. Greene, *Econometric Analysis* (Harlow, England: Pearson, 2020), chapter 2.
[37] William H. Greene, *Econometric Analysis* (Harlow, England: Pearson, 2020), chapter 5.

*7. The error term is normally distributed (not strictly required)*

$$\varepsilon \sim N(0, \sigma^2)$$

This assumption ensures that the errors in the model are distributed normally, which is important for making statistical inference and hypothesis testing. Violation of this assumption could lead to biassed and therefore ineffective hypothesis testing. The D'Agostino and Shapiro Wilk Tests revealed that most of the data on the return of firms was not normally distributed while the long-run regression data was normally distributed[38]. This is not a problem for the thesis, as it relies on support from the Central Limit Theorem, which will be discussed further under '3.4.1.2 Framework for the Event Study'[39].

Additionally, the data were checked for outliers which could influence the results using Cook's D, which measures the influence and similarity of a data point with others[40]. No major outliers were found. A few smaller ones were eliminated.

Omitted variable bias is another important concept, it occurs when a model excludes relevant variables. This causes the effect of the missing variables to be attributed to the error term, and introduces heteroskedasticity into the model. General omitted variable bias cannot be tested for as the error term is unobservable. Given an omitted variable and an instrument for this variable, an estimate can be constructed of the causal relationship[41]. No such variables were found in this thesis, and therefore no statistical tests for omitted variable bias were conducted.

#### 3.4.1.2 Framework for the Event Study:

*1. Define the event and the period where security prices will be examined (event window)*[42]

The event was defined as the submission and publication of firms' S-8 form with the SEC in accordance with the SEC EDGAR database. The S-8 form becomes legally binding once registered,

[38] Michael H. Kutner, *Applied Linear Statistical Models* (Tamail Nadu: McGraw Hill Education (India), 2020), chapter 6.
[39] William H. Greene, *Econometric Analysis* (Harlow, England: Pearson, 2020), chapter 3.
[40] Michael H. Kutner, *Applied Linear Statistical Models* (Tamail Nadu: McGraw Hill Education (India), 2020), chapter 6.
[41] Michael H. Kutner, *Applied Linear Statistical Models* (Tamail Nadu: McGraw Hill Education (India), 2020), chapter 3.
[42] Craig A. MacKinley, "Event Studies in Economics and Finance," *Journal of Economic Literature*, March 1997.

which means the S-8 form is the final step to issuing stock options[43]. While this does not constitute a press release which many other authors have used, it is believed that large institutional stakeholders will use this as their ultimate guide for the issuance, and further, that large institutional stakeholders are the main agents capable of moving the market. Another appealing reason to use the S-8 filings is the lack of consolidated information on firm press releases. As such, this was the defined event. Since the event takes place on a single day, a 5-day event horizon was used, beginning with -1 through to +3 where 0 is the day of the event, as to incorporate the effect of insider trading the day before, and allow some time for the market to react to the news.

Prior to selecting the S-8 form as the event, a smaller event study with 30 firms was conducted using the proxy DEF 14 A form and the annual board meeting date. The DEF 14 A form was found to announce the intent of implementing or amending a stock option plan, while the board meeting was reserved for voting on the proposal. Of these three, the S-8 form showed the most significant results, both theoretically and practically, as a concentration of form 4S (insider trading forms) were filed one to three days after the S-8 filings for a sample of the firms, further strengthening the validity of its use.

*2. Determine criteria for including firms in the analysis[44]*

The criteria further listed under the appendix: 'data collection and sorting', were based on the requirements of having adequate data on firms, including the date of S-8 filings and amount of stock options issued, whom it was issued to, what sector the firm was in, what country the firm was listed in and a check of conflict between data sources. This, to ensure the validity and reliability of the data.

When sorting through data, the following selection criteria were deemed appropriate:

1. The firm must be publicly traded in the US.
2. The firm must have a small, medium, or large market capitalization, where the lower bound is 250, 2 000 and 10 000 US m respectively.
3. The firm must be in the information technology (IT) sector.
4. The firm must have paid out executive stock options at some point since the year 2000.

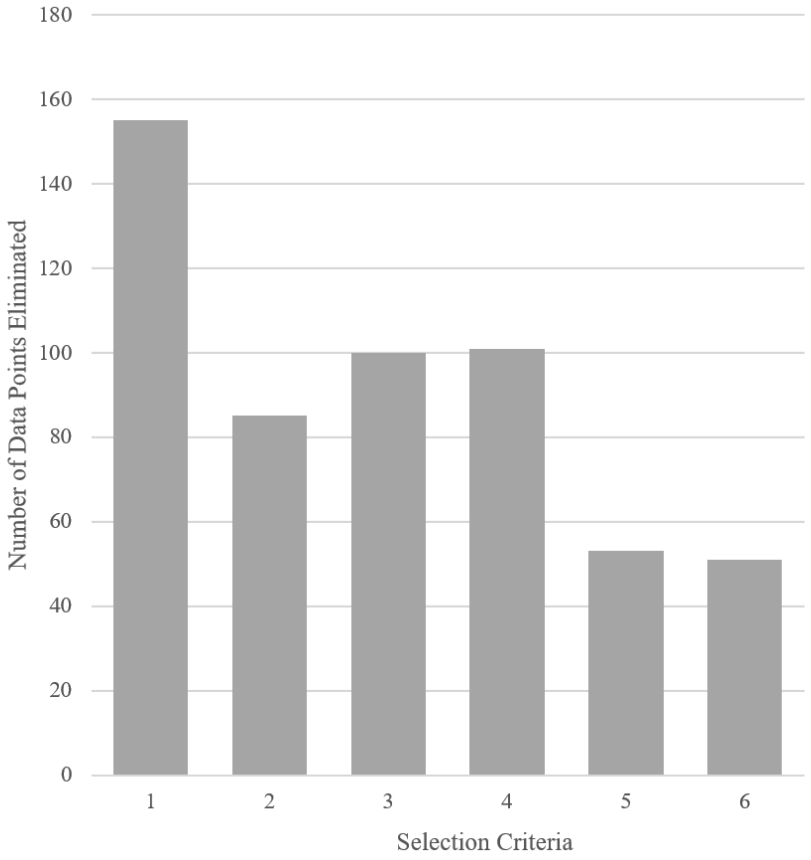
[43] "Form S-8," Legal Information Institute (Legal Information Institute, January 2022), https://www.law.cornell.edu/wex/form_s-8.
[44] Craig A. MacKinley, "Event Studies in Economics and Finance," *Journal of Economic Literature*, March 1997.

5. The firm must have paid these options out to a sitting CEO or top executive.
6. There must be an SEC S-8 filing matching the year of the executive options pay-out, so an event date can be determined.

Illustration 3 displays a bar chart representing the data selection and distribution of firms through the selection process:

Illustration 3 - Elimination of Data Points

The following chart represents the distribution of firms which fall under the categories used to eliminate data points.




Definition of Categories:

1. Not been over 250 USDm market capitalisation long enough or not offered stock options long enough (minimum 3 sequential years and trading data at least 3 trade day years prior to the event day), (155 observations).
2. All companies where a CEO or senior executive had not received stock options between 01-01-2000 and 01-01-2023, this can be explained by owners on the board issuing stock options to themselves as a form of owner compensation, (85 observations).
3. Conflicting data on dates of S-8, year of issued stock options or other data, (100 observations).

4. Missing data, (101 observations).
5. Other mismatching dates, (53 observations).
6. Satisfies all requirements, (51 observations).

In order for the analysis to be reliable, robust and produce significant results given an underlying correlation, the number of observations in the sample (N) must be sufficiently high. Additionally, the sample size must be sufficiently large - at least 30 observations or more to satisfy the Lindenberg condition. Also known as the Central Limit Theorem (CLT) condition, it is a statistical concept that describes the conditions under which the sampling distribution of the mean of a random sample approaches a normal distribution. In order for the Lindenberg condition to hold true, several assumptions must be met. The second being that the random variables being sampled must be independent and identically distributed (I.I.D.), which was shown. Finally, the random variables must have a finite variance which was expected[45].

When these assumptions are met, the sampling distribution of the mean will converge to a normal distribution as the sample size increases. This means that the mean of the sample will be a good estimator of the population mean, and statistical inference methods that assume normality, such as the T-Test or confidence intervals can be employed[46]. In short, the Lindenberg condition is important because it allows the authors to make inferences about a population based on a relatively small sample of data, with a high degree of accuracy.

*3. Define estimation window[47]*

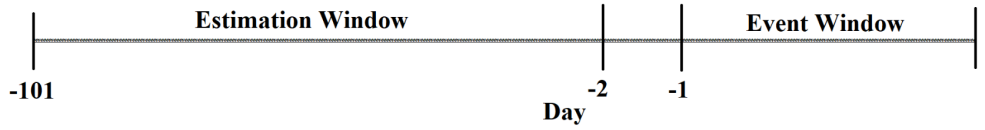
The estimation window collects the necessary data to cleanse the primary data of the event horizon from systemic movements in return. The length of the estimation window T in relation to the event period S will define the bias present in the average abnormal return estimator, (since the regression residuals and prediction errors are reliant upon both sets of data they will be inherently correlated). At T=100 and S=5 the difference between the biassed and unbiased test statistic is approximately 1.6%[48], since most studies appear to use 100 days, this was chosen as the length of the estimation

[45] William H. Greene, *Econometric Analysis* (Harlow, England: Pearson, 2020), chapter 3.
[46] ibid.
[47] Craig A. MacKinley, "Event Studies in Economics and Finance," *Journal of Economic Literature*, March 1997.
[48] Arnold Richard Cowan, "Tests for Cumulative Abnormal Returns over Long Periods: Simulation Evidence," *International Review of Financial Analysis* 2, no. 1 (1993): pp. 51-68, https://doi.org/10.1016/1057-5219(93)90006-4.

window, which ran from -101 up to and including day -2 in the event horizon as per Illustration 4 below.

Illustration 4 - Time Horizon

The following illustration visualises the time horizon used in the event study, and further distinguishes between the estimation window and the event window.




*4. Decide upon a model approach and collect measurements for abnormal return*[49]

In order to extract the movements of the general economy, a model must be used. Several different types have been used in the past, the most notable being:

### 3.4.1.3 Constant Mean Return Model

The constant mean return model is defined as $Ra_{i,t} = R_{i,t} - \overline{R}_{i}$. It is a simplistic model, with the main criticism being that for time periods experiencing high volatility, the returns would be assumed constant with the passing of time, making this model unsatisfactory for this analysis. The issue with the mean return model is that, while it becomes marginally simpler to use than the market model, it does not control for the individual riskiness of the security, nor the market returns. If events are not clustered by calendar, then the bias should average out to zero[50]. It cannot, however, be assumed that the announcements are not clustered, especially since one of the premises in this thesis is that they may be correlated with the business cycle. Thus, it experiences a greater variance than the market model and, as such, was unsuitable for this analysis.

### 3.4.1.3 Adjusted Market Return Model

Here, the normal return is defined as the return of the market portfolio. To aggregate a market portfolio, however, a new data set is required in the same time format to be used as a benchmark for

[49] Craig A. MacKinley, "Event Studies in Economics and Finance," *Journal of Economic Literature*, March 1997.
[50] John J. Binder, "The Event Study Methodology Since 1969," *Review of Quantitative Finance and Accounting*, 1998.

the tested data. Here, $Ra_{i,t} = R_{i,t} - Rm_i$[51]. The authors determined that this additional work would not constitute a significant improvement in the results, and thus was not used for the data analysis.

#### 3.4.1.4 Economic Models

As for economic models, the two most common ones are the Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT)[52]. Due to their potentially unsatisfied assumptions, specifically that no transactional costs are present and that all investors are risk-averse and rational, these were not used.

#### 3.4.1.5 Market model

The market model's parameters are estimated using the return of an index during a period prior to the event with an ordinary least squares regression using robust standard errors, where the security return is the dependent variable and the market return is the independent variable.

In the market model, the firm's normal returns (return free from market effects) are estimated using the price of the market portfolio or index and the relationship between the market and the individual security's returns[53]. The index chosen for the study was S&P 500 Information Technology, as this thesis proposes that the returns of 'tech' stocks, which often exhibit a large appreciation in price, may be better examined in the same environment.

The relationship between the two securities is mapped by the two parameters - alpha and beta. The full model for estimating the normal return is visible below:

$$R^*_{it} = \alpha_i + \beta_i Rm + \varepsilon_i \quad (Equation\ 1)$$

The alpha represents the y-intercept while the beta represents the market return coefficient in an OLS regression model.

After the normal returns have been estimated, the abnormal returns can be calculated as follows:

[51] ibid.
[52] ibid.
[53] ibid.

$$AR = Real\ Return - Normal\ Return^{54} \quad \text{(Equation 2)}$$

Where:

$$R_{it}(Return\ on\ Security\ i\ Day\ t) = ln\left(\frac{P_{it}}{P_{it-1}}\right) \quad (Equation\ 3)$$

$$Rm_t(Market\ Return\ Day\ t) = ln\left(\frac{S\&P_t}{S\&P_{t-1}}\right) \quad (Equation\ 4)$$

Where:

$R_{it}$ is the natural log of the return for firm i on day t,

$P_{it}$ is the price of security i on day t,

$Rm_t$ is the natural log of the return for the S&P IT Index on day t,

$S\&P_t$ is the price of the S&P IT Index on day t,

By using this model, systemic risk and movements in the market during the event period are controlled for, which leads to less biassed data. A drawback is that the beta may change because of an event. When historical price data is collected on a daily basis, issues of nonsynchronous trading may arise. Nonsynchronous trading occurs when data points are recorded in different time periods. This may happen as the closing price is used, which in turn, could have been set before the market closed and at different times for stocks with a shallower order or book depth. This may cause minor inaccuracies; however, it is not expected to cause significant problems[55].

As such, the market model was selected for the event study, as it has desirable characteristics such as cleansing for systemic risk, being relatively simple to use and requiring relatively few data points while being less prone to error than the other approaches. It has also been shown in the literature review to be the method most often entrusted by researchers.

*5. Hypothesis test*

After the data has been collected via the model, and a result for the AARs and CAARs has been compiled, a hypothesis test follows. Hypothesis tests are used to rule out that the observed value could have arisen due to chance within a given level of confidence. There are many types of

[54] ibid.
[55] ibid.

hypothesis tests and many variations within them. For the purpose of testing the AARs and CAARs, this thesis used a two-tailed student's T-Test with significance levels of $\alpha = 0.1$, $\alpha = 0.05$ and $\alpha = 0.01$, because it allows the authors to test a hypothesis of the mean of a small sample when the population standard deviation is unknown. The T-test assumes sampling from a normally distributed population, this would give a normally distributed sample[56], it cannot be assumed that the collected data is normally distributed, therefore the Central Limit Theorem was used as previously stated. This gives that sample sizes above 30 observations are approximately normally distributed, regardless of parent distribution[57].

The T-Test statistic is calculated as follows[58]:

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} \quad (Equation\ 5)$$

Where:

$\bar{x}$ is the observed sample mean of interest,

$\mu$ is the hypothesised mean (0),

$s$ is the standard deviation of the individual observations,

$n$ is the number of firms in the sample,

Once the test statistic has been calculated, a p-value can be determined based on the Student's T-distribution. The extracted p-value is then compared with the significance level and the null hypothesis, is rejected only if the p-value falls below that of the significance level.

The null and alternative hypotheses for both AARs and CAARs are:

$$H_0: AAR_t = 0$$

$$H_a: AAR_t \neq 0$$

[56] Michael H. Kutner, *Applied Linear Statistical Models* (Tamail Nadu: McGraw Hill Education (India), 2020), chapter 6.

[57] William H. Greene, *Econometric Analysis* (Harlow, England: Pearson, 2020), chapter 3.

[58] Michael H. Kutner, *Applied Linear Statistical Models* (Tamail Nadu: McGraw Hill Education (India), 2020), chapter 6.

$$H_0: CAAR_t = 0$$

$$H_a: CAAR_t \neq 0$$

If the null hypothesis is rejected, it can be concluded that the mean of $AAR_t$ and $CAAR_t$ respectively differ from zero at the 1, 5 or 10% significance level. This indicates that there is an abnormal return present in the event window. This reasoning does not work in reverse, thus no conclusions can be drawn from insignificant results.

Extending this, a Patell Z Test was used, which is robust against how the AARs are distributed across the event window as opposed to the T-Test which requires that the abnormal returns be identically distributed. The Patell Z Test requires calculating the increase in variance due to prediction outside the estimation error and arriving at a standardised prediction error for the AARs and CAAR. From this, with the Lindenberg condition satisfied, a normalised sum or Z Stat can be calculated for both the AARs and CAAR, this Z Stat will be standard normally distributed and thus it is possible to apply the standard normal distribution to arrive at a probability of observing a particular statistic. The Patell Test will further calculate an approximately unit normal variate $Z_{Ut}$, which can be used to test hypotheses regarding differences in variance caused by an event[59].

The calculations are as follows[60]:

$$Z_{vt} = \frac{\sum_{i=1}^{n} V_{it}}{\left(\sum_{i=1}^{n} \frac{T_i - 2}{T_i - 4}\right)^{\frac{1}{2}}} \quad (Equation\ 6),$$

$$Z_{wL} = \frac{\sum_{i=1}^{n} W_{iL}}{\left(\sum_{i=1}^{n} \frac{T_i - 2}{T_i - 4}\right)^{\frac{1}{2}}} \quad (Equation\ 7),$$

$$Z_{Ut} = \frac{\sum_{i=1}^{n} (U_{it} - 1)}{\left(\sum_{i=1}^{n} \frac{2(T_i - 3)}{(T_i - 6)}\right)^{\frac{1}{2}}} \quad (Equation\ 8),$$

Where:

$T$ is the number of days in the estimation window,

[59] James M. Patell, "Corporate Forecasts of Earnings per Share and Stock Price Behavior: Empirical Test," *Journal of Accounting Research* 14, no. 2 (1976): p. 246, https://doi.org/10.2307/2490543.
[60] ibid.

$V_{it}$ is the normalised prediction error for firm i and day t,

$u_{it}$ is the prediction error for firm i and day t,

$W_{iL}$ is the normalised cumulative prediction error for firm i,

$L$ is the number of weeks accumulated,

$Z_{vt}$ is the statistic for V day t,

$Z_{wL}$ is the statistic for W,

$U_{it}$ is an approximately unit normal variate for firm i and day t

$Z_{Ut}$ is the statistic for U,

Put in other words, $Z_{vt}$ is the test statistic for AAR day t, while $Z_{wL}$ is the test statistic for the cumulative (entire event window) CAAR. $Z_{Ut}$ closely resembles a test statistic for increased variance during the estimation window; Patell (1976), however, points out that it is much more than so, it should be used in conjunction with the $Z_{vt}$ statistic, and $Z_{vt}$ should signal rejection while $Z_{Ut}$ should not. If both $Z_{vt}$ and $Z_{Ut}$ simultaneously signal rejection, it signals that $Z_{vt}$ is biassed towards rejection. If $Z_{vt}$ is insignificant, then $Z_{Ut}$ can fully be considered a test of increased variance[61]. For a more comprehensive presentation of the equations used, refer to Appendix: '9.4 Patell Z Test Equations'.

The Patell Z Test may be preferred over the T-Test in event studies because it provides greater statistical power, is more robust to heteroscedasticity, and provides more precise estimates of the effect size. It is the belief of the authors that using two hypothesis tests will provide a more robust and comprehensive analysis of the event's impact on the abnormal return[62].

## 3.3.2 Long-Term Regression

### 3.3.2.1 Methodology

An OLS regression variant - a multiple linear regression, was performed with HC3 robust standard errors to check for violations of the underlying OLS assumptions. Control variables for the market cycle, market cap, and option size in relation to firm i's net income were included, and an error term was introduced to account for unexplainable variability. Due to the scarcity of this extended data

[61] ibid.
[62] "Significance Tests for Event Studies," Event Study Tools, accessed May 8, 2023, https://www.eventstudytools.com/significance-tests.

requirement, the number of firms (33) just qualified for the Central Limit Theorem approximation, introducing larger variance and less clear trendlines. Therefore, results were evaluated at $\alpha = 0.01$ and $\alpha = 0.05$, with a supporting discussion held around values at $\alpha = 0.10$ as well, as they may indicate trends only a larger data set could prove.

#### 3.3.2.2 Model Specification

To test for a relationship between long-term performance and the implementation of an executive stock option compensation program, a regression equation was estimated as:

$$LP/E_{it} = \beta_0 + \beta_1(LO/TC_{it}) + \beta_2(LO/NI_{it}) + \beta_3(LGDP_t) + \beta_4(LMC_{it}) + \varepsilon_{it} \quad (Equation\ 9)$$

Where:

$LP/E_{it}$ = The natural logarithm of (one plus) the price to earnings ratio in year t for firm i,

$LO/TC_{it}$ = The natural logarithm of (one plus) the dollar value of options received by the top three executives in year t for firm i, divided by the dollar value of total compensation received by the same executives in year t for firm i,

$LO/NI_{it}$ = The natural logarithm of (one plus) the dollar value of options received by the top three executives in year t for firm i, divided by the net income in year t for firm i,

$LDGP_{iy}$ = The natural logarithm of United States GDP growth in year t,

$LMC_{iy}$ = The natural logarithm of the market cap in year t for firm i,

$\varepsilon_{it}$ = The error term (random error),

With the introduction of a natural log transformation for the dependent variable and all independent and control variables, nonlinearity is addressed and the variance is stabilised[63]. Hence, the coefficients for $LO/TC_{it}$, $LGDP_{iy}$, $LMC_{iy}$, and $LO/NI_{it}$ were interpreted in a log-log fashion, where a 1% change in the variable causes a $\beta_n$% change in the dependent variable.

$LP/E_{it}$ was chosen as the dependent variable to offer a performance measure which could be interpreted from the perspective of both market sentiment and the firm performance. Because the

[63] Lewellen, Wilbur. "Executive Compensation and the Performance of the Firm." Managerial and Decision Economics 13, no. 1 (1992): 65-74. JSTOR.

P/E is a ratio between price of the security and the earnings of one share of the security, a change in the P/E ratio can be due to several factors; either the price of the security can change, the earnings could change, or they could both change by different proportions. Thus, it allowed the regression analysis to examine changes in both market sentiment and firm performance. A high P/E ratio could thus signify either that the stock is overvalued, or that investors expect high future growth rates. While it offers this advantage, there is a cost - given the nature of the P/E ratio, the regression analysis is only capable of judging the change in the relationship between the two components, but no distinction can be made regarding whether a change in price or earnings is behind the ratio's movement. Other performance measures such as revenue growth, total value of assets, or simply earnings would have provided less ambiguity. However, it is the authors' belief that this gap was adequately bridged by economic and financial theory and thus, solely the advantage of using the P/E ratio made itself apparent in the analysis. The reason for not including share price as the dependent variable lies in the inherent ambiguity of its comparison between firms. The share price of a larger firm is not necessarily higher than that of a smaller firm, e.g., further securities issues may inflate the number of shares. This causes great difficulty in comparing share prices between firms.

A regression output, indicating a statistically significant estimate '$\beta_n$' was thus evaluated from the perspective of the firm and the market using two scenarios - one where the effect on the dependent variable was due to a change in price and, one where the change was due to a change in earnings. Accordingly, this allowed the analysis to construct potential relationships between the independent variables and the constituent variables of the P/E ratio, at which point, these relationships were then either substantiated or rejected using pre-existing financial and economic theory. Hence, this allowed for a deeper analysis of performance from both the firm's and the investor's perspectives.

The independent variable $LO/TC_{it}$ was chosen as it offers a gauge of the extent to which a firm uses stock options for compensating their executives, without being affected by the size of the options and by extension the firm. The control variables $LGDP_{iy}$, and $LMC_{iy}$ were included in order to isolate the effects of the business cycle and firm size. The control variable $LO/NI_{it}$ was aimed at controlling for the size of the option compensation in relation to firm earnings, where a larger ratio indicates that executives are granted a larger allocation of the firm's total earnings. Principal agent

theory and managerial power theory were used to further analyse the impact of a significant estimate.

The analysis focused on the performance effects of introducing stock option compensation for executives and, if this significance was independent of cyclicality. If present, the regression should therefore have found the estimate '$\beta_1$' to be significant, and the estimate '$\beta_3$' to be insignificant.

# 4. Short-Term Event Study: Results

*In this section, the results of the short-term event study are presented. Table 1 provides a summary of the collected data, including p-values and abnormal returns, which serve as the foundation for subsequent discussion.*

Table 1

This table presents the most important results from the short-term event study, including the simple return for AAR and CAAR, as well as the T-Stat, Patell Z-Stat and associated P-values.

**T-Test AAR and CAAR**

| Day | Simple Return | Standard Deviation | T-Stat | P-Value | CAAR | Standard Deviation | T-Stat | P-Value |
|---|---|---|---|---|---|---|---|---|
| -1 | 0,005 | 0,021 | 1,637 | 0,108 | 0,005 | 0,021 | 1,637 | 0,108 |
| 0 | 0,004 | 0,025 | 1,010 | 0,318 | 0,009 | 0,037 | 1,656 | 0,104 |
| 1 | 0,003 | 0,041 | 0,582 | 0,563 | 0,012 | 0,054 | 1,565 | 0,124 |
| 2 | 0,002 | 0,038 | 0,358 | 0,722 | 0,013 | 0,044 | 2,068 | 0.044** |
| 3 | 0,002 | 0,022 | 0,592 | 0,557 | 0,015 | 0,051 | 2,044 | 0.046** |

**Patell Z-Test AAR**

| Day | N | Vt | Patell Z | P-Value | Ut | Zut | P-Value |
|---|---|---|---|---|---|---|---|
| -1 | 33 | 7,163 | 0,993 | 0,160 | 22,833 | -0,384 | 0,650 |
| 0 | 33 | 13,934 | 1,931 | 0.027** | 52,561 | 0,021 | 0,492 |
| 1 | 33 | 13,328 | 1,847 | 0.032** | 48,089 | -0,040 | 0,516 |
| 2 | 33 | 12,713 | 1,762 | 0.039** | 53,690 | 0,037 | 0,485 |
| 3 | 33 | 16,365 | 2,268 | 0.012** | 52,783 | 0,024 | 0,490 |

**Patell Z-Test CAAR**

| Day | N | Vt | Patell Z |
|---|---|---|---|
| -1:3 | 31,743 | 4,399 | 0.000* |

*** Significant at α=0.1

** Significant at α=0.05

* Significant at α=0.01

As Table 1 demonstrates, all event days reported positive abnormal returns with the cumulative abnormal return for the event window being approximately 1.5%. The T-Test only returned significant p-values for CAAR 2 and 3. The Patell Z Test returned significant AAR values for all event days except day -1, and for CAAR over all days. The standard deviation of the sample's abnormal returns was generally quite large, which can be explained by the small sample size of 51 firms. The approximately unit normal variate (U) yielded no significant results.

The positive value for the CAAR, for all firms, suggested a positive market sentiment that was further strengthened by the positive coefficients present on all days with statistically significant

abnormal returns. This indicated that the announcement of an executive stock option compensation scheme, through the release of an S-8 form, had a positive effect on performance in the short term; the market reacted favourably to the release of the news and hence, firms saw an increased return in comparison to the market.

Since the majority of the data was concentrated around the years 2006-2007, a separate analysis for the economic expansion (2006 to late August 2007) and all other data points was conducted to decipher the impact of cyclicality on this result. However, the number of observations in each group was too low to affirm that the Central Limit Theorem would hold. As such, these were redacted from the thesis (see the Appendix: '9.3 Redacted Grouping of Firms' for more information).

# 5. Long-Term Regression: Results

*In this section, the results of the long-term multiple linear regression are presented. Table 2 provides a summary of the collected data, including p-values and coefficients, which serve as the foundation for subsequent discussion.*

Table 2

This table presents the obtained coefficient estimates from the long-term regression analysis as well as the associated P-values and overarching regression characteristics such as adjusted R^2.

| | Year 1 | | Year 2 | | Year 3 | |
|---|---|---|---|---|---|---|
| | Coeff. | P-Value | Coeff. | P-Value | Coeff. | P-Value |
| Intercept | -0,252 | 0,091 *** | -0,163 | 0,701 | -0,244 | 0,103 |
| LO/TC | -0,115 | 0,545 | -0,366 | 0,479 | -0,430 | 0,004 * |
| LO/NI | 0,190 | 0,000 * | 0,133 | 0,005 * | 0,110 | 0,001 * |
| LGDP | -0,010 | 0,552 | 0,018 | 0,596 | -0,014 | 0,238 |
| LMC | 0,031 | 0,094 *** | 0,040 | 0,287 | 0,053 | 0,005 * |
| Observations | | 33 | | 33 | | 33 |
| Adjusted R^2 | | 0,561 | | 0,077 | | 0,350 |
| F-Stat | | 11,217 | | 1,671 | | 5,314 |
| P-Value | | 0,000* | | 0,185 | | 0,003* |

*** Significant at α=0.1
** Significant at α=0.05
* Significant at α=0.01

Table 2 highlights the regression results for the analyses conducted one, two, and three years after the event day (260, 520 and 780 trading days respectively)[64]. The independent variable LO/TC showed a statistically significant negative coefficient of -0.430 in year 3, indicating a -0.430% change in the P/E ratio for every 1% increase in the ratio between options to total compensation. LO/NI returned positive coefficients at a one per cent significance level for all three years, predicting 0.190%, 0.133%, and 0.110% increase in P/E when the ratio of options to net income increased by one per cent in years one, two, and three respectively. The control variable LGDP showed no significance. LMC returned positive coefficients for all years, showing significance at the five and ten per cent level in years three and one respectively, confirming a relationship between firm size and P/E. In year three, a one per cent increase in market cap predicted a 0.053% increase in P/E, whilst in year one a 0.031% increase in P/E was predicted.

The significant negative LO/TC coefficient in year three thus indicated that a larger ratio of options to total compensation decreased the P/E ratio of the firm. The insignificance of LGDP indicated that

[64] Bodie, Zvi, Alex Kane, and Alan J. Marcus. Investments. 11th ed. McGraw Hill, 2021. p.7

the regression was unable to confirm a relationship between the business cycle and the P/E ratio. The significant positive coefficient for LMC indicated a positive relationship between firm size and P/E ratio, while the significant positive coefficient for LO/NI indicated a positive relationship between the relative size of the options package compared to total firm earnings. This is validated by the principal-agent theory, as the executive option compensation should align the executive's incentives with that of the shareholders, as explained under '2.2 Theoretical Background'.

Whilst the P/E ratio measures the price per unit earnings, this itself says little without context. From a firm perspective, a large P/E ratio indicates strong market demand for the stock of firm *i,* but simultaneously means that fundamental performance measured in earnings becomes more expensive for investors, ceteris paribus. The extent to which the sign of the coefficients impact the market demand and the firm performance, is not clear-cut. These are further examined in the analysis section, but to briefly illustrate this ambiguity, consider signalling theory, which relies on asymmetric information between the company and the market[65]. A higher share price signals greater performance, while increased earnings also signal greater performance. If both of these variables increase by the same proportion, the P/E ratio will be unaltered, signalling nothing of the underlying variables. A high P/E ratio could thus signal that the stock is overvalued, or that investors are expecting high growth rates in the future. This highlights the importance of basing any analysis on the results of previous research to validate the sign and magnitude of the variables, as seen in the analysis section.

Table 2 further shows that the first- and third-year regressions returned significant F-Values indicating that these regressions explained the observations in the data better than a regression with all coefficients nullified. The opposite was true for year two, which subsequently coincided with a large number of companies entering or experiencing the 2007-2009 financial crisis. The adjusted R-squared values further supported that the regressions for years one and three managed to account for a large degree of unexplained variation whilst year two could not. However, in the context of a financial thesis reliant on market data, the year-one value of 0,561 is rather high and could indicate some degree of multicollinearity. Tests for this have been conducted and can be found in the Appendix: '9.2 OLS Assumptions Long Run Regression'.

[65] Spence, Michael. "Education and Signalling." The Quarterly Journal of Economics 87, no. 1 (1973): 1-31.

# 6. Joint Analysis and Discussion

*In '6.1 Short-Term Event Study' and '6.2 Long-Term Regression' the results of the short-term event study and the long-term regression, respectively, are discussed and compared with previous research findings. Alternative explanations are presented and the authors draw the conclusion which they find most likely given the results of the analysis as well as the conclusions of previous research. Finally, in '6.3 Limitations' the limitations of the thesis and study are discussed in order to promote the reader's critical thinking with regards to the thesis' findings.*

## 6.1 Short-Term Event Study

As noted, the results from the short-term event study indicate that the market reacts favourably to the announcement of an executive stock option compensation scheme, in line with Brickley (1985) et. al.'s previous findings[66]. There are many proposed reasons for this in contemporary research. One understanding of this phenomenon is that XSOs offer greater flexibility in alleviating principal-agent problems between shareholders and executives.

Agency theory proposes that firms grant equity to employees in order to create incentives, which are more aligned with the interest of shareholders. They may offer further benefits in attracting and retaining talent and knowledge in the firm. In perfectly efficient capital markets, with diversified executives and aligned incentives, systematic risk should be the only gauge with which executives make investment decisions. However, Panousi and Papanikolaou (2011) claim that 'the data indicate that there is a significant negative relation between idiosyncratic risk and investment for publicly traded firms in the United States'. They further find that executives in public companies hold sizable stakes in their firms, consistent with agency theory. Coupling these, they argue that poorly diversified managers may decrease the riskiness of investments when there is uncertainty in both the system and the specific firm[67].

Pukthuanthong and Roll (2007) find that when executives have a large portion of their wealth in the form of ownership and future earnings invested in their firms, they become under-diversified and

[66] Brickley, James A., Sanjai Bhagat, and Ronald C. Lease. "The impact of long-range managerial compensation plans on shareholder wealth." Journal of Accounting and Economics 7, no. 1-3 (1985): 115-129.
[67] Vasia Panousi and Dimitris Papanikolaou, "Investment, Idiosyncratic Risk, and Ownership," *SSRN Electronic Journal*, 2011, https://doi.org/10.2139/ssrn.1969420.

shift their optimal investment risk. In turn, this shift may cause them to dismiss 'good' risky investments[68]. Convex contractual payoffs (i.e., those containing more upside than downside) tend to encourage risk-taking in general[69].

Additionally, Pukthuanthong and Roll (2007) find that firms with high levels of convex compensation, such as stock options which increase in value with uncertainty, have lower levels of investment risk sensitivity[70].

It is important to note that equity ownership and stock options have different risk properties (Certo *et al*., 2003)[71]. Option returns are more volatile than those of the underlying equity, therefore holding undiversified option positions entails more risk than the same dollar amount of equity. Conversely, riskier investments increase the value of options, while potentially decreasing that of equity[72]. As such, stock options should be viewed as a complement, not a replacement for stock grants, even though Smith and Stulz (1985), Lippert and Porter (1997), Hemmer *et al*. (2000), Bryan *et al*. (2002) conclude that the performance incentive offered by stock options is stronger than that of stock-based compensation[73]. In essence, it follows naturally that a combination of the two incentive schemes offers more advantages and flexibility than either in isolation.

This is reinforced, once again by the work of Pukthuanthong and Roll (2007), who state that new public companies perform better when there is a combination of the two incentive schemes. This empirical finding is consistent with the theory of managerial risk aversion and the alignment of managerial and owner incentives[74].

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[68] Kuntara Pukthuanthong, Richard Roll, and Thomas Walker, "How Employee Stock Options and Executive Equity Ownership Affect Long-Term IPO Operating Performance," *Journal of Corporate Finance* 13, no. 5 (2007): pp. 695-720, https://doi.org/10.1016/j.jcorpfin.2007.02.003.
[69] Chris S. Armstrong, Frank Zhou, and Allison Nicoletti, "Executive Stock Options and Systemic Risk," *SSRN Electronic Journal*, 2020, https://doi.org/10.2139/ssrn.3689960.
[70] Kuntara Pukthuanthong, Richard Roll, and Thomas Walker, "How Employee Stock Options and Executive Equity Ownership Affect Long-Term IPO Operating Performance," *Journal of Corporate Finance* 13, no. 5 (2007): pp. 695-720, https://doi.org/10.1016/j.jcorpfin.2007.02.003.
[71] Brian L. Connelly *et al*., "Signalling Theory: A Review and Assessment," *Journal of Management* 37, no. 1 (2010): pp. 39-67, https://doi.org/10.1177/0149206310388419.
[72] Kuntara Pukthuanthong, Richard Roll, and Thomas Walker, "How Employee Stock Options and Executive Equity Ownership Affect Long-Term IPO Operating Performance," *Journal of Corporate Finance* 13, no. 5 (2007): pp. 695-720, https://doi.org/10.1016/j.jcorpfin.2007.02.003.
[73] Yenn-Ru Chen and Yulong Ma, "Revisiting the Risk-Taking Effect of Executive Stock Options on Firm Performance," *Journal of Business Research* 64, no. 6 (2011): pp. 640-648, https://doi.org/10.1016/j.jbusres.2010.02.012.
[74] Kuntara Pukthuanthong, Richard Roll, and Thomas Walker, "How Employee Stock Options and Executive Equity Ownership Affect Long-Term IPO Operating Performance," *Journal of Corporate Finance* 13, no. 5 (2007): pp. 695-720, https://doi.org/10.1016/j.jcorpfin.2007.02.003.

Thus, options could help ensure that executives with large amounts of equity, and therefore idiosyncratic risk, continue to take measured and well-weighed investment and management risks.

This is further supported by the findings of Lam & Chng (2006), who find that 'the dominant motivations for XSO grants are consistent with the predictions of agency theory and the signalling hypothesis.'. Furthermore, they find that 'XSO grants are made when there is insider buying activity and can be a more visible signal for favourable price sensitive news', yet, reject alternative explanations on the benefits of stock options such as tax considerations and cash conservation[75].

Coupled with the aforementioned benefits of stock options, the statistically significant Patell Z Test and the performed T-Test, this paper proposes that these benefits are what cause the discovered cumulative average abnormal returns for firms. The positive news of stock option implementation (in line with the efficient market hypothesis) causes the market to evaluate, and thereby correct the price of the firm, leading to positive abnormal returns.

Since all calculated CAARs have been positive despite the concentration of firms experiencing the 2007-2009 financial crisis, this signifies that the market may actually react more positively during an economic crisis. This may be due to the financial crisis having a significant impact on the perceptions of the market, or it may be that the companies who are able to issue stock options during a financial crisis are more profitable, that is survivorship bias may be present. However, the theory which this thesis grounds itself within offers no clarity as to the validity of these claims, and are thus only included to widen the perspective of the analysis and offer ideas as to future areas of research.

In addition, evidence found by Chen and Ma (2011) indicates that the managerial risk-taking encouraged by general stock options increases both long-term and short-term returns. Based on their sample, they find that stock returns actually decrease the short-term returns of the firms included in their sample. They suggest that this implies it takes time for 'accounting performance to reflect the risk-taking effect of ESOs'[76].

[75] Swee-Sum Lam and Bey-Fen Chng, "Do Executive Stock Option Grants Have Value Implications for Firm Performance?," *Review of Quantitative Finance and Accounting* 26, no. 3 (2006): pp. 249-274, https://doi.org/10.1007/s11156-006-7433-3.
[76] Yenn-Ru Chen and Yulong Ma, "Revisiting the Risk-Taking Effect of Executive Stock Options on Firm Performance," *Journal of Business Research* 64, no. 6 (2011): pp. 640-648, https://doi.org/10.1016/j.jbusres.2010.02.012.

This is strengthened by the findings of Lam and Chang (2006), who suggest that the relationship between firm performance and XSOs may vary with the market phase, giving additional weight to the long-term regression analysis that follows[77].

The short-run event study thus confirms the positive market sentiment exhibited by an introduction of XSOs. In aggregate, there is evidence to conclude that XSOs offer incentive alignment which is positive for firm performance, due to the visible positive market sentiment offered by the event study.

## 6.2 Long-Term Regression

The negative coefficient exhibited by LO/TC indicates that the introduction of an XSO compensation that is large in relation to the total executive compensation scheme negatively impacts the P/E ratio. Whilst this seems to contradict the original hypothesis, the business cycle's impact could explain such a phenomenon. As seen in Illustration 2, the dataset has a significant concentration of observed firms which fall under the 2007-2009 financial crisis. This systemic depreciation in stock prices and halt in the global economy causes a cash shortage for firms, whereby options become a more prominent means of compensation. Healthy firms, on the other hand, can continue to employ an optimal combination of equity, options, and cash-based compensation, reducing the LO/TC ratio for these firms. Yermack's findings in his 1995 paper support this analysis, concluding that stock options might be particularly effective as a means of compensation when cash availability is limited[78]. Hence, the variable LO/TC may not gauge the effect of options as much as it gauges the propensity of their implementation in economic contractions.

The significance of the LO/TC variable in year 3, and its insignificance in years 1 and 2, further support this theory as year 3 exhibits a large concentration of firms entering the subsequent economic expansion. Whilst all firms will have relied more heavily on options in years one and two, the true effect of an optimal combination as opposed to solely using stock options is seen in year 3. Such an analysis is grounded in agency theory, whereby executives with a strong incentive

[77] Swee-Sum Lam and Bey-Fen Chng, "Do Executive Stock Option Grants Have Value Implications for Firm Performance?," *Review of Quantitative Finance and Accounting* 26, no. 3 (2006): pp. 249-274, https://doi.org/10.1007/s11156-006-7433-3.
[78] Yermack, David. "Do corporations award CEO stock options effectively?" Journal of Financial Economics 39, no. 2-3 (1995): 237-269.

alignment partake in procyclical investment strategies in times of economic contraction, aiding in the increased performance in the subsequent market expansion[79]. This strong incentive alignment must account for the executives' current, short-term, and long-term horizons, whereas primarily options-based compensation schemes may only target the long-term. Additionally, the fact that firms in the information technology sector were sampled implies a large market beta and any performance effects seen could experience larger volatility than the average firm, exacerbating the need for agency alignment[80]. In short, a reason for the coefficient taking on a negative value could be that the overuse of options does not optimally align the executives' incentives, causing sub-optimal performance on their part, leading to a worsened P/E ratio. Here, healthy firms show the true effect of an optimal combination of options, stock, and cash-based compensation in year 3, whilst others are still recovering from the economic downturn. These firms will continue to employ a large degree of options-based compensation due to cash shortages, thus correlating sub-optimal firm performance with an over-use of options.

Whilst offering valuable insight, the sample does not offer an even distribution of data points in economic contractions and expansions. Therefore, a three-year regression may not be sufficient for judging the true effects of options-based compensation in economic expansions and downturns. This analysis is strengthened by the works of both Hall & Liebman (1998) and Lam & Chng (2006), the prior finding a significant relationship between performance and overall executive compensation in the market upswing between 1980-1994, and the latter concluding that a convex relationship between XSO compensation and performance is present, dependent on the market cycle. While future research is encouraged to shed more light on the phenomena, Lam & Chng (2006) conclude that a cyclical effect is likely present, in which XSO compensation performs significantly better during market expansions[81]. Future research is urged to incorporate this lesson and include a longer time horizon for the regression model, in order to adequately encompass each firm in both economic expansions and contractions, as well as incorporate variables for the combination of different executive compensation structures in a more detailed manner.

[79] Armstrong, Chris S., Frank Zhou, and Allison Nicoletti. "Executive Stock Options and Systemic Risk." *SSRN Electronic Journal*, 2020

[80] Armstrong, Chris S., Frank Zhou, and Allison Nicoletti. "Executive Stock Options and Systemic Risk." *SSRN Electronic Journal*, 2020

[81] Swee-Sum Lam and Bey-Fen Chng, "Do Executive Stock Option Grants Have Value Implications for Firm Performance?," *Review of Quantitative Finance and Accounting* 26, no. 3 (2006): pp. 249-274, https://doi.org/10.1007/s11156-006-7433-3.

The above analysis holds despite the insignificance of the LGDP control variable, as an inability to reject the null hypothesis does not conclude the opposite to be true. For future research, using a different measure of market cyclicality, e.g., interest rate spread or unemployment, could shed more light on its effect.

The most statistically significant factor was by far $LO/NI_{it}$ (the ratio between the dollar value of options paid out to executives and the net income of the firm). One interpretation of this significance is that companies with a relatively large ratio of price to earnings simply perform better, and are thus able to pay a larger share of their earnings to executives without impacting the firm's results. Thus, it is not the implementation of a larger options program itself that causes the larger P/E ratio, but another underlying correlation with intrinsic firm performance. Another interpretation is that the two ratios have earnings as a common denominator. Thus, large shifts in earnings would impact both ratios in a similar manner, and show a strong, statistically significant relationship between them, despite the inherent difference in price and options compensation as numerators in the variables.

A third alternative is also possible, and most likely when considering previous research. A large LO/NI indicates that the executives receive a larger share of total firm earnings in the form of options. Since the P/E ratio is an indicator of future performance, and options align executives' earnings with the firm's future performance, a significant positive coefficient is to be expected. Hall & Liebman's 1998 paper also supports this interpretation, as the effect has shown greater statistical significance in economic expansions. This is perfectly in line with the magnitude of the LO/NI coefficients, as the largest positive relationship between the variables is seen in year three.

Additionally, given the interpretation that a large P/E ratio signifies positive investor expectations of future growth, the sign exhibited by the LO/TC and LO/NI coefficients can be further justified. The negative relation between LO/TC and P/E is more likely caused by negative investor expectations regarding cash constraints in the company, forcing the exacerbated use of options. Since an optimal combination of compensation cannot be used, future performance will be impacted, and in line with the efficient market hypothesis, the price of the stock will decrease, resulting in a negative coefficient. The positive coefficient for LO/NI indicates that a relatively larger option value aligns executive incentives with long-term performance and promotes pro-cyclical investments by

executives. As a result, an expectation for future growth arises, aligned perfectly with the positive impact seen on P/E.

The fact that a large options program is introduced may also be of more concern in estimating future growth than the more detailed ratios between compensational forms. Whilst the efficient market hypothesis assumes that investors have access to all the necessary information, and the time and competence to make investment decisions based on this, reality is far from it. Thus, the information that a large options program is present may be evidence enough for investors to deem the stock as having large growth potential, manifesting itself in LO/NI's significant positive coefficient throughout the three-year period, whereas LO/TC only yielded significant results during the expansionary period.

Despite the fact that the control variable LMC offers no regressional conclusions regarding market capitalization and the propensity towards option compensation, the positive significant coefficient in year three provides valuable insight. The significant positive coefficient on its own simply concludes that larger firms have larger P/E ratios, but the magnitude of the coefficients (0.031 in year 1 at $\alpha = 0.10$ and 0.053 in year 3 at $\alpha = 0.05$) indicated that the relationship is weak. In contrast, the year three coefficient for LO/TC exhibits a magnitude eight times as large and coefficients twice as large for LO/NI, indicating a much stronger performance effect than firm size alone. This further strengthens the original hypothesis that not only is the relative size of options compensation positively correlated with increased firm performance, but firm size and cyclicality also have an impact on the magnitude of the effect, and remain present when these factors are eliminated. As noted, the managerial power theory holds that the power in a firm tends to congregate with executives and managers, and as such, they have the power to extract disproportionate amounts of rent from their respective firms. While this analysis offers no conclusion as to the net effect of stock options, apart from the apparent positive sentiment of the market (manifested by the positive abnormal returns in the short term), the analysis can, with relative certainty, reject the proposal that stock options are used purely by managers and executives to extract rents from firms. This can be concluded by the long-term regression indicating that stock options do in fact have a positive effect on the performance of firms.

Overall, the LO/TC variable offers valuable insight into the necessity for an optimal combination of compensation methods, as opposed to purely XSO-based ones. The variable LO/NI on the other hand, strengthened by the principal-agent theory, suggests that a stronger link between an

executive's personal wealth and the company's yearly performance is to be desired. Long-term performance is thus dependent on an optimal portfolio of executive compensation and a strong alignment between the firm as a principal and the executives' personal wealth as the agent.

## 6.3 Limitations

The limited time horizon, not of the study as a whole (2000-2022), but of the predominant period measured for firms in the long-term regression analysis, approximately 2006-2009 may have introduced relationships only present during economic downturns. This may thus, by extension, invalidate the results when firms are not experiencing an economic downturn.

The selection of criteria for inclusion in the study may have unintentionally introduced bias into the result. It is for example possible that firms in the United States' IT sector who have previously issued stock options may be more proficient in their use, which may cause a larger positive impact on performance than for firms who have not issued stock options previously. If they have previously issued stock options, investors may be more positively inclined towards them, and they may have a better structure to take advantage of the correct incentives. This could lead to biassed appreciation of the share price. While superior compensation structures may increase the performance effects for the firm, this would mean that the results may be skewed and inappropriate to apply to firms new to XSOs. Furthermore, it is possible that the choice of investigating the tech sector alone may yield quite specific reactions to stock options. It has previously been noted that the tech sector whose primary asset is the knowledge of employees, also more actively uses XSOs. Thus, results from this study may prove incorrect or misleading in the context of other sectors.

Since the Dot Com Bubble was not included in the timeframe of the study, the IT companies analysed may be subject to survivorship bias through a selection process (the Dot Com Bubble). This could also contribute to misguided results where past failures have not been accounted for.

It is clear from previous research that cyclicality has an effect on the performance of firms issuing stock options. However, since the control variable LGDP did not show significant results, this may indicate that the regression analysis missed this effect by not including more relevant variables for cyclicality. This may have caused omitted variable bias.

As previously mentioned this study has taken a different approach to the definition of the event, the S-8 form may be a less accurate measure of the effects of introducing XSOs. This could have negative effects on the validity of the study, missing the actual effects of the introduction.

Furthermore, as previously mentioned, this study did not control for other events which may have impacted the dependent variable in both the event study and the regression analysis. As such the P/E ratio may have been influenced by the general price increase of the economy through the constituent - price. The Patell Z Test offers a U variate of which a significant value could, in theory, indicate the presence of other events affecting the data, no such significant value was recorded.

# 7. Conclusion

This paper has examined the effects of executive stock option compensation schemes on firm performance, investor reaction, and risk-taking behaviour. The event study results demonstrate that the market reacts positively to the announcement of such schemes. This positive reaction can be attributed to the potential benefits of XSOs in terms of incentivizing executives and addressing principal-agent problems, and consequently, improving the future performance of the firm.

Moreover, the long-term regression analysis suggests that the introduction of an XSO compensation scheme may have ambiguous effects, dependent on the mix between stock option compensation and other compensation forms. The negative LO/TC indicates that overuse of stock options without regard for an optimal combination of incentives has a detrimental effect on the performance of firms, while the positive LO/NI variable indicates that a stronger alignment between the executive's and firm's future earnings has a positive effect on the P/E Ratio of firms.

The findings of this study are consistent with existing literature, suggesting that a combination of stock-based compensation and stock options, as opposed to solely using options, may be more effective in incentivizing executives and aligning their interests with those of shareholders. The empirical evidence presented in this paper supports the view that XSOs can play a role in mitigating the risk-taking behaviour of executives who hold large amounts of equity and may be under-diversified. However, due to the concentration of firms experiencing economic contractions in the studied period, a deeper analysis should be done on the effects during a large economic expansion.

Finally, it is important to note that the benefits of XSOs are not without their drawbacks. The volatility of option returns and the potential for misaligned incentives and agency problems are issues that must be addressed. However, when implemented correctly, XSOs can be an effective tool for addressing principal-agent problems, incentivizing executives, and promoting long-term firm performance.

To answer the initially posed questions;

*The firm's stock price exhibits statistically significant positive abnormal returns when the implementation of an XSO compensation scheme is announced. Additionally, there exists a statistically significant correlation between the introduction of an XSO compensation scheme and performance in the long term, and whilst the regression offers no statistically significant results regarding the impact of the business cycles, there is strong theoretical evidence to support the claim.*

Future research should continue to explore the benefits and limitations of XSOs and other forms of executive compensation in promoting long-term firm performance and shareholder value. In addition, the cyclical effects and its impact on both effectively aligning incentives to promote procyclical investments, and the sector-specific effects should be explored further to add pieces to the puzzle of maximising firm performance

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# 9. Appendix

## 9.1 Data Collection and Sorting:

The firm specific data used in this report was primarily collected from WRDS Compustat Capital IQ.

The following criteria was used to sort the data from **Capital IQ:**

- Exchange country/region = united states (22138)
- Company type = public Company (16772)
- Industry Classification SIC = Information Technology (1907
- Market Cap in 2000 greater than 250 USDmm, Historical rate, or,
- Market Cap in 2001 greater than 250 USDmm, Historical rate, or,
- …
- Market Cap in 2023 greater than 250 USDmm, Historical rate (939)
- Option Awards in 2000 greater than 0 USDmm, Historical rate, or,
- Option Awards in 2001 greater than 0 USDmm, Historical rate, or,
- …
- Option Awards in 2023 greater than 0 USDmm, Historical rate (586)

This provided a subset of 800 companies that were then further sorted based on the criteria in Illustration 3.

## 9.2 OLS Assumptions Long Run Regression

Table 4 - Correlation Matrix

This table shows the correlation between all possible combinations of independent variables used in the regression for years one through three.

**Correlation Matrix: Year 1**

| | LPE | LO/TC | LO/NI | LGDP | LMC |
|---|---|---|---|---|---|
| LPE | 1 | | | | |
| LO/TC | 0,352 | 1 | | | |
| LO/NI | 0,756 | 0,427 | 1 | | |
| LGDP | 0,026 | -0,115 | 0,119 | 1 | |
| LMC | -0,010 | 0,268 | -0,256 | -0,081 | 1 |

**Correlation Matrix: Year 2**

| | LPE | LO/TC | LO/NI | LGDP | LMC |
|---|---|---|---|---|---|
| LPE | 1 | | | | |
| LO/TC | 0,098 | 1 | | | |
| LO/NI | 0,389 | 0,484 | 1 | | |
| LGDP | -0,035 | -0,013 | -0,279 | 1 | |
| LMC | 0,064 | 0,198 | -0,129 | 0,134 | 1 |

**Correlation Matrix: Year 3**

| | LPE | LO/TC | LO/NI | LGDP | LMC |
|---|---|---|---|---|---|
| LPE | 1 | | | | |
| LO/TC | 0,032 | 1 | | | |
| LO/NI | 0,406 | 0,502 | 1 | | |
| LGDP | 0,022 | -0,006 | 0,272 | 1 | |
| LMC | 0,263 | 0,211 | -0,166 | 0,053 | 1 |

## Table 5 - Other Robustness Checks

This table summarises the results of all other robustness checks performed on the data of the regression analysis.

| White-Test | | | | Breusch-Pagan | | | |
|---|---|---|---|---|---|---|---|
| | **Year 1** | **Year 2** | **Year 3** | | **Year 1** | **Year 2** | **Year 3** |
| **LM Stat** | 5,622 | 0,377 | 0,308 | **LM Stat** | 7,733 | 6,378 | 3,060 |
| **df** | 2 | 2 | 2 | **df** | 4 | 4 | 4 |
| **P-Value** | 0,060 | 0,828 | 0,857 | **P-Value** | 0,102 | 0,173 | 0,548 |
| **Significant** | no | no | no | **Significant** | no | no | yes |
| **F Stat** | 3,080 | 0,173 | 0,141 | **F Stat** | 2,142 | 1,677 | 0,715 |
| **df1** | 2 | 2 | 2 | **df1** | 4 | 4 | 4 |
| **df2** | 30 | 30 | 30 | **df2** | 28 | 28 | 28 |
| **P-Value** | 0,061 | 0,842 | 0,842 | **P-Value** | 0,102 | 0,183 | 0,183 |
| **Significant** | no | no | no | **Significant** | no | no | no |

| Durbin-Watson Test | | | | Variance Inflation Factor (vif) | | | |
|---|---|---|---|---|---|---|---|
| | **Year 1** | **Year 2** | **Year 3** | | **Year 1** | **Year 2** | **Year 3** |
| **D-Stat** | 1,832 | 1,906 | 2,005 | **LO/TC** | 1,553 | 1,456 | 1,595 |
| **D-lower** | 1,193 | 1,193 | 1,193 | **LGDP** | 1,051 | 1,112 | 1,148 |
| **D-upper** | 1,730 | 1,730 | 1,730 | **LMC** | 1,316 | 1,121 | 1,204 |
| **Significant** | no | no | no | **LO/NI** | 1,544 | 1,528 | 1,705 |
| | | | | **Significant** | no | no | no |

| Shapiro-Wilk Test | | | | d'Agostino-Pearson | | | |
|---|---|---|---|---|---|---|---|
| | **Year 1** | **Year 2** | **Year 3** | | **Year 1** | **Year 2** | **Year 3** |
| **W-Stat** | 0,905 | 0,777 | 0,957 | **DA-Stat** | 6,009 | 15,590 | 5,622 |
| **P-Value** | 0,007 | 0,000 | 0,217 | **P-Value** | 0,050 | 0,000 | 0,060 |
| **Significant** | no | no | yes | **Significant** | no | no | yes |

The case for significance between tests vary, significance is reported as yes or no

## Table 6 - Raw Regression Output

This table presents the unedited, raw output from the long-term regression.

**Year 1**

| OVERALL FIT | |
|---|---|
| Multiple R | 0.785 |
| R Square | 0.616 |
| Adjusted R Square | 0.561 |
| Standard Error | 0.168 |
| Observations | 33 |

| | |
|---|---|
| AIC | -113.021 |
| AICc | -109.790 |
| SBC | -105.538 |

| ANOVA | | | | | Alpha | 0.05 |
|---|---|---|---|---|---|---|
| | *df* | *SS* | *MS* | *F* | *p-value* | *sig* |
| Regression | 4 | 1.271 | 0.318 | 11.217 | 0.000 | yes |
| Residual | 28 | 0.793 | 0.028 | | | |
| Total | 32 | 2.065 | | | | |

| | *coeff* | *std err* | *t stat* | *p-value* | *lower* | *upper* | *vif* |
|---|---|---|---|---|---|---|---|
| Intercept | -0.252 | 0.144 | -1.751 | 0.091 | -0.547 | 0.043 | |
| LO/TC | -0.115 | 0.187 | -0.613 | 0.545 | -0.497 | 0.268 | 1.553 |
| LGDP | -0.010 | 0.016 | -0.601 | 0.552 | -0.043 | 0.024 | 1.051 |
| LMC | 0.031 | 0.018 | 1.733 | 0.094 | -0.006 | 0.067 | 1.316 |
| LO/NI | 0.190 | 0.030 | 6.244 | 0.000 | 0.128 | 0.252 | 1.544 |

**Year 2**

| OVERALL FIT | |
|---|---|
| Multiple R | 0.439 |
| R Square | 0.193 |
| Adjusted R Square | 0.077 |
| Standard Error | 0.393 |
| Observations | 33 |

| | |
|---|---|
| AIC | -57.112 |
| AICc | -53.882 |
| SBC | -49.630 |

| ANOVA | | | | | Alpha | 0.05 |
|---|---|---|---|---|---|---|
| | *df* | *SS* | *MS* | *F* | *p-value* | *sig* |
| Regression | 4 | 1.031 | 0.258 | 1.671 | 0.185 | no |
| Residual | 28 | 4.318 | 0.154 | | | |
| Total | 32 | 5.349 | | | | |

| | *coeff* | *std err* | *t stat* | *p-value* | *lower* | *upper* | *vif* |
|---|---|---|---|---|---|---|---|
| Intercept | -0.163 | 0.419 | -0.388 | 0.701 | -1.021 | 0.696 | |
| LO/TC | -0.366 | 0.511 | -0.717 | 0.479 | -1.414 | 0.681 | 1.456 |
| LGDP | 0.018 | 0.034 | 0.536 | 0.596 | -0.052 | 0.088 | 1.112 |
| LMC | 0.040 | 0.037 | 1.086 | 0.287 | -0.035 | 0.115 | 1.121 |
| LO/NI | 0.133 | 0.043 | 3.088 | 0.005 | 0.045 | 0.221 | 1.528 |

**Year 3**

| OVERALL FIT | |
|---|---|
| Multiple R | 0.657 |
| R Square | 0.432 |
| Adjusted R Square | 0.350 |
| Standard Error | 0.133 |
| Observations | 33 |

| | |
|---|---|
| AIC | -128.678 |
| AICc | -125.447 |
| SBC | -121.196 |

| ANOVA | | | | | Alpha | 0.05 |
|---|---|---|---|---|---|---|
| | *df* | *SS* | *MS* | *F* | *p-value* | *sig* |
| Regression | 4 | 0.375 | 0.094 | 5.314 | 0.003 | yes |
| Residual | 28 | 0.494 | 0.018 | | | |
| Total | 32 | 0.868 | | | | |

| | *coeff* | *std err* | *t stat* | *p-value* | *lower* | *upper* | *vif* |
|---|---|---|---|---|---|---|---|
| Intercept | -0.244 | 0.145 | -1.687 | 0.103 | -0.541 | 0.052 | |
| LO/TC | -0.430 | 0.138 | -3.117 | 0.004 | -0.713 | -0.147 | 1.595 |
| LGDP | -0.014 | 0.012 | -1.207 | 0.238 | -0.039 | 0.010 | 1.148 |
| LMC | 0.053 | 0.018 | 3.044 | 0.005 | 0.017 | 0.089 | 1.204 |
| LO/NI | 0.110 | 0.031 | 3.594 | 0.001 | 0.048 | 0.173 | 1.705 |

## 9.3 Redacted Grouping of Firms

A separate group was constructed from firms who issued stock options, although not during the financial crisis (late August 2007 to July 2009). For this dataset, AAR-1 was significant (at the 10% significance level) in the T-Test while CAAR was the only significant result from the Patell Z Test at 5%.

## 9.4 Patell Z Test Equations

$$s_i^2 = \frac{\sum_{\tau=1}^{T} \hat{\epsilon}_{i\tau}^2}{T-2} \quad (Equation\ 10),$$

$$C_{it} = 1 + \frac{1}{T} + \frac{(Rm_t - \overline{Rm})^2}{\sum_{\tau=1}^{T} (Rm_\tau - \overline{Rm})^2} \quad (Equation\ 11),$$

$$\overline{Rm} = \frac{1}{T} \sum_{\tau=1}^{T} Rm_\tau \quad (Equation\ 12),$$

$$V_{it} = \frac{u_{it}}{s_i\sqrt{C_{it}}} \quad (Equation\ 13),$$

$$W_{iL} = \sum_{t=1}^{L} \frac{u_{it}}{s_i\sqrt{LC_{it}}} \quad (Equation\ 14),$$

$$Z_{vt} = \frac{\sum_{i=1}^{n} V_{it}}{\left(\sum_{i=1}^{n} \frac{T_i-2}{T_i-4}\right)^{\frac{1}{2}}} \quad (Equation\ 6),$$

$$Z_{wL} = \frac{\sum_{i=1}^{n} W_{iL}}{\left(\sum_{i=1}^{n} \frac{T_i-2}{T_i-4}\right)^{\frac{1}{2}}} \quad (Equation\ 7),$$

$$U_{it} = \frac{u_{it}^2}{C_{it}s_i^2} * \frac{T_i-4}{T_i-2} \quad (Equation\ 15),$$

$$Z_{Ut} = \frac{\sum_{i=1}^{n} (U_{it}-1)}{\left(\sum_{i=1}^{n} \frac{2(T_i-3)}{(T_i-6)}\right)^{\frac{1}{2}}} \quad (Equation\ 8),$$

Where:

$s_i^2$ is the variance of the regression residuals during the estimation window for firm i,

τ refers to a day during the estimation window,

$T$ is the number of days in the estimation window,

$\hat{\epsilon}_{i\tau}^2$ is the square of the residual for firm i and day τ,

$C_{it}$ is the increase in variance due to prediction outside the estimation window for firm i and day t,

$V_{it}$ is the normalised prediction error for firm i and day t,

$u_{it}$ is the prediction error for firm i and day t,

$W_{iL}$ is the normalised cumulative prediction error for firm i,

$L$ is the number of weeks accumulated,

$Z_{vt}$ is the statistic for V day t,

$Z_{wL}$ is the statistic for W,

$U_{it}$ is an approximately unit normal variate for firm i and day t

$Z_{Ut}$ is the statistic for U,