ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics
Master Thesis Financial Economics

The Opportunistic Timing of Share Repurchases Around Stock Option Grants To Company Executives

L.A.C. de Jong (387090)

October 2019

Abstract

Companies repurchase their shares for several reasons, on average leading to a positive share price effect. This research investigates the potential opportunistic timing of open-market share repurchases around at-the-money stock option grants to company executives. The relation between stock option grants and share repurchase activity is tested using ordinary least squares and logistic regression models after successfully establishing a matched panel dataset. The results show that companies significantly increase their share repurchase activity around stock option grants, supporting the anti-dilution and stock option funding theory. The CEO, CFO and CIO effectively time company share repurchases opportunistically for their private benefits by postponing the significant increase in share repurchases until after receiving at-the-money stock options. This prevents the price increasing effect to inflate the exercise price of their at-the-money granted stock options. Executives other than the CEO, CFO and CIO seem to be unable to time share repurchases opportunistically, as the share repurchase activity is significantly increased both before and after receiving at-the-money stock options. This paper reveals a new form of agency problem. The opportunistic timing is expected to be costly for shareholders and therefore additional restrictions are needed.

Keywords: Share repurchases, stock option grants, market timing, agency problems
JEL classification: G30, G32, G35

Supervisor: Dr. S. Obernberger
Second Assessor: To be Determined

Contents

List of Figures

List of Tables

1. Introduction

In 1982, the Securities and Exchange Commission (SEC) implemented Rule 10b-18, allowing companies to repurchase their shares without risking to violate anti-fraud regulations. Companies repurchase their shares in the open-market, through tender offers or by negotiating private deals. Apart from the two years following the financial crisis of 2008, the total annual dollar value of the shares companies repurchase has been growing since this new regulation. Between 2007 and 2016, S&P 500 companies on average spent 54% of their profits repurchasing their own shares (Egan, 2018). In 2018, the total value of all shares repurchased by S&P 500 firms reached a new all-time high of $806.41 billion, partly as a result of the reduction in the corporate tax rate from 35% to 21% by the Trump administration in 2017 (Knott, 2019; PRNewswire, 2019).

Many academics have devoted research on companies repurchasing their shares, and conclude that companies repurchase their shares for several, non-mutually exclusive, reasons. Among others, Ikenberry, Lakonishok, and Vermaelen (1995) show that companies repurchase their shares to signal share undervaluation. Jensen (1986) finds that share repurchases mitigate the free cash flow problem and DeAngelo and Masulis (1980) suggests that share repurchases help companies to attain their preferred capital structure. Moreover, share repurchases could prevent hostile takeovers (Bagwell, 1991). Finally, companies repurchase their shares to offset the dilutive effect of stock option exercises or to fund these exercises (Kahle, 2002; Bens, Nagar, Skinner, & Wong, 2003). Except for the use to prevent hostile takeovers, actual share repurchases generally lead to positive price effects caused by the information component and an increase in demand (Dann, 1981; Ikenberry, Lakonishok, & Vermaelen, 2000; Zhang, 2005; McNally, Smith, & Barnes, 2006). As prior research shows, companies have many reasons to repurchase their shares. However, the price increasing effect of share repurchases might have consequences as well. In this empirical research, I investigate whether company executives time share repurchases to exploit the price increasing effect for their private benefit. This potential self incentivized market timing of share repurchases to maximize private wealth is denoted as opportunistic timing throughout this paper. This research focuses on the potential opportunistic timing of share repurchases when executives receive stock options of the company.

Smith Jr and Watts (1992) and Core and Guay (1999) argue that companies compensate their executives with stock options to stimulate executives to maximize the long-term value of the company, alleviating agency problems. Equity stakes allow executives to share in the benefits when the value of the company increases. Moreover, stock option grants can substitute cash salaries or serve as additional bonus compensation. The value of stock options is mainly driven by the current share price and the exercise price of the stock option. Stock options are granted at-the-money when the exercise price is equal to the share price at the moment of granting. The stock option holder in this case can buy a share of the company in the future for the current market price. When the exercise price is below or exceeding the market price, stock options are considered to be granted respec-

tively in-the-money and out-of-the-money. Considering the price increasing effect of actual share repurchases, executives have an incentive to opportunistically time the moment of the share repurchases when receiving at-the-money stock option grants. By decreasing the share repurchase activity prior to receiving stock options, they prevent the share repurchases to inflate the exercise prices of their stock options. On the contrary, executives might increase the share repurchase activity after receiving stock options, pushing their stock options in-the-money. This would allow them to maximize their payoff when exercising their stock options and selling the shares afterwards. The corresponding research question of this study is formulated as: **Do executives opportunistically time company share repurchases when receiving at-the-money granted stock options?**

The potential relation between stock option grants and company share repurchases is worthwhile to investigate. Stock options are granted to alleviate agency problems, however, might give the rise to new agency problems instead. The opportunistic timing of share repurchases is expected to be costly for both the company and its shareholders, as companies deviate from their optimal share repurchase activity for short-term price concerns. Executives might act in their own interest instead of that of the company. When managers indeed pursue private wealth maximization at the expense of companies and its shareholders, restrictions on the ability for the executives to make these myopic decisions are preferable. This research is therefore not only relevant to shareholders, as government regulators might need to expand current insider trading regulations if executives indeed exploit their knowledge of the share price.

The opportunistic timing of share repurchases has is investigated by prior research. Fried (2001) is the first to address the managerial opportunism theory, suggesting that executives pursue private wealth maximization when announcing open-market share repurchases. The theory suggests that executives announce share repurchases to signal undervaluation both when the shares are undervalued and when they are not. The price increasing effect of the (false) undervaluation signal allows executives to maximize their payoff when selling a substantial portion of their shares of the company. The author argues that this explains why companies do not commit to their announced share repurchase programs, as repurchasing overvalued shares would be value destroying. Stephens and Weisbach (1998) show that many companies announce repurchases they never actually repurchase. Furthermore, it would be less likely for executives to sell their shares if the shares in fact are undervalued, as suggested by the share repurchase announcement. However, a vast amount of research finds an increase of company insiders selling their shares of the company following company share repurchases (Pettit, Ma, & He, 1996; Louis, Sun, & White, 2010; Bonaime & Ryngaert, 2013). Busch and Obernberger (2016) suggest that share repurchases allow executives to sell their shares closer to their fundamental value, as share repurchases increase the price efficiency when shares are undervalued. However, executives might use share repurchases to push the share price beyond its fundamental value to create favorable trading conditions, at the expense of other shareholders. Edmans, Fang, and Huang (2018) and Moore (2018) find evidence supporting the managerial opportunism theory using actual share repurchases. Both studies show that companies increase

the volume and frequency of shares repurchases when executives' stock options vest, a proxy for stock option exercises. This allows executives to maximize their payoff when selling their shares. The share repurchases associated with vesting equity lead to negative returns in the two years following the repurchases, implying that the short-term share price increase is value destroying in the long run.

The potential opportunistic timing of actual share repurchases around stock option grants is not yet covered in detail. Dittmann, Keusch, and Obernberger (DKO, 2019) investigated the potential opportunistic timing of company share repurchases around stock option grants to the CEO of the company. They conclude that companies significantly decrease their share repurchase activity in the three months prior to granting stock options, when compared to the share repurchase activity in the normal period. Company share repurchase activity is measured in the number of shares repurchased, the dollar value of the shares repurchased and the likelihood that a share repurchase will occur. The normal period consists of the sixth to fourth month preceding the stock option grant, months in which the share repurchase activity is expected to be unaffected by the grants. By decreasing the share repurchase activity prior to receiving at-the-money stock options, CEOs avoid the share price increasing effect of share repurchases to inflate the exercise price of their stock options.

In this research, I first reconstruct the research conducted by DKO (2019). I find similar results when reconstructing their research. Share repurchase activity is significantly negatively related to stock option grants in the months preceding the grants. Thereafter, I use an improved panel dataset and refined research design to test the relation between share repurchases and stock option grants. The three main differences comprise (*i*) the inclusion of stock options granted to the CFO and CIO of the firm, (*ii)* the reduction of both the normal and pre period to only two months instead of three, and (*iii)* the allowance of non-overlapping stock option grant windows only. The improvements in research are necessary to find the true relationship between share repurchases and stock option grants, and the differences lead to striking differences in results. In a panel dataset from 2006-2010 consisting open-market share repurchases, I use the propensity score matching procedure to match months in which stock options are granted, to months in which there are not. The propensity a stock options would have been granted, however, is similar. This allows for comparison in share repurchase activity. Only stock options granted to the chief executive officer (CEO), chief financial officer (CFO) and the chief investment officer (CIO) of the company are of interest, as these executives are considered to have discretion over the company's share repurchase activity. These executives are therefore denoted as *empowered* executives. Besides the CEO and CFO, the two highest ranked executives, the CIO is considered to be empowered to alter the share repurchase activity, as share repurchases are classified as investment decisions (Dann, 1981; Ikenberry et al., 1995).

Using ordinary least squares and logistic regression models, I show that the share repurchase activity of treatment companies is significantly positively related to the value of stock options when scaled to executives' total cash salary. This measure proxies for the fraction of the executives' compensation paid in stock options and shows that companies

increase their share repurchase activity when granting more stock options. This supports the anti-dilution and stock option funding theories as suggested by Kahle (2002) and Bens et al. (2003). I include proxies for company size, growth opportunities, free cash flow problems, cash restraints and share undervaluation to control for other explanation for companies to repurchase their shares. Furthermore, I find that treatment firms significantly increase their share repurchase activity in the three months following stock option grants. More specifically, companies increase the amount of share repurchases as percentage of the total number of shares outstanding by 0.0477 percentage points. This magnitude is of economic significance given that companies on average repurchase 0.176% of their shares each month. The share repurchase activity in the pre period is not significantly different from the normal share repurchase activity.

The conclusion of this research is that executives seem to opportunistically time share repurchase activity by postponing the increase in share repurchase activity for anti-dilution and stock option funding reasons until after the stock option grants. This would prevent share price increases of share repurchases to inflate the exercise prices of the stock options. To verify this conclusion, I investigate the share repurchase activity around stock option grants to non-empowered executives. These executives have no discretion over the share repurchase activity and therefore are unable to time share repurchase activity. I find a significant increase in both the months preceding and following stock option grants. The difference allows me to draw two main conclusions. First, companies significantly increase their share repurchase activity both before and after granting stock options to their executives, to prevent dilution and fund stock option exercises. Secondly, empowered executives opportunistically time this increase in share repurchase activity by postponing the share repurchases until after they have received their stock options. This allows them to prevent the share price increasing effect of share repurchases to inflate the exercise price of their at-the-money granted stock options. Non-empowered executives have no power to postpone the increase in share repurchase activity before to receiving their stock options.

The direction of the relation between stock option grants and share repurchase activity is verified by separating stock option grants in scheduled and unscheduled grants. It could be that executives time stock option grants instead. However, the findings confirm the causality of the relation as initially suggested as there is a significant relation between share repurchase activity and both scheduled and unscheduled grants. If executives would be timing stock option grants, there would be no relation for scheduled grants as executives would not be able to time stock options that are already scheduled. Executives therefore time share repurchases opportunistically around stock option grants, and not the other way around.

I contribute to the existing literature by using an improved panel dataset and refined research design, allowing for more accurate research. Extensive data preparation allowed for thorough research leading to striking new insights. By implementing the differences compared to prior research one by one, I conclude the differences in outcome can mainly be devoted to the allowance for non-overlapping stock option grant windows only. The other differences increase the robustness of my conclusions. As far as I know, my research is the

first to conclude that executives having discretion over the company's share repurchase activity actively time share repurchases opportunistically by postponing share repurchases until after they receive at-the-money stock option grants. Shareholders and government regulators should be aware of this agency problem and restrict the ability for executives to alter the share repurchase activity around stock option grants. Further research should investigate the associated costs of the opportunistic timing, which is beyond the scope of this research.

The remainder of this paper proceeds as follows. In Chapter 2, I discusses prior research in detail and develop the hypotheses of this research. Chapter 3 describes the data selection and panel dataset construction procedure needed. Continuing, Chapter 4 outlines the research design I use in this research, allowing me to investigate changes in share repurchase activity. Chapter 5 presents the findings of this research and provides answers to the hypotheses. Finally, in Chapter 6 I draw conclusions when answering the research question.

2. Theoretical Framework

In this chapter, I discuss literature relevant for this research. First, the emergence and execution methods of share repurchases are explained. Prior research shows that companies repurchase their shares for several non-mutually exclusive reasons. Thereafter, I explain the use of stock options to compensate executives and introduce the theory behind potential timing of share repurchases around these stock option grants. Finally, I will present the hypotheses that will be tested in this research.

2.1 Literature Review

2.1.1 Share Repurchases in Practice

In dollar value, shares are primarily repurchased in high-tech industries such as the chemical, machinery and computer equipment, finance and insurance, and electronics industry. However, correcting for industry sizes, share repurchases are most common for companies concerned with tobacco products, printing and publishing, and food and kindred products (Kahle, 2002). Companies can repurchase their shares in the open-market, through tender offers or with privately negotiated deals. Most common are the open-market repurchases, in which the company repurchases shares in the open-market for market prices, either directly or through intermediaries. Comment and Jarrell (1991) argue that it could last several months or even years before the company repurchased the desired amount of shares within the preferred price range. Alternatively, the company could persuade shareholders to sell their shares to the company, by offering a premium over the market share price. These so called tender offer share repurchase programs generally consist of a specified number of shares the company is planning to repurchase, the price the company offers for each share, and the period of time during which the offer is in effect. In a fixed-price tender offer program, the company offers a fixed premium to all shareholders, after which shareholders can decide whether they wish to participate in the program and sell their shares to the company. To keep the premium over the market price to its minimum, the company could initiate a Dutch-auction tender offer program instead. In this program, shareholders determine what price should be offered for the shares, in order to repurchase the desired amount of shares. Shareholders willing to participate in the Dutch-auction tender offer program first disclose their minimum acceptable ask-price. After sorting these prices from low to high, shares are summed starting at the lowest price until the cumulative number of shares equals the number of shares the company wishes to repurchase. The price corresponding to the shares added last to fulfill the program is appointed as the offer price, which is offered to all participating shareholders. The included premium of a Dutch-auction tender offer is lower than the premium offered in a fixed-tender offer, as for the prior, the tender price is determined by the lowest acceptable ask-prices of participating shareholders. Both fixed-price and Dutch-auction tender offer

programs are usually completed within one month (Kamma, Kanatas, & Raymar, 1992). If the number of shares the company wishes to repurchase is not met when the program expires, the company can decide to extend the repurchase program. On the contrary, if the number of tendered shares exceeds the initiated maximum, the company is obligated by SEC regulation to repurchase from all tendering shareholders on a pro rata basis (Berman, 1987). Privately negotiated share repurchases, lastly, are the least common. The deals are typically of substantial size, often involve a large shareholder and can be initiated by both the shareholder and the company. Either a premium or a discount is paid, dependent on who was the initiator of the deal and the reason for the share repurchase (Dann, 1981; Vermaelen, 1981). This research focuses on actual open-market share repurchases. First of all, data limitations restrict the possibility to include tender offer or Dutch auction share repurchase programs. Furthermore, the price effect of the the latter two depends on the motivation for the share repurchases and the credibility of the conveyed information, as explained in the subsequent section. Lastly, actual share repurchase programs are preferred as Stephens and Weisbach (1998) show that companies often do not actually repurchase the shares they announce to repurchase.

2.1.2 The Reasoning Behind Share Repurchases

Last decades, a vast amount of literature has investigated the different reasons for companies to repurchase its shares. The various reasons for share repurchases need to be accounted for when investigating the relation between share repurchases and stock option grants. Considering the semi-strong efficiency of capital markets and information asymmetry between company executives and investors, shares are not always priced correctly. In contrast to investors, executives of the company are expected to have superior knowledge about the true value of the company. Share repurchases convey positive information, revealing executives' believes about future prospects and signals that the shares are currently undervalued. This is referred to as the signaling hypothesis (Vermaelen, 1981; Ikenberry et al., 2000; Peyer & Vermaelen, 2008). Share repurchases are perceived to increase price efficiency and reduce idiosyncratic risk when share prices decrease below their fundamental values (Busch & Obernberger, 2016). By actively trading the shares themselves, executives reveal information regarding the underlying company and increase the liquidity of the stock. Signaling undervaluation leads to an increase of the share price as investors rectify their valuations based on the new information (Dann, 1981; Lakonishok & Vermaelen, 1990; Comment & Jarrell, 1991; Ikenberry et al., 1995). The positive price impact depends on the perceived credibility of the undervaluation signal, determined by the financial implications of falsely signaling undervaluation. The credibility is therefore positively related to the premium offered and the amount of shares repurchased, as repurchasing overvalued shares with a premium would be value destroying. Tender offer share repurchases are therefore more effective when signaling undervaluation. Furthermore, the credibility of the signal is fueled by the degree of management ownership and managers buying shares concurrently with share repurchases, as managers have their skin in the game by putting their private money at risk (Comment & Jarrell, 1991; Fried, 2000;

Babenko, Tserlukevich, & Vedrashko, 2012).

Moreover, companies repurchase their shares to payout free cash flows; cash in excess of the amount of cash needed to fund all positive net investment opportunities. To mitigate agency problems arising from free cash flows, the company can decide to distribute the excessive cash among shareholders, most commonly through a share repurchase or a dividend payment (Jensen, 1986). Share repurchases and dividend payments can be seen as substitutes. The permanence of the generation of the excessive cash partially determines what payout method is preferred. An increase of the dividend payments indicates that the generation of the free cash flows are expected to stick in time, as dividend payments are generally periodically recurrent. However, cash flows could be rather volatile, leading to transient or just one-off free cash flows. By repurchasing shares, the management can distribute cash in a more flexible matter without committing to future cash payments to shareholders (Grullon & Ikenberry, 2000; Guay & Harford, 2000; Jagannathan, Stephens, & Weisbach, 2000). Besides, share repurchases have a tax advantage over dividends when shareholders are not tendering in the share repurchase. Whereas the ownership of non-tendering shareholders is pro-rata increased and no direct capital gain is realized, shareholders receive cash when dividend is distributed. Dividends are to their full amount subjected to the income tax upon receiving. Shareholders not tendering in the share repurchase, in contrast, deter their tax payment until selling their shares. Moreover, the capital gain tax falls below the income tax rate (Dann, 1981). Share repurchases, lastly, are preferred by executives holding non-dividend protected stock options. This implies that the exercise price is not proportionally decreased if the dividend payout causes a share price decrease (Fenn & Liang, 2001).

Furthermore, share repurchases could be used to meet earnings per share (EPS) forecasts, as the EPS automatically increases when shares outstanding decrease, ceteris paribus. The probability of a share repurchase is substantially higher for companies that would have missed the EPS forecast without the repurchase, compared to companies that just beat this forecast (Almeida, Fos, & Kronlund, 2016). In line with this theory, companies tend to repurchase their shares to alleviate the dilutive effect when stock options are exercised (Bens et al., 2003; Hribar, Jenkins, & Johnson, 2006). Stock options are considered to be dilutive upon exercising when their exercise price is below the market price of the corresponding shares. Kahle (2002) supports this theory and besides suggests that companies repurchase their shares to fund stock option exercises, referred to as the stock option funding hypothesis. She finds that companies announce share repurchases when their executives have large amounts stock options outstanding and when employees have large amounts of exercisable stock options. The size of the actual share repurchase is positively related to the number of exercisable stock options of all employees, but independent of the stock options held by the executives.

Companies also repurchase its shares in an effort to alter the capital structure. The leverage ratio increases when a company repurchases its shares, as equity flows out of the company. This effect intensifies when share repurchases are financed with new issued debt. The optimal capital structure is obtained when the marginal benefits and the marginal

costs of debt and equity are in equilibrium, maximizing the firm's market value (DeAngelo & Masulis, 1980). Companies that engage in a share repurchase, often have lower leverage ratios than their industry peers. Allowing the industry average to represent the optimal leverage ratio, one could say that share repurchasing companies have a lower debt ratio than optimal (Vermaelen, 1981; Dittmar, 2000; Lie, 2002).

Finally, Bagwell (1991) argues that share repurchases could serve as an instrument to thwart hostile takeover attempts. A share repurchase increases the ownership and the average share valuation of shareholders, ceteris paribus. Shareholders have heterogeneous valuations of the company. The shareholders tendering in the share repurchase program are automatically those with the lowest company valuation, leaving the ones with a higher valuation behind. This could successfully fend off the acquirer. However, this takeover defence is rather costly, as companies have to compete with the acquirer for the same shares and therefore, non-justified premiums might be needed. Dutch-auction tender offers minimize the cost of repurchasing shares to prevent a takeover, as the premium is kept to its minimum (Persons, 1994). Nonetheless, Denis (1990) shows that the announcement of a defensive share repurchase has a significant negative effect on both the target shareholders' wealth and the share price. By focusing on open-market share repurchase programs in this research, I automatically exclude programs initiated to prevent hostile takeovers, as open-market share repurchases would be ineffective for this purpose. Open-market share repurchase programs are used for all other motivations for companies to repurchase its shares, leading to positive price effects (Lakonishok & Vermaelen, 1990; Comment & Jarrell, 1991; Ikenberry et al., 1995; Dittmar & Field, 2015).

2.1.3 Stock Option Grants to Company Executives

Executives are compensated in company equity for a number of reasons. Similar to share repurchases, stock options and other equity-based compensation methods are used to mitigate agency problems arising from the shareholders' inability to monitor the executives properly. Equity-based compensation aligns shareholders' and executives' incentivizes to pursue net profitable investment opportunities and to maximize the long-term value of the company (Demsetz & Lehn, 1985; Jensen & Murphy, 1990; Smith Jr & Watts, 1992; Core & Guay, 1999). Core and Guay (1999) developed a cross-sectional model for the optimal level of equity, denoted as equity incentives. A deviation from the optimal level of equity incentives is reflected as a residual in their regression model. Companies use grants of shares and stock options to adjust the executive's equity portfolio towards the optimal level. Equity incentives are defined as the sensitivity of the executive's equity portfolio to changes in firm value, measured as the dollar value change of shares and stock options held by the executive, caused by a 1% change in share price.

Moreover, Yermack (1995) and Dechow, Hutton, and Sloan (1996) find a positive relation between the use of stock option compensation and cash constraints of the company. Stock options serve as a substitute for cash salaries, as stock options require no immediate cash payout. Furthermore, stock options are used to reward executives for company performance (Mehran, 1995; Baber, Janakiraman, & Kang, 1996; Frye, 2004). These stock

options are generally granted at-the-money. As mentioned already, this implies that the exercise price of the stock option is equal to the current share price. Recipients are allowed to exercise the stock option when stock options vest. Vesting schemes are either performance based or time based. Whereas performance based stock options vest when certain performance thresholds are met, time based stock options vest after a prespecified time period. However, stock options are also granted without vesting requirements. Due to limitations on the

2.2 Timing of Share Repurchases Around Stock Option Grants

Numerous studies proclaim that companies successfully time the market when executing share repurchase programs. Dittmar and Field (2015) show that companies succeed in repurchasing its shares when prices are significantly below the average share price. This implies that executives of the company effectively time the market when executing their share repurchase programs. Previous research already shows that executives not only time share repurchases for the benefit of the company. As mentioned earlier, Edmans et al. (2018) and Moore (2018) show that executives allegedly boost the share price by repurchasing shares allowing for payoff maximization when selling their equity of the company. Fried (2005) contemplates that share repurchases could be used to falsely signal the share price is undervalued. DKO (2019) raises the question if the CEO of the company times open-market share repurchases for his private benefits. Opportunistic timing of share repurchases would allow them to exploit the price increasing effect. Considering the positive price impact of share repurchases, executives prefer a decrease in share repurchase activity prior to receiving at-the-money stock options. The authors indeed find that companies are 1.1% less likely to repurchase their shares in the three months preceding stock option grants. Inspired by DKO (2019), I investigate the relation between share repurchases and stock option grants in more detail. For the remainder of this paper, I refer to share repurchases as actual open-market share repurchases, and stock options are considered to be granted at-the-money. The research focuses on at-the-money granted stock options only, as share repurchases are assumed not to be affecting the exercise price of in-the-money and out-of-the-money granted stock options. This implies that timing share repurchases around these types of stock options has no effect. As mentioned earlier, the CEO, CFO and CIO are considered to be empowered to alter the share repurchase activity and therefore have the opportunity to time share repurchases opportunistically for their private benefit.

2.3 Hypothesis Development

Executives have an incentive to control the sequence of both share repurchases and stock option grants. I develop six hypotheses in order to investigate whether empowered executives opportunistically time share repurchase activity. Similar to DKO (2019), I expect empowered executives to decrease company share repurchase activity prior to stock option grants. This would avoid an increase of the share price and a simultaneous increase of the

exercise price of the stock options. The share repurchase activity prior to stock option grants is compared to the share repurchase activity in a normal period. This normal period is considered not to be affected by the stock option grant and is discussed in further detail in Section 3.1.2. The first hypothesis is denoted as:

H_1: The share repurchase activity in the months preceding stock option grants is significantly lower compared to the share repurchase activity in the normal period.

Following stock option grants, I expect companies to increase the share repurchase activity. If the share repurchase activity is indeed decreased prior to stock option grants, companies might want to make up for this. Furthermore, executives have an incentive to increase share repurchase activity, as the share price increasing effect will push their stock options in-the-money. This would allow them to maximize their payoff upon selling the shares after exercising the stock options, as suggested by Edmans et al. (2018) and Moore (2018). Lastly, following Kahle (2003) and Bens et al. (2003), companies could increase their share repurchase activity to fund stock option exercises and to compensate for their value diluting effect. By timing the share repurchases until after the stock option grant, again, the positive share price effect is postponed until after receiving the stock options. This implies that there are multiple explanations for companies to increase their share repurchase activity. Research will determine what explanation is most likely. My second hypothesis postulates:

H_2: The share repurchase activity in the months following stock option grants is significantly higher compared to the share repurchase activity in the normal period.

The intensity of the relation between stock option grants and share repurchase activity is expected to be stronger when executives receive more stock options. The fraction of their total compensation received in stock options determines the exposure to changes in the share price and therefore the executives' incentive to change the share repurchase activity opportunistically. Opportunistic timing of share repurchases will have more impact when executives are exposed to the share price to a greater extend. Due to data limitations and inconsistencies in the reported measure for executives' total compensation, cash salary is used as proxy instead. The proportion of total compensation received in stock options is therefore measured as the fair value of the granted stock options, scaled by the executives' cash salary. The measure is denoted as the *compensation proportion* measure and is expected to be negatively related to the share repurchase activity in the months preceding stock option grants. Similar to the reasoning behind the first hypothesis, the relation is expected to be negative as I assume that empowered managers opportunistically time share repurchases to prevent the share price to increase before receiving stock options. Share price increases would simultaneously inflate the exercise price of the stock options. I formulate the third hypothesis as:

H_3: The compensation proportion measure has a significant negative effect on the

share repurchase activity in the months preceding stock option grants.

The opposite relation is expected with respect to the share repurchase activity in the months following stock option grants. Following stock option grants, I expect the relation to be significantly positive. Similar to the second hypothesis, the positive relation can be explained by the executive's incentive to increase share prices, to fund stock option exercises and in order to compensate for their dilutive effect. Empowered executives are expected to opportunistically time these share repurchases until after receiving the stock options. Although research needs to determine what explanation is the most appropriate, an increase in share repurchase activity is the expected result in all cases. Therefore, the fourth hypothesis posits:

H_4: The compensation proportion measure has a significant positive effect on the share repurchase activity in the months following stock option grants.

I perform two robustness checks to rule out causality problems and validate my results. Until now, executives are expected to time share repurchases around stock option grants. However, the direction of this relation could be questioned. Alternatively, stock option grants might be timed around share repurchases instead. When executives would time stock option grants prior to share repurchases, they similarly exploit the price effect as the price increasing effect would be avoided. The causality of the relation is examined by investigating the share repurchase activity around both scheduled and unscheduled stock option grants. Empowered executives cannot opportunistically time scheduled stock option grants. Stock options are considered to be scheduled when in the preceding year, stock options are granted to the same executive in a 7-day window. If executives indeed time stock option grants around share repurchase activity, a significant relation is only expected between share repurchase activity and unscheduled stock option grants. However, if the relation between share repurchase activity and both scheduled and unscheduled grants is significant, there is no reason to question the causality of the relation. I expect share repurchases to be timed around stock option grants and not the other way around. This implies that the relation between share repurchases and scheduled stock option grants should not be significantly different compared to the relation between share repurchase activity and unscheduled stock option grants. The hypothesis that will be tested:

H_5: The relation between share repurchase activity and stock option grants is significantly different between scheduled and unscheduled stock option grants.

To validate the results and draw conclusions correctly, I test the share repurchase activity around stock option grants to non-empowered executives. Only empowered executives are expected to be able to opportunistically time share repurchases, as they are considered to be the only ones having discretion over the share repurchase activity. The relation between share repurchase activity and stock options grants to both empowered and non-empowered executives will be compared. Differences between the relations of em-

powered and non-empowered executives and share repurchase activity would imply that empowered executives effectively change company share repurchase activity. If the relation is not different, the question whether empowered executives opportunistically time share repurchases, would remain. I formulate the last hypothesis as:

H_6: The relation between share repurchase activity and stock option grants to non-empowered executives is significantly different in the months preceding the grants and the months following the grants.

3. Data

The following chapter covers the composition of the cross-sectional time-series dataset, i.e., panel dataset, on firm-month level. Data is obtained from multiple databases and tailored to my needs. Thereafter, I identify the *treatment group* following a careful selection procedure. The treatment group consists of months in which stock options are granted. The propensity score matching procedure is used to select a *control group*; months in which no stock options are granted. Finally, detailed descriptive statistics are provided to determine whether the matching procedure was successful.

3.1 Panel Dataset Composition

3.1.1 Data Sources

From March 2004, the SEC requires companies listed in the United States to disclose detailed information about their share repurchase activity in their quarterly and annual statements. This information includes the amount of shares repurchased and the average share price paid. However, the accessibility of this information through the available channels is limited. Therefore, the hand-collected and manually checked dataset used in the research conducted by DKO (2019) will thankfully be used in this research. The dataset consists of the actual monthly open-market share repurchase activity from October 2003 to January 2011, retrieved from the 10-Q and 10-K filings of 2,901 different companies traded on the New York Stock Exchange (NYSE), American Stock Exchange (AMEX) and the National Association of Securities Dealers Automated Quotations (NASDAQ).

The Standard & Poor's (S&P) ExecuComp database, accessible via Compustat, provides data regarding the compensation of S&P 1500 firms' top five executive officers, including stock option grants from 2006 onward. For each stock option grant, I gather the grant date, the number of granted stock options, the fair value of the stock options and the corresponding exercise price and market price. In most literature, stock options are valued using the Black-Scholes valuation model[1] (Yermack, 1995; Core & Guay, 1999). However, not all necessary data to compute this valuation is available. Accounting standard FAS 123R requires companies to expense the fair value of stock option grants on their financial statements in order to reflect the economic transaction between a company and the recipient of the stock option grant. The fair value of the stock option grant will be used as an alternative for the Black-Scholes valuation.

Fundamental company information is obtained from Compustat (Capital IQ). The gathered information consists of the Standard Industry Classification (SIC) code and items filed in the companies' income statements, balance sheets and cash flows state-

[1] The Black-Scholes valuation of stock options is determined by the market interest, the current price of the underlying stock, the share price volatility, the stock option's exercise price and the date that the stock option expires (Black & Scholes, 1973).

ments. Lastly, the Center for Research in Security Prices (CRSP) provides information regarding daily share prices and stock holding returns.

3.1.2 Sample Selection

Stock option data is available from January 2006, whereas share repurchase activity is available until January 2011. However, the share repurchase activity in January 2011 seems to be incomplete compared to other months. The panel dataset is therefore established from January 2006 until December 2010. This initial panel data set consists of 141,764 firm-months of 2,607 unique companies. Companies and corresponding firm-months are excluded from the panel dataset, when data is missing. Panel A of Table I gives a detailed account for the first sample selection, described hereafter.

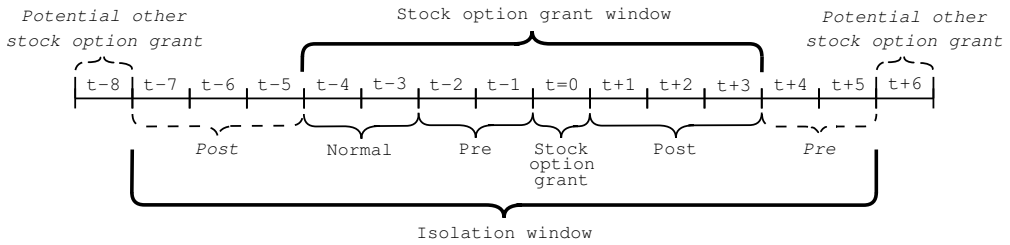
A large amount of firm-months is eliminated because data from Compustat or ExecuComp is missing or incomplete. Thereafter, companies with fiscal year-end months other than December are excluded. Both share repurchase activity and stock option grant behavior are expected to be different around fiscal year closings and corresponding annual shareholder meetings, compared to other months. Companies tend to revise the equity incentives of their executives using stock option grants, more often around the fiscal year-end (Core & Guay, 1999). When allowing for only one fiscal year-end month, the comparison of share repurchase activity between companies with different fiscal year-end months is prevented. December is the most customary fiscal year-end month. Furthermore, companies available in Compustat for less than twelve months are eliminated from the dataset. Companies meeting this condition either resolve in 2006 or emerge in 2010. Also the firm-months of incomplete years are excluded. Companies disappear from Compustat in the course of the time frame as a result of i.e. bankruptcies, delistings or mergers, whilst first appearances indicate listings instead. For both cases, I expect both share repurchase activity and stock option granting to be different than normal.

In order to prevent coinciding effects of different stock option grants on the share repurchase activity, sufficient time between two stock option grants is required to qualify for the treatment group. In this research, the share repurchase activity in the two months preceding and three months following a stock option grant will be investigated, as share repurchase activity in these months is expected to be affected. These periods are referred to as the *pre* and *post* period, respectively. The share repurchase activity in the third and fourth month preceding the stock option grant are considered unaffected by the stock option grant and will, therefore, represent the normal share repurchase activity of the company. These months are therefore denoted as the *normal* period. The pre, post and normal period together, are referred to as the stock option *grant window*. Whereas Figure 3.1 further clarifies the grant window, I present evidence for the correctness of the selected time window in Section 3.2.4. Besides the stock option grant window, the *isolation window* is of importance. The isolation window is a 13-month time window surrounding the stock option grant. More specifically, the window stretches from seven months before until five months after the stock option grant. To qualify for the treatment group, no other stock option is allowed in this isolation window, apart from the stock option grant in t=0.

This is needed, as potential post en pre periods of other stock option grants need to be accounted for. Stock options with overlapping stock option grant windows, cannot be used for the analyses. For clarity, a stock option grant in the sixth-month (t+6) after the stock option grant of interest (t=0) does not qualify for the treatment group, as its normal period coincides with a post period of another stock option grant. However, the stock option grant in t=0 in not affected by any pre or post period of other stock option grants. Firm-months are excluded from the dataset when not a single stock option grant has an isolation window meeting the requirements.

Figure I: Stock Option Grant Windows

This Figure visualizes the firm-months of interest surrounding a stock option grant. Each "t" period represents the firm-month with reference to the stock option grant in t=0. The impact of potential other stock option grants are shown for clarification.



Considering the initial 141,764 firm-months and corresponding 2,607 unique companies, respectively 54,258 and 1,590 remain. In 5,971 of these firm-months, stock options are granted by 813 unique companies. In 48,287 months, no stock options are granted. Unsurprisingly, all of the 1,590 companies at least have one month in which no stock options are granted.

3.1.3 Determination Treatment Group and Potential Control Group

The firm-months remaining after the first selection procedure are submitted to additional requirements to determine the treatment and potential control group, as shown in Panel B and Panel C of Table I.

Again, stock options with coinciding grant windows are dropped. These observations are not deleted in the first selection procedure, as the stock option grant windows apparently not overlap for all stock option grants. Moreover, stock options are not be included in the treatment group when granted before August 2006. Stock options granted in December 2005 are expected to affect the share repurchase activity until March 2006. Requiring the pre and normal period to be uncolliding with the post period of a potential stock option grant in December 2005, stock options in the first seven months of 2006 cannot be used. Only a small amount of stock option grants are actually dropped, as stock option grants prior to May did not qualify in the first place. For those stock option grants it was not possible to establish the grant window, as their normal or pre period comprised months in 2005. Data for these months is unavailable. Therefore, the months deleted now

are stock options granted between May and July 2006 only.

Furthermore, stock options not granted at-the-money are excluded, as timing of share repurchases is expected to be only effective when the exercise price is related to the current share price. The so called *moneyness* is determined by comparing the exercise price of stock options to the actual closing share price at the corresponding day, gathered from CRSP. Allowing for small deviations and roundups, stock options are considered to be granted at-the-money when the difference between the exercise price and closing share price is lower than 1% of the closing share price. Stock option grants are aggregated on month level per company. At least one empowered executive is required to be among the recipients to qualify for the treatment group. As discussed, opportunistic timing of share repurchases is otherwise not feasible. The final treatment group contains 713 months of 406 unique companies.

The firm-months without stock option grants are submitted to similar but less criteria, described in Panel C of Table I. The firm-months that remain include the potential control group. For the control group, t=0 represents a placebo event firm-month. No stock options are allowed in the isolation window, as control firm-months are required to represent the share repurchase activity when no stock options would have been granted. Remember that the isolation window extends across 13 firm-months (See Figure I). Furthermore, months before August 2006 are excluded from the potential control group. Again, potential stock option grants in December 2005 could disturb the share repurchase activity of the normal period and pre period, this time considering the control group. The potential control group consists of 4,596 firm-months of 708 unique companies.

3.2 The Matching of Treatment and Control Firm-Months

Treatment months are matched to control months based on similar propensity scores to grant at-the-money stock options to empowered executives. This allows me to isolate the relationship between stock option grants and the company's share repurchase activity, as the matched control group is expected to correctly reflect the share repurchase activity of the treatment group if no stock options were granted, ceteris paribus.

The propensity score is conditional on the variables identified as determinants for stock option grants. The more covariates included in the propensity score matching procedure, the harder it is to find the right match. Bias arises as the bandwidth of the variables needs to be expanded to find control months with common support on all selected variables. On the other hand, when including too few covariates to the model, control months with dissimilar propensities to grant stock options might be selected. Therefore, deciding on the number of variables to include is a trade-off.

3.2.1 Stock Option Grant Determinants

To determine what variables to include in the propensity score matching procedure, I test the predictive power of variables suggested by prior research to be determinants for stock option grants. Companies grant stock options to align shareholders' and executives' long-

Table I: Sample Construction

This table provides an overview of the panel dataset selection procedure. In Panel A, an initial screening identifies months with and without stock option grants. The initial panel dataset is constructed using the share repurchase data. In Panel B and C, the potential treatment and control group are identified using additional criteria. The number of companies reflect unique companies included at least once in the dataset.

Panel A: Sample Selection			
		Observations (months)	Companies
Initial panel dataset		141,764	2,607
Missing Compustat data		-9,913	
Missing ExecuComp data		-31,526	
Fiscal year-end other than December		-36,755	
Company in Compustat for less than one year		-203	
Incomplete years		-2,350	
Overlapping stock option grant windows only		-6,756	
	Remaining	54,261	1,590
	No stock option grants	48,289	1,590
	With stock option grants	5,972	813

Panel B: Potential Treatment Group Determination			
		Observations (months)	Companies
With stock option grants		5,972	813
Overlapping stock option grant windows		-4,367	
Stock option grants before August 2006		-29	
Not at-the-money granted stock options		-740	
No empowered stock option recipients		-123	
	Remaining	713	406

Panel C: Potential Control Group Determination			
		Observations (months)	Companies
Without stock option grants		48,289	1,590
Affected by stock option grants		-43,539	
Observations before August 2006		-154	
	Remaining	4,596	708

term incentives (Demsetz & Lehn, 1985; Jensen & Murphy, 1990; Smith Jr & Watts, 1992; Core & Guay, 1999). Agency problems arising from monitoring costs are decreased when granting executives equity in the firm. Core and Guay (1999) find that stock option grants depend on the executives' current levels of equity incentives. Equity incentives are defined as the sensitivity of the executive's equity portfolio to changes in firm value, measured as the dollar value change of shares and stock options held by the executive, caused by a 1% change in share price. For shares, this sensitivity is straightforwardly measured as 1% of the value of the shares, as the share value has a 1-on-1 relation to the share price. Considering stock options however, this is a little more complicated as the dollar value change depends on the parameters of each individual option contract. The dollar value sensitivity of share options is estimated using the partial derivative of each stock option value with respect to the share price, representing the stock option's delta. To compute the risk-neutral valuation of stock options granted to executives, Core and Guay (1999) use the Black and Scholes (1973) model, modified by Merton et al. (1973) to account for dividend distributions. However, due to data limitations on share option contracts separately, it is impossible to determine the individual deltas necessary to compute the

equity portfolio dollar value sensitivity caused by stock options. Therefore, the sensitivity is based on their shares only, measured as 1% of the dollar value of the shares held by the executive. Baker and Hall (2004) show that the executive's incentives function is concave and decreasingly rising with firm size. The predictive power of the sensitivity of the executive's equity portfolio for stock option grants is tested using the natural logarithm, in an attempt to normalize the distribution. Like many variables in business data, the distribution is heavily skewed to the right. Furthermore, the natural logarithm corrects for heteroskedasticity and outliers, leading to a disproportionate influence on statistical analyses.

Growth opportunities increase monitoring difficulties that lead to agency problems. Companies grant stock options to their executives to incentivize them to pursue the net present value growth opportunities (Smith Jr & Watts, 1992; Core & Guay, 1999). The predictive power of growth opportunities for the use of stock option grants is tested by using the book-to-market ratio and the annual revenue growth in percentages. The book-to-market ratio is winsorized at the 5% and 95% level to reduce the effect of outliers, whereas I use the natural logarithm of the annual revenue growth to control for outliers and heteroskedasticity. Core and Guay (1999) and Himmelberg, Hubbard, and Palia (1999) find a positive relation between free cash flows and executive ownership. Following Lang, Stulz, and Walkling (1991), the free cash flow problem is included in the predictive power test using the three-year average of the difference between the operating cash flow and common and preferred dividends, scaled by total assets. However, when the book-to-market ratio is below one, free cash flows are considered to be absent as sufficient growth opportunities are expected to be available. The measure takes the value of zero when this is the case.

The relation between the firm's size and the amount of stock option grants is determined by testing the predictive power of the natural logarithm of total assets. To test for the relation between the use of stock option grants and companies suffering from cash constraints, a dummy for loss is used as a proxy for cash constraints. Quite self explanatory, the dummy is given a value of one when the company reports a loss in a particular year. Stock option grants require no immediate cash payout and can therefore substitute cash salaries. Moreover, I test the predictive power of the leverage ratio. The costs of debt increases with the amount of leverage in the company. The costs of debt have a disciplinary effect on the executives, as they are bonded to recurring debt payments. Therefore, an increase in the leverage ratio leads to a reduction of the agency problem (Jensen, 1986). A negative relation between the leverage ratio and the use of stock option grants is expected. Lastly, the amount of stock option grants is expected to be positively related to firm performance. Firm performance is measured as the industry adjusted stock performance. This market-based performance measure is computed by subtracting the annual industry return from the company's reported annual stock return. The industry is determined by the company's corresponding two-digit SIC code and the Fama-French 12-Industry Classification System (Fama & French, 1997). The performance measure is winsorized at the 95% level to control for outliers.

3.2.2 Logistic Regression Model

The binominal logistic regression model is used to test for the predictive power of aforementioned endogenous variables on the probability of an at-the-money stock option grant to an empowered executive. All variables used in the logit estimation are lagged, as stock options are expected to be granted because of company characteristics in the prior period. Furthermore, this ensures the causality of the relation between the variables of interest and stock option grants.

To discard unobserved heterogenetic, time-invariant and interindustry differences leading to correlation between the error term and our variables of interest, I control for year-month and industry fixed effects. Demsetz and Lehn (1985) argue that firms operating in noisier industries endure higher monitoring costs. Stock options are expected to be granted more often, as a higher level of executives' ownership is appropriate. Moreover, firms operating in new economies are inclined to grant stock options more often in order to retain their employees (Ittner, Lambert, & Larcker, 2003). Furthermore, stock options are granted less often by companies operating in highly regulated industries (Smith Jr & Watts, 1992; Yermack, 1995). Industries denoted as the finance and utilities industry are determined to be industries with heavy regulations[2]. Standard errors are clustered by firm as they are expected to be not independently and identically distributed which otherwise would lead to heteroskedasticity and autocorrelation. More robust standard errors are obtained when clustering the standard errors. The explanatory power of logistic regression models is quantified by the McKelvey & Zavoina's R-squared, identified by prior research as the best measure when using logistic regression models (Windmeijer, 1995). The adjusted R-squared and McKelvey & Zavoina's R-squared can be interpreted similarly.

The result of the logistic regression are shown in Table II. There is no significant relation between the probability of stock option grants and the leverage ratio, industry adjusted returns and the proxies for the potential free cash flow problem and cash restriction. None of these variables will, therefore, be used in the propensity score matching procedure, except for the industry adjusted return variable. This variable is included anyway, as control firms with similar industry adjusted returns are expected to represent the share repurchase activity of treatment firms better. Similar to DKO (2019), the variables that will be used in the propensity score matching procedure comprise the proxies for the equity incentive level, growth opportunities, firm size and firm performance.

The probability for a stock option grant is positively related to the firm's size, expressed as the natural logarithm of the firm's assets. The effect is statistically significant at the 1% level. The book-to-market ratio has a negative relation, whereas the effect of the revenue growth is positive. This implies that an increase in growth opportunities increases the probability of a stock option grant. This in line with the literature as growth opportunities tend to increase monitoring difficulties (Smith Jr & Watts, 1992; Core & Guay, 1999).

[2] The logit regression model determines that the probability of a stock option grant is smaller for companies operating in the finance industry, compared to the consumer non-durables industry. This difference is statistically significant at the 5% level. This probability is not statistically smaller for the utilities industry

Table II: The Predictive Power on Stock Option Granting

This table provides the results of the logistic regression estimating the predictive power of variables for the probability of an at-the-money stock option grant to an empowered executive in a certain month. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. All variables are defined in Table XIV of the Appendix.

	At-the-Money Stock Option Grant to Empowered Executive
Ln(Assets) $_{t-1}$	0.344***
	(5.73)
Book-to-Market Ratio $_{t-1}$	-0.532*
	(-1.95)
Annual Industry-Adjusted Stock Return $_{t-1}$	0.311
	(0.72)
Ln(Revenue Growth) $_{t-1}$	0.656*
	(1.82)
Ln(Executives' Equity Sensitivity) $_{t-1}$	-0.184***
	(-3.91)
Industry Fixed Effects	YES
Year-Month Fixed Effects	YES
Observations (# Months)	5,309
McKelvey & Zavoina's R-Squared	0.3893

However, both effects are only significant at the 10% level. I find a strong positive relation between the probability of a stock option grant and the executives' equity sensitivity, the proxy for the executives' equity incentives. This is not what I anticipated, as I expect that extra equity incentives would not be effective when an executive is highly exposed to company equity already. As a matter of fact, increasing the exposure even further might lead to risk averse executives instead. The positive relation could possibly be explained as executives with a certain level of equity incentives apparently work at companies that grant stock options more often. As mentioned already, the effect of the annual industry-adjusted stock return, the proxy for stock performance, is not significant.

3.2.3 The Execution of the Propensity Score Matching Procedure

The propensity score matching procedure matches treatment firm-months to control firm-months with the closest propensity score based on the nearest neighbor principle. The propensity score is conditional on the variables identified by the logit estimation as determinants for stock option grants. Treatment months are matched without replacement, which implies that each control observation can be used as a match to a treatment observation only once. Matching with replacement could lead to overrepresentation, when a particular control firm-month is selected multiple times. All treatment firm-months are matched to a control firm-month, resulting in 713 firm-months for both the treatment group and the control group.

Table III provides a descriptive summary of both the treatment and control group. As stock options grants in the months before August 2006 do not qualify for the treatment group, only a small number of treatment months take place in 2006. Stock options are granted the most in the first three months of a year. This endorses my choice to exclude companies with different fiscal year-end months. The finance industry is the dominating industry with the most treatment firm-months. This is not as expected considering the heavy regulation in this industry leading to a significant lower propensity for stock option grants. However, this is explained by the industry distribution of the firm-months remaining after the first sample selection. Out of the 54,282 firm-months remaining, 15,068 (27.8%) belong to companies operating in the finance industry. The observed selection of 162 firm-months for the treatment group is, therefore, only 1.08% of the initial number of firm-months belonging to the finance industry. For other industries, on average 1.39% of the initial firm-months are included in the treatment group. This confirms that stock options indeed are granted less often by firms operating in the finance industry.

Panel B of Table III shows that a company can be included in both the control group and the treatment group at different moments in time. To be specific, 105 companies are included in both the control group and the treatment group. Out of the total of 553 unique companies, 147 companies provide firm-months for the control group only, whereas 301 companies are included in the treatment group only.

The caliper extension is used as a first robustness check to determine whether the matching procedure is successful. The caliper matching add-on is used to avoid low quality matches, by imposing a tolerance level on the maximum difference when comparing the propensity scores between treatment and control firm-months. When for a particular treatment firm-month, no match can be found within the specified propensity score range, the treatment observation will remain unmatched. The implementation of a caliper of 0.25 standard deviation does not lead to a decrease in the number of matches[3]. This gives a first indication of a successful matching procedure.

3.2.4 Mean Comparison

The success of the propensity score matching procedure is tested in more detail by conducting a mean comparison analysis. Panel A of Table IV provides descriptive statistics for the variables used in the propensity score matching procedure. The two-sample t-test shows that there are no significant differences between the means of the treatment group and the control group. The standard deviations of the *Book-to-Market Ratio*, *Ln(Assets)*, and *Ln(Executives' Equity Sensitivity)* are statistically different between the treatment group and control group. This is controlled for by conducting a unequal two-sample t-test for these variables. I conclude that the propensity score matching procedure has effectively selected a control group. The control group's share repurchase activity is considered to be representative for the treatment group's share repurchase activity, if no stock options would have been granted.

[3] A caliper of 0.25 is considered to be an appropriate caliper to find adequate matches without causing inefficiencies and selection bias due to excluding an extensive amount of control firm-months (Cochran & Rubin, 1973; Raynor Jr, 1983)

Table III: Descriptive Summary

Panel A shows the distribution of firm-months over the different years, year-months and industries for both the treatment and control group. Panel B contains information regarding stock option grants included in the treatment group and the distributions of the unique companies between the two groups.

Panel A: Distributions Treatment Group and Control Group					
		Treatment Group		Control Group	
Grant Year		Frequency	Percent	Frequency	Percent
2006		25	3.5	32	4.5
2007		154	21.6	157	22.0
2008		193	27.1	186	26.1
2009		186	26.1	186	26.1
2010		155	21.7	152	19.8
	Totals	713	100	713	100
Grant Month					
January		98	13.7	105	14.7
February		292	41.0	261	36.6
March		99	13.9	116	16.3
April		29	4.1	23	3.2
May		46	6.5	51	7.2
June		19	2.7	18	2.5
July		23	3.2	25	3.5
August		23	3.2	26	3.6
September		10	1.4	14	2.0
October		18	2.5	20	2.8
November		27	3.8	29	4.1
December		29	4.1	25	3.5
	Totals	713	100	713	100
Industry					
Consumer Non-Durables		30	4.2	26	3.6
Consumer Durables		19	2.7	18	2.5
Manufacturing		83	11.6	58	8.1
Oil, Gas, and Coal Extraction and Products		21	2.9	21	2.9
Chemicals and Allied Products		16	2.2	13	1.8
Business Equipment		124	17.4	117	16.4
Telephone and Television Transmission		16	2.2	14	2.0
Utilities		26	3.6	22	3.1
Wholesale, Retail and Services		43	6.0	42	5.9
Healthcare, Medical Equipment, and Drugs		69	9.7	71	10.0
Finance		162	22.6	207	29.0
Other		104	14.6	104	14.6
	Totals	713	100	713	100

Panel B: Descriptive Summary	
Mean female recipients	7.6%
Mean fair value stock option grants (x 1,000)	$ 6,483
Median fair value stock option grants (x 1,000)	$ 3,726
Number of unique companies treatment group and control group combined	553
Number of companies in treatment group only	301
Number of companies in control group only	147
Number of companies in both treatment group and control group	105

Panel B provides descriptive statistics for the different measures of share repurchase activity in the normal period. Share repurchase activity is measured as the natural logarithm of the dollar value of the shares repurchased (*Ln(Repurchase Value)*), the number of shares repurchased scaled by the number of shares outstanding (*Repurchase Volume*), and a dummy indicating the occurrence of a share repurchase *(dRepurchase)*. *Repurchase Volume* is winsorized at the 95% level to correct for outliers and thereafter multiplied by 100 to increase the readability when analyzing the data. The normal period consists of firm-months t-3 and t-4 with respect to the stock option grant or placebo event in t=0 for the treatment group and control group, respectively. There are only 317 and 300 observations available for respectively periods t-3 and t-4 of the control group, as some of the placebo event windows are overlapping. This is allowed, as the share repurchase activity in the control firm-months is not affected by stock option grants. Furthermore, the propensity score matching procedure would be unsuccessful when requiring control group time windows not to coincide. Only a small number of potential control firm-months would remain, leading to significant differences between the matched control group and the treatment group.

Again, the two-sample t-test determines that in the normal period, there are no significant differences in the measures *Ln(Repurchase Value)* and *Repurchase Volume* between the treatment and control group. The Pearson's chi-squared test shows that the number of observations of *dRepurchase* does not significantly differ from expected frequencies. Therefore, I conclude that the normal period consisting of firm-months t-3 and t-4 with respect to the stock option grant or placebo event is considered to be correct.

3.2.5 Reconstruction of Prior Research I: Data

The panel dataset selection procedure differs from prior research in three predominant ways. In their research, DKO (2019) only include stock option grants to the CEO of the company and do not take into account the implications of coinciding stock option grant windows. Stock option grant windows are therefore allowed to overlap. Furthermore, they use a pre and normal period consisting of three months consecutively before the stock option grants. In order to elaborate on potential differences in outcome because of the changes in panel dataset construction and research design, the prior research needs to be reconstructed first. Table XV of the Appendix shows the selection procedure when reconstructing the panel dataset of prior research. Data concerning stock option grants is still gathered from ExecuComp as Equilar is inaccessible. After the selection procedure, 2,362 firm-months remain of 844 unique companies in which at-the-money stock options are granted to the CEO of the company. This is still less than the 8,218 treatment firm-months used in DKO (2019), which can be devoted to the use of ExecuComp instead of Equilar. All firm-months are successfully matched to a control firm-month. Again, the mean comparison analysis shows no differences in the variables used for the propensity score matching procedure.

Table IV: Mean Comparison

Panel A provides descriptive statistics for the variables used in the propensity score matching procedure for both the treatment months and control months. All variables are lagged by one month and the descriptor N reflects the number of months. Two-sample t-tests find no significant differences in the means. Panel B provides descriptive statistics for the different measures of share repurchase activity for both t-3 and t-4, which represents the normal period. Two-sample t-tests find no significant differences in the means of *Ln(Repurchase Value)* and *Repurchase Volume*. Furthermore, the Pearson's chi-squared finds no significant difference in means regarding *dRepurchase*. All variables are defined in Table XIV of the Appendix.

Panel A: Comparison of Propensity Score Matching Variables

	Treatment Group						Control Group						Difference in Mean
	N	Mean	SD	25	Median	75	N	Mean	SD	25	Median	75	(p-value)
Ln(Assets) $_{t-1}$	713	7.957	1.937	6.533	7.823	9.269	713	7.756	2.210	6.277	7.727	9.126	0.069
Book-to-Market $_{t-1}$	713	0.535	0.362	0.284	0.453	0.660	713	0.548	0.366	0.285	0.463	0.713	0.493
Annual Industry-Adjusted Stock Return $_{t-1}$	713	0.007	0.106	-0.046	0.002	0.054	713	0.009	0.107	-0.049	0.002	0.060	0.700
Ln(Revenue Growth) $_{t-1}$	713	0.737	0.180	0.685	0.729	0.770	713	0.731	0.211	0.669	0.727	0.772	0.578
Ln(Executives' Equity Sensitivity) $_{t-1}$	713	5.019	1.728	3.935	5.035	6.197	713	4.993	2.155	3.684	5.225	6.390	0.798

Panel B: Comparison of Share Repurchase Activity

	Treatment Group						Control Group						Difference in Mean
	N	Mean	SD	25	Median	75	N	Mean	SD	25	Median	75	(p-value)
Shares Repurchased / Shares Outstanding $_{t-3}$	713	0.185	0.454	0.000	0.000	0.086	317	0.202	0.511	0.000	0.000	0.033	0.599
Shares Repurchased / Shares Outstanding $_{t-4}$	713	0.163	0.423	0.000	0.000	0.039	300	0.166	0.479	0.000	0.000	0.018	0.921
dRepurchase $_{t-3}$	713	0.290	0.454	0.000	0.000	1.000	317	0.293	0.456	0.000	0.000	1.000	0.708
dRepurchase $_{t-4}$	713	0.275	0.447	0.000	0.000	1.000	300	0.287	0.453	0.000	0.000	1.000	0.917
Ln(Repurchase Value) $_{t-3}$	713	1.737	2.996	0.000	0.000	3.466	317	1.514	2.778	0.000	0.000	2.177	0.262
Ln(Repurchase Value) $_{t-4}$	713	1.627	2.960	0.000	0.000	2.421	300	1.454	2.753	0.000	0.000	1.972	0.388

4. Research Design

The following chapter describes the methodological framework used to test the hypotheses. Multiple regression equations are formulated and the included variables are explained. High over statistical analyses provide an insight of the distributions of the variables and examines their interdependency.

4.1 Statistical Techniques

Two different test are used to determine the effect of stock option grants on share repurchase activity surrounding stock option grants. A simple difference analysis investigates differences in share repurchase activity over time for the treatment group only. Significant results would imply either an increase or decrease in share repurchase activity, compared to another period in time. However, these differences might be time driven. The matched control group is used to conduct a difference-in-difference analysis. This analysis determines whether the difference in share repurchase activity between two periods is significantly different between the treatment and control group.

As described in Section 3.2.4, share repurchase activity is expressed in three different measures; *Ln(Repurchase Value)*, *Repurchase Volume* and *dRepurchase*. The relationship between stock option grants and share repurchase activity is estimated using regression analyses. Regression techniques predict the value of the dependent variable given known values of the independent variables. The parametric panel regression test is based on the ordinary least squares (OLS) assumption, minimizing the sum of the squares of the differences between observed and predicted values of the dependent variable. Throughout this research, this method is referred to as the OLS regression model. The logistic regression function is used when assessing the relation for *dRepurchase*, as its distribution is binary. The logistic regression estimates the probability that a firm repurchases shares in a particular month, using odds ratios. Odds ratios greater than one indicate that a share repurchase is more likely to occur. Although its interpretability more difficult, the advantage of the logit regression model is the automatic remedy for the large amount of firm-months in which no stock options are repurchased, leading to zero inflated dependent variables. The logit regression model does not need a normal distribution. DKO (2019) decided to use the OLS regression for all measures of share repurchase activity.

4.2 Explanatory Variables

The choice of explanatory variable changes, dependent on the investigated hypothesis. For the first and second hypotheses, the variable of interest is a dummy variable representing the occurrence of a stock option grant in a particular month. For the control group, the value of this variable will therefore be zero in all occasions. This variable is denoted as

dTreat. To test the third and fourth hypotheses, I use the proportion of the empowered executives' compensation paid in stock options, referred to as the *Compensation Proportion*. To specify, this measure is measured as the natural logarithm of the dollar value of stock options divided by the executives' salary. Salary is used instead of total compensation as data regarding the latter is incomplete for most executives. I use the natural logarithm of this measure to correct for outliers and establish a normal distribution. For the fourth and fifth hypotheses, stock option grants are divided in scheduled and unscheduled grants. All stock option grants are granted at-the-money and at least one empowered executive is among the recipients, as required in the selection procedure (see Section 3.1.2).

Different time period dummies are included to determine differences in share repurchase activity over time. As discussed in Section 3.1.2, all time periods are in respect to the stock option grant for the treatment group, and the placebo event for the control group. These events occur in month t=0. The normal period consists of the third and fourth month preceding the event month (t-3 and t-4). The pre period represents the two months preceding the event (t-1 and t-2), whereas the post period includes the three months following the event (t+1, t+2 and t+3). I include dummy variables *dPre* and *dPost* in the regression model to distinguish between the different time periods. dTreat is interacted with the different time periods to investigate the effect of stock option grants on the share repurchase activity before and after the stock option grant.

4.3 Composition of the Regression Equations

The first two hypotheses assume significant differences in share repurchase activity in the periods preceding and following the stock option grant, compared to the normal period. To get a first indication, I compare the share repurchase activity between the pre and post period using Regression Equation I. In this setting, the interaction variable indicates the difference in share repurchase activity between the pre and post period for the treatment group when accounting for the same difference for the control group. When this variable is significant, this would indicate that the treatment group more strongly changes its share repurchase activity compared to the control group.

$$\begin{aligned} \textit{Share Repurchase Activity}_{i,t} = \alpha_i \; + \; \beta_1 dTreat_{i,t} \; + \; \beta_2 dPost_{i,t} \; + \; \beta_3 dTreat \times dPost_{i,t} \\ + \; \beta_j Controls_{i,t} \; + \; u_t \; + \; v_i \; + \; \varepsilon_{i,t} \end{aligned} \tag{I}$$

The constant (α) represents the mean in share repurchase activity when all independent variables are equal to zero. To avoid finding spurious relations between stock option grants and share repurchase activity, control variables are added to the regression model. Control variables account for alternative reasoning for share repurchase activity, driven by company and executive characteristics. The control variables included are discussed in the subsequent section. The model is influenced by time-invariant and firm-invariant unobservable variables leading to heterogeneity and omitted variable bias. To obtain valid statistical inferences, these unobserved variables need to be controlled for. The Durbin–Wu–Hausman test finds the fixed effect models are appropriate for the OLS

regression models, whereas for the logit regression the random errors model leads to the highest efficiency. Considering the fixed effects model, I control for firm fixed effects (u) and year-month fixed effects (v). The firm fixed effects automatically control for industry specific effects. Variance in share repurchase activity that cannot be explained by the independent variables is captured in the error term (ε). The OLS regression method assumes the error term to be independent and identically distributed with a mean of zero. Standard errors are clustered by firm to increase their robustness and control for both heteroskedasticity and autocorrelation.

To determine whether the share repurchase activity in either one of the periods is significantly different from normal, both the pre and post period are interacted with the treatment dummy in Regression Equation II. In this situation, the share repurchase activity in either pre and post will be compared to the share repurchase activity in the normal period. A significant coefficient for one of the interaction variables would imply that the treatment group deviates from its share repurchase activity in the normal period more strongly than the control group does. Hypothesis 1 suggests a significant negative coefficient for interaction variable *dTreat* x *dPre*, whereas hypothesis 2 suggests a significant positive coefficient for interaction term *dTreat* x *dPost*.

$$\begin{aligned} \textit{Share Repurchase Activity}_{i,t} = {} & \alpha_i + \beta_1 dTreat_{i,t} + \beta_2 dPre_{i,t} + \beta_3 dTreat \times dPre_{i,t} \\ & + \beta_4 dPost_{i,t} + \beta_5 dTreat \times dPost_{i,t} + \beta_j Controls_{i,t} \\ & + u_t + v_i + \varepsilon_{i,t} \end{aligned} \tag{II}$$

To challenge the third and fourth hypotheses, the treatment dummy is replaced for a continuous variable representing the dollar fair value of the stock options granted to empowered executives, scaled by their cash salary. As discussed in Section 3.1.3, this measure is denoted as the *Compensation Proportion*. I use the natural logarithm of this measure to correct for outliers and establish a normal distribution. Again, the share repurchase activity preceding and following the stock option grant is compared to the share repurchase activity in the normal period. Therefore, Regression Equation III is denoted as:

$$\begin{aligned} \textit{Share Repurchase Activity}_{i,t} = {} & \alpha_i + \beta_1 Ln(\textit{Compensation Proportion})_{i,t} + \beta_2 dPre_{i,t} \\ & + \beta_3 dPost_{i,t} + \beta_4 Ln(\textit{Compensation Proportion}) \times dPre_{i,t} \\ & + \beta_5 Ln(\textit{Compensation Proportion}) \times dPost_{i,t} \\ & + \beta_j Controls_{i,t} + u_t + v_i + \varepsilon_{i,t} \end{aligned} \tag{III}$$

Finally, I compose a regression equation to test the causality of the expected relation between share repurchase activity and stock option grants. Stock option grant dummy *dTreat* is separated into a two dummies representing scheduled and unscheduled stock option grants. Both dummies are interacted with dummy *dPost* to determine whether the difference in share repurchase activity between the pre and post period differs for scheduled and unscheduled stock option grants. The fourth regression equation is formulated as:

$$\begin{aligned} Share\,Repurchase\,Activity_{i,t} = \alpha_i + \beta_1 dScheduled_{i,t} + \beta_4 dScheduled \times dPost_{i,t} \\ + \beta_5 dUnscheduled \times dPost_{i,t} + \beta_j Controls_{i,t} + u_t + v_i + \varepsilon_{i,t} \end{aligned} \tag{IV}$$

Only treatment firms are included in this regression equation and the share repurchase activity is compared to the share repurchase activity in the pre period before unscheduled stock option grants.

4.4 Control Variables

As discussed in Section 2.1.2, companies repurchase their shares for a variety of reasons. Control variables are included to account for these and other company and executive characteristics affecting share repurchase activity. Share undervaluation is accounted for by including the stock return in the three months preceding the stock option grant. A negative relation between the stock return and the share repurchase activity is expected as undervaluation is more likely following negative stock return (Vermaelen, 1981; Comment & Jarrell, 1991; Stephens & Weisbach, 1998). Control variable *Stock Return* is measured as the holding period return in a particular month and is included for each month separately. I include the return on assets using proxy *ROA* to control for the firms profitability and potential free cash flow problem. *ROA* is measured as EBITDA scaled by total assets. On the other hand, I include a dummy variable *dLoss* indicating whether a company reported a loss in a particular year. Losses are expected to be negatively related to share repurchase activity, as losing companies are less likely to be able to distribute cash to shareholders. Companies either repurchase shares or pay dividends when they wish to pay out (excessive) cash among shareholders. To control for the substitution theory, control variable *Dividend Yield* is added to the model. The dividend yield is measured as the annual dollar value of dividends per share divided by the closing share price at the last trading day of the year. Furthermore, growth opportunities are once more included using variable *Book-to-Market Ratio*. A negative relation with share repurchases is assumed, as investing in positive net present value projects should be preferred over paying out cash to shareholders (Grullon & Michaely, 2004). To account for the use of share repurchases to alter the capital structure, variable *Leverage Ratio* is added to the control variables. The leverage ratio is measured as total liabilities divided by total assets. Similar to the logit estimation, the natural logarithm of the company's assets is included to control for the size of the company. Share repurchase activity is expected to be negatively related to the liquidity of the shares, as the costs to repurchase a certain amount of shares increases when shares are less liquid. The liquidity is quantified as the bid-ask spread, the difference between the price investors are willing to sell and to buy the shares for. Lastly, variable *Blackout Period* is included, representing the days between the report date of the quarterly earnings and the actual end date of the corresponding period. Companies are expected to restrain from share repurchases to prevent to cross insider trading legislation, implying a negative relation to share repurchase activity.

DKO (2019) find a significant negative relation between share repurchase activity and participation in the Troubled Assets Relief Program (TARP)[1], a proxy for financial distress. Financial distress restricts companies from repurchasing its shares. However, data limitations restrain the use of TARP and other proxies for financial distress such as credit default swaps (CDS) or the Standard & Poor's credit rating. Moreover, the cash-assets ratio cannot be included for the same reason.

Besides control variables on firm-level, the model is extended by characteristics of the empowered executives. The executive-level control variables account for the presence of the chairman of the board among the empowered executives, the mean age of the empowered executives, the proportion of empowered executives with an age of at least 62, the proportion of female empowered executives and the mean of the equity sensitivities of empowered executives.

4.5 Descriptive Statistics

In order to get a sense of the dataset and the distribution of the variables included in the analyses, descriptive statistics are provided in Table V. Considering the treatment and control group during the normal, pre and post period, there is a 29.2% chance that a company conducts an open-market share repurchase in the given firm-months. This is relatively high compared to DKO (2019), in which they find share repurchases in only 18.2% of the months. When following the data selection and panel dataset construction of aforementioned research, this percentage is even higher as it increases to 30.7%. The differences in percentages compared to prior research can be devoted to the only remaining difference in data selection procedure; the use of ExecuComp instead of Equilar. The *Repurchase Volume* measure is skewed to the right as in many firm-months no share repurchases take place, leading to a zero-inflated dependent variable. The table shows that companies on average repurchase 0.176% of their shares each month. Recall that this measure is multiplied by 100 to increase the readability when analyzing the data. More than half (56.7%) of the observation belong to the treatment group. This percentage would have been 50% if the treatment and control group would consist of the same amount of firm-months. This is not the case, as I cannot prevent placebo event windows not to overlap. Months of overlapping windows can be included in the dataset only once and therefore, the control group consists of less observations than the treatment group. I classify 32.9% of the stock option grants as scheduled, implying that the empowered executives received stock options in the preceding year in a 7-day window.

Before executing the regression analyses, the correlation between variables is investigated, as multicollinearity is not allowed under the OLS regression assumptions. When variables are highly linearly related, regression coefficients cannot be estimated correctly and spurious relations would emerge. The concerned variables would interfere with each other when trying to estimate the dependent variable. Under general statistical rules, vari-

[1] The US government initiated TARP under the Emergency Economic Stabilization Act in reaction to the financial crisis of 2008 to increase the liquidity of a number of financial distressed financial institutions and car manufacturers.

ables are accepted when their correlation is beneath 70% (Asuero, Sayago, & Gonzalez, 2006). The collinearity between the independent variables is tested using the correlation matrix shown in Table VI.

The correlation between *dRepurchase* and *Repurchase Value* is 86.9%. However, this is no problem as the first three variables all represent the share repurchase activity. High correlations are therefore allowed and as expected. All other correlations are within acceptable levels. As the dataset and included variables are approved upon, the regression analyses can be executed.

Table V: Univariate Descriptives

This table provides descriptive statistics for the variables used in the analyses, on firm-month level for the treatment and control group during the normal, pre and post period. All variables are defined in Table XIV of the Appendix.

	Mean	SD	p25	Median	p75
Repurchase Volume	0.176	0.453	0.000	0.000	0.048
dRepurchase	0.292	0.455	0.000	0.000	1.000
Ln(Repurchase Value)	1.618	2.931	0.000	0.000	2.338
dTreat	0.567	0.496	0.000	1.000	1.000
Ln(Compensation Proportion)	0.918	1.081	0.326	0.982	1.617
dScheduled	0.329	0.391	0.000	0.000	1.000
dUnscheduled	0.670	0.470	0.000	1.000	1.000
Blackout Period	31.841	21.927	24.000	29.000	35.000
Ln(Assets) $_{t-1}$	7.771	2.049	6.320	7.630	9.134
Book-to-Market Ratio $_{t-1}$	0.526	0.347	0.282	0.451	0.667
ROA $_{t-1}$	0.125	0.114	0.045	0.115	0.178
Loss $_{t-1}$	0.149	0.356	0.000	0.000	0.000
Stock Return $_{t-1}$	0.007	0.145	-0.056	0.005	0.065
Stock Return $_{t-2}$	0.007	0.141	-0.053	0.005	0.063
Stock Return $_{t-3}$	-0.003	0.138	-0.061	0.000	0.057
Dividend Yield $_{t-1}$	0.014	0.036	0.000	0.005	0.021
Leverage Ratio $_{t-1}$	0.561	0.268	0.338	0.566	0.789
Bid-Ask Spread $_{t-1}$	-0.067	0.280	-0.05	-0.03	-0.01
dChairman	0.697	0.460	0.000	1.000	1.000
Age	52.180	4.542	49.200	52.400	55.000
Age ≥ 62	0.102	0.168	0.000	0.000	0.200
Females	0.076	0.119	0.000	0.000	0.167
Ln(Executives' Equity Sensitivity) $_{t-1}$	5.178	1.884	4.044	5.220	6.430

Table VI: Correlation Matrix

This table provides the linear correlations between variables. A value of zero reflects no correlation, whereas one represents perfect correlation, either positive or negative. Variables are automatically perfectly (positively) correlated to itself. The asterisk reflects significance at the 1% level (p-value=0.05). All variables are defined in Table XIV of the Appendix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) Repurchase Volume	1.000																		
(2) dRepurchase	0.613*	1.000																	
(3) Ln(Repurchase Value)	0.682*	0.869*	1.000																
(4) Blackout Period	-0.028*	-0.084*	-0.095*	1.000															
(5) Ln(Assets) $_{t-1}$	0.013	0.111*	0.242*	-0.160*	1.000														
(6) Book-to-Market Ratio $_{t-1}$	-0.078*	-0.144*	-0.177*	0.028*	0.124*	1.000													
(7) ROA $_{t-1}$	0.092*	0.105*	0.134*	-0.019	-0.231*	-0.490*	1.000												
(8) dLoss $_{t-1}$	-0.063*	-0.141*	-0.151*	0.085*	-0.129*	0.330*	-0.334*	1.000											
(9) Stock Return $_{t-1}$	0.025*	0.039*	0.039*	-0.023*	-0.017	-0.093*	0.042*	-0.069*	1.000										
(10) Stock Return $_{t-2}$	0.046*	0.042*	0.051*	-0.028*	-0.025*	-0.122*	0.032*	-0.093*	0.100*	1.000									
(11) Stock Return $_{t-3}$	0.047*	0.053*	0.057*	-0.005	-0.040*	-0.158*	0.073*	-0.091	-0.095*	0.112*	1.000								
(12) Dividend Yield $_{t-1}$	-0.054*	-0.026*	-0.037*	-0.044*	0.196*	0.131*	-0.071*	-0.010	-0.035*	-0.033*	-0.042*	1.000							
(13) Leverage Ratio $_{t-1}$	-0.043*	-0.024*	0.017	-0.096*	0.553*	0.094*	-0.265*	0.002	-0.009	-0.027*	-0.035*	0.199*	1.000						
(14) Bid-Ask Spread	-0.031*	-0.019	-0.023*	-0.023*	-0.036*	-0.021*	-0.082*	0.016	0.006	0.004	-0.002	0.017	-0.016						
(15) dChairman	0.005	0.067*	0.081*	-0.148*	0.199*	-0.093*	0.115*	-0.133*	-0.004	-0.014	-0.015	0.035*	0.001	0.023	1.000				
(16) Age	-0.043*	0.014	0.043*	-0.074*	0.262*	0.031*	-0.063*	-0.071*	0.000	-0.002	-0.011	0.125*	0.157*	0.016	0.160*	1.000			
(17) Age $\geq$ 62	-0.019	0.001	-0.014	-0.023*	-0.007	0.006	-0.002	-0.016	-0.011	-0.006	-0.003	0.047*	-0.001	-0.034*	0.131*	0.628*	1.000		
(18) Females	0.009	0.051*	0.050*	0.013	0.020	0.024*	0.010	-0.007	-0.010	-0.020	-0.032*	-0.007	0.009	0.013	-0.077*	-0.033*	-0.044*	1.000	
(19) Ln(Executives' Equity Sensitivity) $_{t-1}$	0.061*	0.132*	0.177*	-0.088*	0.358*	-0.258*	0.180*	0.180*	-0.220*	0.022	0.033*	-0.025*	0.031*	-0.061*	0.338*	0.179*	0.160*	-0.22	1.000

5. Results

In this chapter, the results of this research are discussed. First, prior research conducted by DKO (2019) is reconstructed to allow for the comparison of results. Thereafter, I use the improved panel dataset and methodology as discussed in previous sections and present the outcomes of the statistical research. The results provide answers to the hypotheses.

5.1 Reconstruction of Prior Research II: Results

In their research, DKO (2019) find a significant decrease in share repurchase activity prior to at-the-money stock option grants to CEOs when compared to the share repurchase activity in the normal period. To get a first indication of potential changes in share repurchase activity around stock option grants, the share repurchase activity between the pre and post period is compared using Regression Equation I. Table VII shows the results of both the simple difference analyses and difference-in-difference analyses for each different measure for share repurchase activity.

Models (1), (3) and (5) comprise the simple difference analyses for the treatment group only, whereas models (2), (4) and (6) represent the difference-in-difference analyses with the control firms included. As mentioned in Section 4.1, DKO (2019) use the OLS regression for all measures of share repurchase activity. The objective of the OLS regression model is to minimize the sum of the squared residuals. Its success is measured as the adjusted R-squared, representing the goodness-of-fit estimating the overall explanatory power of the regression model. The measure is adjusted for the number of variables included in the model and only increases when the variance of the dependent variable not explained by the independent variables decreases when adding new variables. The constant is excluded from this and all other upcoming regression models, as it has no explanatory value. The constant represents the share repurchase activity when all explanatory variables and control variables are given the value zero. As this will never be the situation, the constant is meaningless.

Dependent variable *Ln(Repurchase Value)* is given preference when testing the relation with the explanatory variables. The logarithmic transformation generated a more normal distribution of share repurchase activity and reduced outliers, leading to the highest adjusted R-squared. However, the unit of measurement makes it difficult to draw quantified conclusions about the effect on share repurchase activity. Dependent variable *Repurchase Volume* does allow for the quantification of the relation, however, consists of many zero's and therefore has a non-normal distribution. This also applies for *dRepurchase*, as DKO (2019) uses the OLS regression for this model as well. For this last measure, explanatory and non-explanatory variables are expressed as their increasing or decreasing effect on the likelihood of a share repurchase to occur, however, the size of the share repurchases is not accounted for. To conclude, each measure of share repurchase activity has its (dis)advantages, and together they will be used to optimally draw conclusions.

Table VII: Reconstruction of Prior Research I

This table provides the results of Regression Equation I when replicating the research of DKO (2019). The OLS regression method is used in all regression models and compares the share repurchase activity between the pre and post period. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. All variables are defined in Table XIV of the Appendix.

Model	(1) Treatment Firms Only OLS	(2) Treatment & Control Firms OLS	(3) Treatment Firms Only OLS	(4) Treatment & Control Firms OLS	(5) Treatment Firms Only OLS	(6) Treatment & Control Firms OLS
Dependent Variable	Repurchase Volume		dRepurchase		Ln(Repurchase Value)	
dPost	0.0220**	-0.0011	0.0269***	-0.0038	0.1560***	0.0248
	(2.19)	(-0.07)	(3.26)	(-0.27)	(2.79)	(0.30)
dTreat		-0.0374*		-0.0296		-0.1660
		(-1.81)		(-1.49)		(-1.32)
dTreat x dPost		0.0211		0.0268*		0.1090
		(1.18)		(1.76)		(1.18)
Blackout Period	-0.0001*	-0.0003*	-0.0007**	-0.0007***	-0.0058***	-0.0036***
	(-1.90)	(-1.94)	(-2.55)	(-3.73)	(-4.06)	(-3.71)
Ln(Assets) $_{t-1}$	0.1610***	0.1420***	0.1326***	0.1040***	0.8990***	0.7710***
	(4.86)	(5.12)	(3.79)	(3.59)	(3.81)	(3.98)
Book-to-Market Ratio $_{t-1}$	-0.0378	-0.0297	-0.0443	-0.0357	-0.0695	-0.0137
	(-1.02)	(-1.02)	(-1.29)	(-1.29)	(-0.31)	(-0.08)
ROA $_{t-1}$	0.2870**	0.2800**	0.2101*	0.2482***	1.1450	1.4180**
	(2.20)	(2.56)	(1.78)	(2.60)	(1.53)	(2.34)
dLoss $_{t-1}$	-0.0187	-0.0108	-0.00471	-0.0092	0.0124	0.00741
	(-1.00)	(-0.72)	-0.0047	(-0.69)	(0.14)	(0.11)
Stock Return $_{t-1}$	0.0467	0.0556**	0.0342	0.0429**	0.3550**	0.3230***
	(1.53)	(2.20)	(1.40)	(2.09)	(2.47)	(2.77)
Stock Return $_{t-2}$	0.0661*	0.0725**	0.0696**	0.0470**	0.5120***	0.3960***
	(1.92)	(2.48)	(2.53)	(2.12)	(3.25)	(3.18)
Stock Return $_{t-3}$	0.0323	0.0323	0.0657**	0.0503**	0.4710***	0.3600***
	(0.97)	(1.22)	(2.25)	(2.11)	(2.87)	(2.81)
Dividend Yield $_{t-1}$	-0.0244	-0.0592	-0.1078	-0.1841**	-0.8210	-1.0920*
	(-0.37)	(-0.88)	(-1.59)	(-2.05)	(-1.64)	(-1.95)
dChairman $_{t-1}$	0.0389	0.0459	-0.0134	0.0020	-0.0603	-0.0749
	(0.68)	(1.04)	(-0.27)	(0.05)	(-0.21)	(-0.30)
Ln(Age)	-0.0273	-0.0284	-0.1162	-0.0976	0.0973	-0.0731
	(-0.14)	(-0.17)	(-0.54)	(-0.54)	(0.07)	(-0.07)
Age $\geq$ 62	0.1230	0.0341	0.0825	0.0289	0.6140	0.0487
	(1.60)	(0.57)	(0.97)	(0.44)	(1.05)	(0.11)
Female CEO	0.0124	0.0225	-0.1551	-0.1705	-0.6420	-0.7330
	(0.10)	(0.21)	(-1.22)	(-1.52)	(-0.70)	(-0.95)
Ln(Executives' Equity Sensitivity) $_{t-1}$	-0.0091	-0.0102	0.0000	-0.0031	0.0454	0.0042
	(-1.09)	(-1.56)	(0.01)	(-0.48)	(0.78)	(0.09)
Firm Fixed Effects	YES	YES	YES	YES	YES	YES
Year-Month Fixed Effects	YES	YES	YES	YES	YES	YES
Random Effects	NO	NO	NO	NO	NO	NO
Observations (# Months)	12,606	17,842	12,606	17,842	12,606	17,842
# Unique Firms	844	1,153	844	1,153	844	1,153
Adjusted R-Squared	0.1817	0.1901	0.4012	0.3883	0.4512	0.4541

Considering the simple difference models, the coefficients of variable *dPost* show that the per month average share repurchase activity in the three months following stock option grants is significantly higher than during the two months preceding stock option grants, for each measure of share repurchase activity. However, this difference is not consistently

significantly different compared to the difference in share repurchase activity of the control group, as shown by variable *dTreat* x *dPost* in the difference-in-difference analyses. The interaction variable only shows some significance when using dependent variable *dRepurchase*. Given only marginal significance levels, the interaction variable indicates that the likelihood to repurchase shares seems to increase more strongly from the pre to post period for treatment firms than for control firms. DKO (2019) do find statistically significant positive coefficients for the interaction variables in their difference-in-difference models.

Variable *dTreat* in model (2) indicates that treatment firms in general repurchase their shares in significantly lower volumes, however, this relation again is only marginally significant and not consistent for the other models. The control variables are not in line with the commonly accepted theories involving company share repurchases in all cases. The positive significant relation between share repurchase activity and the stock performance is counterintuitive as this implies that the share repurchase activity tends to increase when the stock performance increases. This contradicts the undervaluation theory as undervaluation is less likely after positive stock performance (Vermaelen, 1981; Comment & Jarrell, 1991; Stephens & Weisbach, 1998). A possible explanation could be the effect of the financial crisis starting in 2008. During this economic downturn, it might be the case that only well performing companies were able to repurchase their shares. This would result in a positive relation between share repurchase activity and the stock performance. However, this conclusion cannot be drawn based on any evidence and is only intuitive. Furthermore, I cannot confirm the effect of growth opportunities on share repurchase activity, as variable *Book-to-Market Ratio* is not statistically significant. Also dummy *dLoss* has no significant coefficient, which implies that cash constraints do not have a significant impact on the share repurchase activity. The reason for the insignificance and different implications of aforementioned control variables is unclear. Regarding the rest of the control variables, the coefficients are as expected. Similar to DKO (2019), I find a significant negative relation between the blackout period and share repurchase activity. This implies that the share repurchase activity decreases when the number of days between the report date of the quarterly earnings and the actual end date of the corresponding period, increases. Bigger size companies tend to repurchase their shares more frequently and in a greater extend, both in volume and dollar value. *ROA* has a significant positive relation with share repurchase activity, supporting the theory that share repurchases are used to payout free cash flows (Jensen, 1986). Furthermore, the negative effect of the *Dividend Yield* variable supports the substitution effect of share repurchases as suggested by e.g. Jagannathan et al. (2000), although its significance is not consistent for all models. None of the control variables representing CEO characteristics has a statistically significant impact on the share repurchase activity. I do not exclude the insignificant control variables from the models as doing so would lead to a lower adjusted R-squared. This suggests that the control variables nevertheless add value to the regression models.

The share repurchase activity in both the pre and post period needs to be compared to the share repurchase activity in the normal period to conclude upon significant increases or decreases compared to normal share repurchase activity. Still using the dataset similar to

Table VIII: Reconstruction of Prior Research II

This table provides the results of Regression Equation II when replicating the research of DKO (2019). The OLS regression method is used for all regression models and compares the share repruchase activity in both the pre and post period to the share repurchase activity in the normal period. The partial F-test finds no signficant differences between interaction variables *dTreat* x *dPre* and *dTreat* x *dPost*. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. All variables are defined in Table XIV of the Appendix.

Model	(1) Treatment & Control Firms OLS	(2) Treatment & Control Firms OLS	(3) Treatment & Control Firms OLS
Dependent Variable	Repurchase Volume	dRepurchase	Ln(Repurchase Value)
dPre	0.0206	0.0085	0.0975
	(1.90)	(0.70)	(1.33)
dPost	0.0256	0.0035	0.1010
	(1.40)	(0.24)	(1.06)
dTreat	0.0054	-0.0063	0.0397
	(0.26)	(-0.32)	(0.29)
dTreat x dPre	-0.0335*	-0.0228	-0.1910**
	(-1.85)	(-1.59)	(-2.12)
dTreat x dPost	-0.0115	0.0067	-0.0592
	(-0.54)	(0.40)	(-0.53)
Blackout Period	-0.0004***	-0.0008***	-0.0045***
	(-3.03)	(-4.38)	(-4.86)
Ln(Assets) $_{t-1}$	0.1550***	0.1152***	0.8580***
	(6.15)	(4.37)	(4.72)
Book-to-Market Ratio $_{t-1}$	-0.0263	-0.0167	0.0344
	(-1.01)	(-0.63)	(0.21)
ROA $_{t-1}$	0.2590***	0.2402***	1.5040**
	(2.71)	(2.68)	(2.57)
dLoss $_{t-1}$	-0.0073	-0.0118	0.0053
	(-0.55)	(-1.00)	(0.08)
Stock Return $_{t-1}$	0.0432*	0.0379**	0.3120***
	(1.95)	(2.09)	(3.02)
Stock Return $_{t-2}$	0.0616**	0.0381**	0.3630***
	(2.50)	(2.06)	(3.31)
Stock Return $_{t-3}$	0.0286	0.0358*	0.3600***
	(1.24)	(1.68)	(3.10)
Dividend Yield $_{t-1}$	-0.0637	-0.1547*	-0.9000*
	(-0.94)	(-1.82)	(-1.66)
dChairman $_{t-1}$	0.0396	-0.0182	-0.1850
	(1.20)	(-0.46)	(-0.83)
Ln(Age)	-0.0411	-0.0161	0.1590
	(-0.27)	(-0.10)	(0.15)
Age $\geq$ 62	0.0369	0.0339	0.1370
	(0.73)	(0.56)	(0.34)
Female CEO	0.0278	-0.1372	-0.5140
	(0.31)	(-1.31)	(-0.71)
Ln(Executives' Equity Sensitivity) $_{t-1}$	-0.0125**	-0.0032	0.0052
	(-2.14)	(-0.53)	(0.13)
Firm Fixed Effects	YES	YES	YES
Year-Month Fixed Effects	YES	YES	YES
Random Effects	NO	NO	NO
Observations (# Months)	24,679	24,679	24,679
# Unique Firms	1,153	1,153	1,153
Adjusted R-Squared	0.1884	0.3830	0.4501
p-values of Partial F-test	0.0630	0.0523	0.0935

prior research, Table VIII shows the outcomes of Equation II for which only difference-in-difference analyses are conducted. The coefficient of the interaction variable *dTreat* x *dPre*

is significantly negative, indicating that treatment firms decrease their share repurchase activity prior to stock option grants more strongly than control firms do before placebo events, when comparing to the share repurchase activity in the normal period. This result is similar to the results found by DKO (2019) and suggests that CEOs indeed opportunistically time the share repurchase activity prior to receiving at-the-money granted stock options. The decrease in share repurchase activity would prevent a share price increase that otherwise would be negatively impacting the value of at-the-money granted stock options. In contrast to the results of prior research, the overall share repurchase activity of the treatment group is no longer significantly different compared to the control group. Also, the partial F-test points out that there is no signficant difference between the coefficients of interaction variables *dTreat* x *dPre* and *dTreat* x *dPost*. The control variables show similar signs and significance as in Table VII.

5.2 Improved Panel Dataset Regression Results

Now that the prior paper is reconstructed and similar results are found, it is time to use the improved panel dataset established in Chapter 3. In contrast, the improved panel dataset uses non-overlapping at-the-money stock option grants to the CEO, CFO and CIO of the company. Furthermore, the normal and pre time periods consist of two instead of three months. Besides the differences in panel dataset, there are some small deviations in methodology. When investigating dependent variable *dRepurchase*, I use the logit regression model as this model is better suited when using binary distributed dependent variables. For these models, it is better to control for random effects instead of fixed effects (Harrell Jr, 2015). Lastly, two new control variables are introduced as a significant relation with share repurchase activity is expected.

Again, Regression Equation I determines whether the share repurchase activity preceding stock option grants is significantly different compared to post stock option grants, of which the results are presented in Table IX. Again, variable *dPost* of the simple difference models shows that the share repurchase activity in the post period is significantly higher compared to the share repurchase activity in the pre period. Although its better suitability, the logistic regression model is less interpretable than the OLS model, however. The coefficient of *dPost* implies that the log odds ratio of a share repurchase is increased by 0.4090 in the post period of a stock option grant. This positive effect of *dPost* on the likelihood that a share repurchase will occur is statistically significant at the 1% level.

However, the difference in share repurchase activity between the pre and post period is not statistically significant when accounting for the difference between pre and post of the control group. Therefore, I conclude that treatment firms do not increase their share repurchase activity from pre to post stock option grants more strongly than control firms do around placebo events.

The interpretation of the control variables is similar to the interpretation of prior conducted regression models. In addition, the new introduced control variable *Leverage Ratio* shows a strong negative relation with share repurchase activity with a coefficient significant on either the 5 or 1% level. An increase in the leverage ratio leads to a decrease in

Table IX: Results Regression Analysis Comparing Pre vs Post

This table provides the results of Regression Equation I using the improved panel dataset established in Chapter 3. For the *Repurchase Volume* and *Ln(Repurchase Value)* dependent variables the OLS regression method is used, whereas I use a logit regression for the *dRepurchase* dependent variable. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. All variables are defined in Table XIV of the Appendix.

Model	(1) Treatment Firms Only OLS	(2) Treatment & Control Firms OLS	(3) Treatment Firms Only Logit	(4) Treatment & Control Firms Logit	(5) Treatment Firms Only OLS	(6) Treatment & Control Firms OLS
Dependent Variable	Repurchase Volume		dRepurchase		Ln(Repurchase Value)	
dPost	0.0384*	0.0030	0.4090***	-0.0164	0.3110***	-0.0221
	(1.73)	(0.13)	(2.72)	(-0.10)	(2.76)	(-0.17)
dTreat		-0.0002		-0.1190		-0.1940
		(-0.01)		(-0.50)		(-0.77)
dTreat x dPost		0.0106		0.2280		0.2010
		(0.47)		(1.27)		(1.56)
Blackout Period	0.0000	-0.0001	-0.0208**	-0.0082	-0.0046**	-0.0030
	(-0.03)	(-0.31)	(-2.07)	(-1.18)	(-2.45)	(-1.22)
Ln(Assets) $_{t-1}$	0.2430***	0.1640***	0.5010***	0.4010***	1.4960***	1.1500***
	(3.43)	(2.89)	(4.84)	(4.81)	(4.14)	(3.35)
Book-to-Market Ratio $_{t-1}$	-0.1630**	-0.0953**	-1.4890***	-0.7850**	-0.8340**	-0.4970*
	(-2.22)	(-2.14)	(-3.04)	(-2.20)	(-2.10)	(-1.81)
ROA $_{t-1}$	0.4740*	0.3170	3.0100***	2.7850***	2.8710*	1.6400
	(1.89)	(1.62)	(2.97)	(3.14)	(1.68)	(1.64)
dLoss $_{t-1}$	-0.0100	0.0096	-0.0943	-0.0257	0.2530	0.2020
	(-0.24)	(0.37)	(-0.30)	(-0.12)	(1.38)	(1.58)
Stock Return $_{t-1}$	0.0245	0.0092	-0.0070	0.3210	0.1890	0.1550
	(0.47)	(0.23)	(-0.01)	(0.83)	(0.77)	(0.75)
Stock Return $_{t-2}$	0.0521	0.0264	0.6490	0.3440	0.4080*	0.3150*
	(0.71)	(0.54)	(1.57)	(1.15)	(1.67)	(1.72)
Stock Return $_{t-3}$	-0.0191	0.0238	0.4290	0.6760*	0.3590	0.5040**
	(-0.25)	(0.46)	(0.88)	(1.72)	(1.17)	(2.30)
Dividend Yield $_{t-1}$	0.2090**	0.0266	-6.7120***	-5.2190***	0.0982	-0.7960
	(2.04)	(0.18)	(-3.13)	(-2.77)	(0.14)	(-0.75)
Leverage Ratio $_{t-1}$	-0.9070***	-0.4850**	-2.3900***	-1.7350***	-4.4250***	-3.0120***
	(-3.24)	(-2.55)	(-3.70)	(-3.26)	(-3.22)	(-2.83)
Bid-Ask Spread $_{t-1}$	-0.0336	-0.0393**	-0.4880	-0.1250	-0.6780	-0.1590
	(-0.46)	(-2.03)	(-0.97)	(-1.58)	(-1.55)	(-1.25)
dChairman $_{t-1}$	0.0029	-0.0411	-0.07830	-0.1370	-0.6890	-0.8350
	(0.03)	(-0.55)	(-0.28)	(-0.60)	(-1.00)	(-1.63)
Age	0.0210***	0.0147**	-0.0157	0.0097	0.1430***	0.1030**
	(2.89)	(2.37)	(-0.41)	(0.34)	(2.62)	(2.45)
Age ≥ 62	-0.1090	-0.0041	0.3920	0.2330	-0.9890	-0.4750
	(-1.03)	(-0.05)	(0.46)	(0.35)	(-1.17)	(-0.70)
Females	-0.3380	-0.1810	0.4860	0.1550	-3.8350**	-2.7080*
	(-1.25)	(-0.86)	(0.44)	(0.19)	(-2.00)	(-1.83)
Ln(Executives' Equity Sensitivity) $_{t-1}$	-0.0003	-0.0091	0.0323	0.0393	0.0364	-0.0030
	(-0.02)	(-0.66)	(0.38)	(0.59)	(0.32)	(-0.04)
Firm Fixed Effects	YES	YES	NO	NO	YES	YES
Year-Month Fixed Effects	YES	YES	NO	NO	YES	YES
Random Effects	NO	NO	YES	YES	NO	NO
Observations (# Months)	3,533	5,498	3,533	5,498	3,533	5,498
# Unique Firms	406	553	406	553	406	553
Adjusted R-Squared	0.2633	0.2331			0.4981	0.4710
McKelvey & Zavoina's R-Squared			0.2475	0.1712		

share repurchase activity, as expected based on research on capital structures (Vermaelen, 1981; Dittmar, 2000; Lie, 2002). Companies seem to repurchase less shares as percentage of total shares outstanding when the liquidity of their shares worsens, as shown by the *Bid-Ask Spread* variable. A higher bid-ask spread leads to higher repurchasing costs. The coefficient of variable *Book-to-Market Ratio* is now statistically significant as well. Companies repurchase their shares significantly less often and to a lesser extent when growth opportunities increase. Investing in positive net present value projects should be preferred over paying out cash to shareholders (Grullon & Michaely, 2004). The goodness-of-fit is increased as shown by the higher adjusted R-squared and McKelvey & Zavoina's R-squared when compared to the regression models when reconstructing DKO (2019). This indicates that the variance of the dependent variable is explained better by the regression model when using the improved panel dataset and slightly different research design. As discussed, the McKelvey & Zavoina's R-squared is better suited for the logistic regression model and is interpretated similarly.

Table X presents the results when investigating the share repurchase activity in the pre and post period in more detail. Using difference-in-difference regression models only, the share repurchase activity in both periods is compared to the share repurchase activity in the normal period. I find striking results now using the improved panel dataset. My findings do not support the results of DKO (2019) suggesting a significant decrease in the per month share repurchase activity in the months preceding stock option grants, as the coefficient of the interaction variable *dTreat* x *dPre* is not statistically significant. As a matter of fact, the coefficient of interaction term *dTreat* x *dPost* is now significantly positive. This result suggests that treatment companies increase their share repurchase activity after stock option grants more strongly than control firms do, when compared to the share repurchase activity in the normal period. However, its significance is inconsistent and the partial F-test shows no difference between the coefficients of both interaction variables. Given the multiplication of dependent variable *Repurchase Volume* by 100 to increase the readability, treatment firms increase the number of shares they repurchase as percentage of the total number of shares outstanding by 0.0477 percentage points in the post period when compared to the share repurchase activity in the normal period. This magnitude is of economic significance given that companies on average repurchase 0.176% of their shares each month. Based on the results, hypothesis 1 is rejected whereas hypothesis 2 can be accepted.

The results could be attributed to two explanations. First, the increase might be explained by the option funding and anti-dilution theory suggested by Kahle (2002) and Bens et al. (2003). Share repurchases provide shares to be distributed when stock options are exercised and effectively offset the dilutive effect of the exercises. Empowered executives have an incentive to postpone these share repurchases and their additional price increasing effect until after receiving their at-the-money granted stock options. Secondly, the results might be attributable to empowered executives increasing the share repurchase activity following stock option grants in order to benefit from share price increases instead. The share price increases push the stock options in-the-money, allowing them to maximize

Table X: Results Regression Analysis Using the Normal Period

This table provides the results of Regression Equation I using the improved panel dataset established in Chapter 3. For the *Repurchase Volume* and *Ln(Repurchase Value)* dependent variables the OLS regression method is used, whereas I use a logit regression for the *dRepurchase* dependent variable. The partial F-test finds no signficant differences between interaction variables *dTreat* x *dPre* and *dTreat* x *dPost*. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. All variables are defined in Table XIV of the Appendix.

Model	(1) Treatment & Control Firms OLS	(2) Treatment & Control Firms Logit	(3) Treatment & Control Firms OLS
Dependent Variable	Repurchase Volume	dRepurchase	Ln(Repurchase Value)
dPre	0.0002	-0.0004	0.0357
	(0.01)	(-0.00)	(0.33)
dPost	0.0067	0.0212	0.0285
	(0.26)	(0.11)	(0.19)
dTreat	-0.0255	-0.1930	-0.2360
	(-0.73)	(-0.77)	(-0.93)
dTreat x dPre	0.0347	0.0981	0.1150
	(1.30)	(0.55)	(0.92)
dTreat x dPost	0.0477*	0.3410	0.3340**
	(1.69)	(1.62)	(2.12)
Blackout Period	0.0000	-0.0088	-0.0030
	(-0.27)	(-1.64)	(-1.20)
Ln(Assets) $_{t-1}$	0.1540***	0.3910***	1.1430***
	(2.74)	(4.79)	(3.32)
Book-to-Market Ratio $_{t-1}$	-0.1100**	-0.7500**	-0.5040**
	(-2.58)	(-2.13)	(-1.99)
ROA $_{t-1}$	0.3380*	2.6930***	1.3810
	(1.92)	(3.09)	(1.51)
dLoss $_{t-1}$	0.0373	-0.0850	0.2170**
	(1.61)	(-0.46)	(2.01)
Stock Return $_{t-1}$	-0.0031	0.4320	0.2420
	(-0.08)	(1.24)	(1.41)
Stock Return $_{t-2}$	0.0520	0.6190**	0.4670***
	(1.12)	(1.97)	(2.67)
Stock Return $_{t-3}$	0.0105	0.6910*	0.5100**
	(0.22)	(1.81)	(2.42)
Dividend Yield $_{t-1}$	0.0500	-2.9000	-0.2290
	(0.40)	(-1.18)	(-0.32)
Leverage Ratio $_{t-1}$	-0.4250***	-1.7620***	-3.0310***
	(-2.62)	(-3.26)	(-2.96)
Bid-Ask Spread $_{t-1}$	-0.0273	-0.0113	-0.0517
	(-1.43)	(-0.14)	(-0.47)
dChairman $_{t-1}$	-0.0635	-0.2710	-0.8510**
	(-1.04)	(-1.23)	(-2.12)
Ln(Age)	0.0141***	0.0102	0.0934**
	(2.74)	(0.37)	(2.54)
Age $\geq$ 62	-0.0159	0.4800	-0.1590
	(-0.22)	(0.77)	(-0.27)
Females	-0.0632	0.3010	-1.8610
	(-0.36)	(0.38)	(-1.43)
Ln(Executives' Equity Sensitivity) $_{t-1}$	-0.0010	0.0662	0.0082
	(-0.08)	(1.13)	(0.11)
Firm Fixed Effects	YES	NO	YES
Year-Month Fixed Effects	YES	NO	YES
Random Effects	NO	YES	NO
Observations (# Months)	7,432	7,432	7,432
# Unique Firms	553	553	553
Adjusted R-Squared	0.2084		0.4553
McKelvey & Zavoina's R-Squared		0.1706	
p-Value of Partial F-Test	0.5683	0.1678	0.0949

their payoff if they would sell their shares after exercising the stock options, like suggested by Edmans et al. (2018). Both explanations for the observed increase in share repurchase activity following stock option grants suggest that empowered executives opportunistically time the moment of the share repurchases for private benefits. The correct explanation still needs to be determined.

The insignificance of variable *dTreat* shows that the share repurchase activity in the normal period does not significantly differs between the treatment and control group. This once more supports the choice for the months included in the normal period. The effect of at-the-money stock options grants on share repurchase activity per month separately is presented in Table XVI of the Appendix. The result of simple difference model (1) shows that control firms do not significantly change their share repurchase activity. When compared to the share repurchase activity in the normal period, treatment firms significantly increase this share repurchase activity only in the months that reflect the post period as shown in model (2). This again affirms the correctness of both the selection of the control group and the selected time periods.

The difference in results between my research and the research conducted by DKO (2019) can be devoted to the difference in the panel dataset selection procedure and research design. To determine what change drives the differences in results, I execute the regression models for each change separately. Starting with the panel dataset and research design similar to DKO (2019), I make changes once at the time to isolate their effect on the results. When adding stock options granted to the CIO and CFO, I find results similar to prior research. The significance of interaction variable *dTreat* x *dPre* even increases. This can be explained by the increase in the number of observations and furthermore confirms the assumed power of the CFO and CIO to alter the share repurchase activity. When changing the normal and pre period to only two months instead of three, again the significance of the negative coefficient of interaction variable *dTreat* x *dPre* increases. This substantiates my choice for the shorter time periods.

The difference in results between prior research and mine can be devoted to the allowance of non-overlapping stock option grant windows only. When restricting on non-overlapping stock option grants when reconstructing prior research, I find evidence for the significant increase in share repurchase activity following stock option grants, instead of the significant decrease in share repurchase activity preceding stock option grants. Again, the robustness of the model increases when adding stock options granted to the CFO and CIO, and when reducing the normal and pre period to only two months.

5.3 Stock Options and Cash Salary Compensation Balance

The relation between stock option grants and share repurchase activity is expected to be stronger when the executives' exposure to the share price increases. Regression Equation III measures the relation between the share repurchase activity and the natural logarithm of the *Compensation Proportion*. Hypotheses 3 states that the relation is negative in the pre period as I expect empowered executives to be incentivized to prevent share price increases prior to receiving at-the-money granted stock options. Hypothesis 4 sounds that

the relation between the two is significantly positive in the post period as empowered executives gain more private wealth from share price increases when receiving a large proportion of their compensation in stock options. On the other hand, companies compensating their executives in stock options to a larger extent might increase their share repurchase activity to fund stock option exercises and prevent their dilutive effect. Table XI provides the results of Regression Equation III, assessing the relation between the *Compensation Proportion* measure and share repurchase activity.

Table XI: Results Compensation Proportion Analysis

This table provides the results of Regression Equation III reflecting the relation between the natural logarithm of the *Compensation Proportion* measure and share repurchase activity, using the difference-in-difference model. Control variables are included in the regression models, however not shown in the results due to space limitations. For the *Repurchase Volume* and *Ln(Repurchase Value)* dependent variables the OLS regression method is used, whereas I use a logit regression for the *dRepurchase* dependent variable. The partial F-test finds no significant differences between interaction variables *Ln(Compensation Proportion)* x *dPre* and *Ln(Compensation Proportion)* x *dPost*. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. All variables are defined in Table XIV of the Appendix.

Model	(1) Treatment & Control Firms OLS	(2) Treatment & Control Firms Logit	(3) Treatment & Control Firms OLS
Dependent Variable	Repurchase Volume	dRepurchase	Ln(Repurchase Value)
dPre	0.0084	-0.0398	0.0591
	(0.54)	(-0.35)	(0.75)
dPost	0.0244	0.0999	0.1448
	(1.30)	(0.69)	(1.28)
Ln(Compensation Proportion)	-0.0136	-0.0083	-0.0220
	(-0.90)	(-0.07)	(-0.18)
Ln(Compensation Proportion) x dPre	0.0260**	0.1773**	0.1027
	(2.01)	(2.04)	(1.53)
Ln(Compensation Proportion) x dPost	0.0227	0.2416**	0.1873**
	(1.53)	(2.30)	(2.24)
Control Variables	YES	YES	YES
Firm Fixed Effects	YES	NO	YES
Year-Month Fixed Effects	YES	NO	YES
Random Effects	NO	YES	NO
Observations (# Months)	7,411	7,411	7,411
# Unique Firms	551	551	551
Adjusted R-Squared	0.2079		0.4452
McKelvey & Zavoina's R-Squared		0.1752	
p-Value of Partial F-Test	0.8066	0.4948	0.2676

The coefficient of variable *Ln(Compensation Proportion)* itself is not significant which implies that the fair value of stock options scaled by total cash salary has no significant impact on the share repurchase activity in the normal period. However, the *Compensation Proportion* measure does have a significant positive effect on the share repurchase activity in both the months preceding and following stock option grants. Again, the difference-in-difference method accounts for the difference in share repurchase activity between the

normal period and both the pre and post period surrounding the placebo event of control firms. The included control variables are not shown in detail due to space limitations, however, their signs and significance is similar to the prior regression models.

Unfortunately, the relation of the interaction variables cannot be quantified due to the use of the natural logarithm of the *Compensation Proportion* measure. Still, hypothesis 3 can be rejected as I conclude that companies actually significantly increase the share repurchase activity prior to stock option grants when *Compensation Proportion* measure increases. As this significant increase is also found for the post period, hypothesis 4 is accepted. The results support the anti-dilution and stock option funding theories, suggesting that companies increase their share repurchase activity around stock option grants when companies to a greater extent compensate executives in stock options. I find no evidence suggesting that executives opportunistically time the share repurchase activity. A partial F-test determines that the difference between the coefficients of interaction variables *Ln(Compensation Proportion)* x *dPre* and *Ln(Compensation Proportion)* x *dPost* is not statistically significant.

5.4 Robustness Checks and Results Comprehension

In an effort to verify the direction of the relation between stock option grants and share repurchase activity, I attend to hypothesis 5. Instead of timing share repurchases around stock option grants, empowered executives might be timing stock option grants around share repurchases instead. As discussed in Section 4.3, I separate dummy variable *dTreat* into two new dummies representing scheduled and unscheduled stock option grants to test the causality of the relation. Table XII provides the results of Regression Equation IV.

The interaction variables estimate the difference in share repurchase activity between the pre and post period surrounding both scheduled and unscheduled stock option grants. Model (1) suggests that indeed a relation between share repurchase activity and stock option grants only exists for unscheduled stock option grants. The amount of shares companies repurchase as proportion of total number of shares outstanding is 0.0410 percentage points higher after than before unscheduled stock option grants. As the relation with scheduled stock option grants is not significant, one could argue that empowered executives opportunistically time the moment of stock option granting prior to share repurchases instead. However, this relation is only marginal significant and more explanatory power can be attributed to the second and third regression model. Both models show a significant positive relation between share repurchase activity and both scheduled and unscheduled stock option grants. Considering the logit regression, the log odds for companies to repurchase their shares after scheduled and unscheduled stock option grants is respectively 0.4431 and 0.4680 higher than in the period preceding scheduled and unscheduled stock option grants. Partial F-tests finds no statistical significant differences between the coefficients of interaction variables *dScheduled* x *dPost* and *dUnscheduled* x *dPost* for all measures of share repurchase activity. Therefore, I conclude that the relation between share repurchase activity and stock option grants is not statistically different for scheduled or unscheduled stock option grants, and therefore hypothesis 5 is accepted. There are no

Table XII: Results Causality Test

This table provides the results of Regression Equation IV, testing for differences between share repurchase activity around scheduled and unscheduled stock option grants. For the *Repurchase Volume* and *Ln(Repurchase Value)* dependent variables the OLS regression method is used, whereas I use a logit regression for the *dRepurchase* dependent variable. The regression models are all simple difference analyses, as only the treatment group is included. Control variables are accounted for however not shown in detail. The partial F-test finds no significant differences between interaction variables *dScheduled* x *dPost* and *dUnscheduled* x *dPost*. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. All variables are defined in Table XIV of the Appendix.

Model	(1) Treatment Firms only OLS	(2) Treatment Firms only Logit	(3) Treatment Firms only OLS
Dependent Variable	Repurchase Volume	dRepurchase	Ln(Repurchase Value)
dScheduled	0.0673	0.3912	0.2102
	(1.61)	(1.49)	(1.31)
dScheduled x dPost	0.0354	0.4431***	0.3090**
	(1.39)	(2.60)	(2.18)
dUnscheduled x dPost	0.0410*	0.4680***	0.3601***
	(1.84)	(2.75)	(2.95)
Control Variables	YES	YES	YES
Firm Fixed Effects	YES	NO	YES
Year-Month Fixed Effects	YES	NO	YES
Random Effects	NO	YES	NO
Observations (# Months)	3,533	3,530	3,533
# Unique Firms	406	406	406
Adjusted R-Squared	0.2635		0.5002
McKelvey & Zavoina's R-Squared		0.2543	
p-Value of Partial F-Test	0.9250	0.8414	0.7881

reasons to believe that stock options are opportunistically timed around share repurchases.

Until now, it remains unclear whether to attribute the relation between stock option grants and share repurchase activity to the opportunistic timing theory, the theories regarding stock option funding and anti-dilution, or a combination of both. In an effort to disentangle both rationales and draw clear conclusions, I investigate the relation between share repurchases and at-the-money granted stock options to non-empowered executives. Differences in relations can be attributed to the ability to time share repurchase activity, as non-empowered executives are presumed not to have discretion over the share repurchase activity.

A panel dataset is now constructed including at-the-money stock option grants to non-empowered executives only. Again, the selected treatment group is matched to a control group generating 799 successful matches. Table XIII presents the results of the difference-in-differences analyses using the accustomed dependent variables and research design. The dummy *dTreat* now represents at-the-money stock option grants to non-empowered executives only. The results in this setting are interesting, as I find a significant increase in share repurchase activity in both the pre and post period surrounding stock option grants to non-empowered executives when compared to the normal period. This result supports

the anti-dilution and stock option funding theories. The partial F-test shows that the significant positive increasing effect does not differs between the pre and post period and therefore the sixth hypothesis is accepted. The results provide no evidence supporting the opportunistic timing theory, as non-empowered executives are subjected to share price increases due to the share repurchases prior to receiving the stock options. When investigating stock option grants to empowered executives, I only find a significant increase in share repurchase activity in the post period. Based on this difference in results, I conclude that empowered executives effectively time the share repurchases opportunistically for their private benefit.

Table XIII: Results Robustness Check Analysis

This table provides the results of the robustness check using stock option grants to non-empowered executives. For the *Repurchase Volume* and *Ln(Repurchase Value)* dependent variables the OLS regression method is used, whereas I use a logit regression for the *dRepurchase* dependent variable. Control variables are accounted for however not shown in detail. The partial F-test finds no significant differences between interaction variables *dTreat (Non-Empowered* x *dPre* and *dTreat (Non-Empowered* x *dPost*. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. All variables are defined in Table XIV of the Appendix.

Model	Treatment Control Firms OLS	Treatment Control Firms Logit	Treatment Control Firms OLS
Dependent Variable	Repurchase Volume	dRepurchase	Ln(Repurchase Value)
dPre	-0.0338	-0.2726	-0.1436
	(-1.41)	(-1.59)	(-1.20)
dPost	0.0148	0.1223	0.0763
	(0.59)	(0.63)	(0.56)
dTreat (Non-Empowered)	-0.0495	-0.1759	-0.2137
	(-1.57)	(-0.79)	(-0.95)
dTreat (Non-Empowered) x dPre	0.0804***	0.4337**	0.2850**
	(2.84)	(2.15)	(2.05)
dTreat (Non-Empowered) x dPost	0.0499*	0.3001	0.2873**
	(1.85)	(1.50)	(2.07)
Control Variables	YES	YES	YES
Firm Fixed Effects	YES	NO	YES
Year-Month Fixed Effects	YES	NO	YES
Random Effects	NO	YES	NO
Observations (# Months)	7,993	7,993	7,993
# Unique Firms	574	574	574
Adjusted R-Squared	0.2167		0.4725
McKelvey & Zavoina's R-Squared		0.2051	
p-Value of Partial F-Test	0.1747	0.4964	0.9897

6. Conclusion and Implications

6.1 Conclusion

In this research, I investigate the potential opportunistic timing of open-market share repurchase activity around at-the-money stock option grants to the CEO, CFO and CIO of the company. These executives are considered to be empowered to change the share repurchase activity of the company. They have an incentive to time share repurchases as this would allow them to privately benefit from the share price increasing effect share repurchases cause. Using OLS and logistic regression models, I find that share repurchase activity is significantly positively related to the executives' proportion of compensation granted in stock options, both in the months preceding and following stock options. The increase in share repurchase activity around stock option grants is in line with the anti-dilution and stock option funding theory as suggested by Kahle (2002) and Bens et al. (2003). However, when comparing to the normal period, companies significantly increase their share repurchase activity only following at-the-money stock option grants to empowered executives. More specifically, companies increase the amount of share repurchases as percentage of the total number of shares outstanding by 0.0477 percentage points. This magnitude is of economic significance given that companies on average repurchase 0.176% of their shares each month. This suggests that empowered executives opportunistically time the moment of the share repurchases. An increase in share repurchase activity prior to the grants would inflate the exercise price of their at-the-money granted stock options. To verify this conclusion, I investigate the relation between share repurchase activity and stock option grants to non-empowered executives. In this setting, companies significantly increase their share repurchase activity in both the months preceding and following stock option grants. The increase in share repurchase activity around stock option grants is in line with the anti-dilution and stock option funding theory as suggested by Kahle (2002) and Bens et al. (2003).

To confirm the direction of the relation between share repurchase activity and stock option grants, stock options are separated in scheduled and unscheduled grants. If empowered executives in fact would be timing stock option grants around share repurchases, one would expect to see a relation only for unscheduled stock option grants, as they would not be able to opportunistically time scheduled stock option grants. I find a significant relation between share repurchase activity and both scheduled and unscheduled stock options and therefore no longer question the causality of the relation. When combining the results of this research, I draw two main conclusions. (i) Companies significantly increase their share repurchase activity both before and after stock option grants to fund stock option exercises and prevent their dilutive effect. (i) Empowered executives opportunistically time these repurchases by postponing the share repurchase activity until after they receive their at-the-money stock options.

My research is inspired by DKO (2019), in which the researchers as well conclude that share repurchases are opportunistically timed around at-the-money granted stock options. However, they find a significant decrease prior to the stock option grants instead. I contribute to the literature by using an improved panel dataset and by refining the research design to test for opportunistic timing of share repurchase activity around at-the-money stock option grants to empowered executives. The main driver for the differences in results can is the allowance for non-overlapping stock option grant windows only, whereas the other changes increase the robustness of the analyses. The improvements generate new insights and contribute to a vast amount of research regarding agency problems.

6.2 Implications and Suggestions for Further Research

The conclusion that empowered executives effectively time company share repurchases opportunistically around the moment they receive at-the-money granted stock options is of importance for the shareholders of the company. Companies grant stock options to align executives' incentives to those of the shareholders. However, this research shows that the stock option granting in fact leads to new agency problems instead. The opportunistic timing of share repurchase activity is expected to be costly for shareholders, as the company needs to divert from its optimal share repurchase strategy. The monetary implications of this practice are beyond the scope of this research, however worthwhile to investigate in further research. Shareholders might need to restrict the empowered executives' ability to alter the share repurchase activity in the months surrounding stock option grants, in an attempt to prevent opportunistic timing.

The conclusions regarding the anti-dilution and stock option funding theories are based on the expectation that stock options are granted without a vesting time and therefore can be executed immediately. However, stock options are often granted with either a vesting time or vesting threshold that needs to be reached first before execution is allowed. If this is the case, there is no need for the company to repurchase shares fund stock option exercises or to offset the dilutive effect. There is insufficient data available to focus on stock option grants without vesting clauses solely. I expect the relation between share repurchase activity and stock option grants to be even stronger when focusing on stock option grants without vesting restrictions. Furthermore, this research focuses on open-market share repurchases only. Detailed information on other types of actual share repurchases is limited. I suggest further research to include tender offer share repurchase programs as their price increasing effect in general is stronger, increasing the incentive for executives to time them to their personal benefits.

7. Appendix

Table XIV: Variable Definitions

The following table provides the descriptions of all variables used in this research. The variables are ordered alphabetically.

Variable	Description
Age ≥ 62	The proportion of empowered executives with an age of at least 62
Annual Industry-Adjusted Stock Return	The company's annual stock return adjusted for the annual industry return, determined by the company's corresponding SIC code. The measure is winsorized at the 95% level
Bid-Ask Spread	The dollar value difference between the bid price and ask price at the last trading day of the corresponding month
Blackout	The number of days between the report date of the quarterly earnings and the actual end date of the corresponding period
Book-to-Market Ratio	The book value of equity divided by the market value of equity
dChairman	A dummy variable indicating if one of the empowered executives is concurrently the chairman of the board
Dividend Yield	The annual cumulative dollar value of dividends per share divided by the closing share price at the last trading day of the year
dLoss	A dummy variable indicating whether the company reported a loss in the corresponding quarter
dPre	A dummy variable indicating the pre period; the two months preceding a stock option grant
dPost	A dummy variable indicating the post period; the three months following a a stock option grant
dRepurchase	A dummy variable indicating whether the company conducts an open-market share repurchase
dScheduled	A dummy variable indicating whether the stock option grant was scheduled. A stock option grant is considered to be scheduled when the same executive received stock options in the preceding year in a 7-day window
dTreat	A dummy variable indicating the occurrence of a stock option grant
dUnscheduled	A dummy variable indicating whether the stock option grant was unscheduled. See the description of variable *dScheduled* for the definition of the scheduledness of stock option grants
Empowered Executive	An executive is considered to be empowered to change the share repurchase activity when holding either the CEO, CFO or CIO position in the company
Females	The proportion of empowered executives being females
Leverage Ratio	The book value of total liabilities divided by the book value of total assets
Ln(Age)	The natural logarithm of the average age of empowered executives
Ln(Assets)	The natural logarithm of the book value of total assets. Proxy for the size of the company
Ln(Compensation Proportion)	The natural logarithm of the dollar fair value of the stock option grant divided by the dollar value of the executives' total cash salary
Ln(Executives 'Equity Sensitivity)	The natural logarithm of 1% of the average market value of assets owned by empowered executives. Proxy for the exposure to the share price of the company
Ln(Repurchase Value)	The natural logarithm of the per month average dollar value of the shares repurchased in the open-market
Ln(Revenue Growth)	The natural logarithm of the annual revenue percentage growth
Normal period	The third and fourth month preceding stock option grants. The share repurchase activity in these month is expected to be unaffected by the grant
Repurchase Volume	The per month average amount of shares repurchased in the open-market as percentage of the total amount of shares outstanding
ROA	The return on assets measured as the dollar value of the EBITDA in a year scaled by the book value of total assets
Stock Return	The dollar value stock return of the company in a particular month

Table XV: Replicating Sample Construction Prior Research

This table provides an overview of the sample selection when following the criteria used in the research conducted by DKO (2019). The remaining firm-months in Panel B are all successfully matched to control firm-months, selected from the sample of firm-months without stock option grants remaining in Panel A.

Panel A: Sample Selection			
		Firm-Months	Companies
Initial panel dataset		141,764	2,607
Missing Compustat data		-9,913	
Missing ExecuComp data		-31,526	
	Remaining	100,325	2,436
	Without stock option grants	92,514	2,436
	With stock option grants	7,811	1,332

Panel B: Potential Treatment Group Determination			
		Firm-Months	Companies
With stock option grants		7,811	1,332
Non-at-the-money granted stock options		-3,561	
Stock options granted to others than the CEO		-1,888	
	Remaining	2,362	844

Table XVI: Results Share Repurchase Activity Per Month

This table shows the relation between stock option grants and the share repurchase activity per month separately when compared to the normal period. Control variables are included in the regression, however, not shown in the results due to space limitations. For the *Repurchase Volume* and *Ln(Repurchase Value)* dependent variables the OLS regression method is used, whereas I use a logit regression for the *dRepurchase* dependent variable. Z-statistics are displayed in the parentheses. Considering a two-tailed test, *, **, *** indicate statistical significance at the 10, 5 and 1% level, respectively. As shown, the control group does not significantly change its share repurchase activity surrounding placebo events. The treatment group significantly increases its share repurchase activity in the three months following the stock option grant. However, these differences are only marginal significant in t+1 and t+3 when accounting for the difference in share repurchase activity of the control group, as reflected by the difference-in-difference model (5). All variables are defined in Table XIV of the Appendix.

Model	(1) Control Firms Only OLS	(2) Treatment Firms Only OLS	(3) Treatment & Control Firms OLS	(4) Treatment & Control Firms Logit	(5) Treatment & Control Firms OLS
Dependent Variable	Ln(Repurchase Value)		Repurchase Volume	dRepurchase	Ln(Repurchase Value)
t-2	0.0240	0.1530	0.0201	0.0034	0.0627
	(0.17)	(1.37)	(0.60)	(0.02)	(0.45)
t-1	-0.0319	0.132	-0.0003	0.0062	0.0279
	(-0.18)	(1.07)	(-0.01)	(0.03)	(0.19)
t+1	-0.1520	0.4860***	0.0184	0.0900	0.0278
	(-0.72)	(3.23)	(0.52)	(0.37)	(0.14)
t+2	-0.2950	0.3010**	0.0136	-0.0725	-0.0174
	(-1.51)	(2.02)	(0.38)	(-0.32)	(-0.09)
t+3	-0.3510*	0.4520***	-0.0131	-0.0466	-0.0047
	(-1.74)	(3.00)	(-0.38)	(-0.19)	(-0.02)
dTreat			-0.0116	-0.1960	-0.2810
			(-0.29)	(-0.74)	(-1.08)
t-2 x dTreat			0.0112	0.1350	0.1290
			(0.30)	(0.59)	(0.75)
t-1 x dTreat			0.0204	0.0459	0.0992
			(0.60)	(0.18)	(0.58)
t+1 x dTreat			0.0561	0.2890	0.4030*
			(1.36)	(1.06)	(1.89)
t+2 x dTreat			0.0021	0.2820	0.2360
			(0.05)	(1.10)	(1.21)
t+3 x dTreat			0.0333	0.4260	0.3510*
			(0.90)	(1.56)	(1.70)
Control Variables	YES	YES	YES	YES	YES
Firm Fixed Effects	YES	YES	YES	NO	YES
Year-Month Fixed Effects	YES	YES	YES	NO	YES
Random Effects	NO	NO	NO	YES	NO
Observations (# Months)	2,865	4,469	7,334	7,334	7,334
# Unique Firms	252	406	553	553	553
Adjusted R-Squared	0.5110	0.4723	0.2123		0.4596
McKelvey & Zavoina's R-Squared				0.1738	

References

Almeida, H., Fos, V., & Kronlund, M. (2016). The real effects of share repurchases. *Journal of Financial Economics*, *119*(1), 168–185.

Asuero, A. G., Sayago, A., & Gonzalez, A. (2006). The correlation coefficient: An overview. *Critical reviews in analytical chemistry*, *36*(1), 41–59.

Babenko, I., Tserlukevich, Y., & Vedrashko, A. (2012). The credibility of open market share repurchase signaling. *Journal of Financial and Quantitative Analysis*, *47*(5), 1059–1088.

Baber, W. R., Janakiraman, S. N., & Kang, S.-H. (1996). Investment opportunities and the structure of executive compensation. *Journal of Accounting and Economics*, *21*(3), 297–318.

Bagwell, L. S. (1991). Share repurchase and takeover deterrence. *The Rand journal of economics*, 72–88.

Baker, & Hall, B. J. (2004). Ceo incentives and firm size. *Journal of Labor Economics*, *22*(4), 767–798.

Bens, D. A., Nagar, V., Skinner, D. J., & Wong, M. F. (2003). Employee stock options, eps dilution, and stock repurchases. *Journal of Accounting and Economics*, *36*(1-3), 51–90.

Berman, M. L. (1987). Sec takeover regulation under the williams act. *NYUL Rev.*, *62*, 580.

Black, F., & Scholes, M. (1973). The pricing of options and corporate liabilities. *Journal of political economy*, *81*(3), 637–654.

Bonaime, A. A., & Ryngaert, M. D. (2013). Insider trading and share repurchases: Do insiders and firms trade in the same direction? *Journal of Corporate Finance*, *22*, 35–53.

Busch, P., & Obernberger, S. (2016). Actual share repurchases, price efficiency, and the information content of stock prices. *The Review of Financial Studies*, *30*(1), 324–362.

Cochran, W. G., & Rubin, D. B. (1973). Controlling bias in observational studies: A review. *Sankhyā: The Indian Journal of Statistics, Series A*, 417–446.

Comment, R., & Jarrell, G. A. (1991). The relative signalling power of dutch-auction and fixed-price self-tender offers and open-market share repurchases. *The Journal of Finance*, *46*(4), 1243–1271.

Core, J., & Guay, W. (1999). The use of equity grants to manage optimal equity incentive levels. *Journal of accounting and economics*, *28*(2), 151–184.

Dann, L. Y. (1981). Common stock repurchases: An analysis of returns to bondholders and stockholders. *Journal of Financial Economic*, 113-138.

DeAngelo, H., & Masulis, R. W. (1980). Optimal capital structure under corporate and personal taxation. *Journal of financial economics*, *8*(1), 3–29.

Dechow, P. M., Hutton, A. P., & Sloan, R. G. (1996). Economic consequences of accounting for stock-based compensation. *Journal of Accounting Research*, *34*, 1–20.

Demsetz, H., & Lehn, K. (1985). The structure of corporate ownership: Causes and consequences. *Journal of political economy*, *93*(6), 1155–1177.

Denis, D. J. (1990). Defensive changes in corporate payout policy: Share repurchases and special dividends. *The Journal of Finance*, *45*(5), 1433–1456.

Dittmann, I., Keusch, T., & Obernberger, S. (2019). Share repurchases and stock options grants (working paper). *Available at SSRN 3316793*.

Dittmar, A. K. (2000). Why do firms repurchase stock. *The Journal of Business*, *73*(3), 331–355.

Dittmar, A. K., & Field, L. C. (2015). Can managers time the market? evidence using repurchase price data. *Journal of Financial Economics*, *115*(2), 261–282.

Edmans, A., Fang, V. W., & Huang, A. (2018). The long-term consequences of short-term incentives (working paper no. 527/2017).

Egan, M. (2018). Are stock buybacks deepening america's inequality? *CNN Business*. Retrieved 2019-10-20, from `https://money.cnn.com/2018/03/05/investing/stock-buybacks-inequality-tax-law/index.html`

Fama, E. F., & French, K. R. (1997). Industry costs of equity. *Journal of financial economics*, *43*(2), 153–193.

Fenn, G. W., & Liang, N. (2001). Corporate payout policy and managerial stock incentives. *Journal of financial economics*, *60*(1), 45–72.

Fried, J. M. (2000). Insider signaling and insider trading with repurchase tender offers. *U. Chi. L. Rev.*, *67*, 421.

Fried, J. M. (2001). Open market repurchases: signaling or managerial opportunism? *Theoretical inquiries in Law*, *2*(2).

Fried, J. M. (2005). Informed trading and false signaling with open market repurchases. *Calif. L. Rev.*, *93*, 1323.

Frye, M. B. (2004). Equity-based compensation for employees: firm performance and determinants. *Journal of Financial Research*, *27*(1), 31–54.

Grullon, G., & Ikenberry, D. L. (2000). What do we know about stock repurchases? *Journal of Applied Corporate Finance*, *13*(1), 31–51.

Grullon, G., & Michaely, R. (2004). The information content of share repurchase programs. *The Journal of Finance*, *59*(2), 651–680.

Guay, W., & Harford, J. (2000). The cash-flow permanence and information content of dividend increases versus repurchases. *Journal of Financial Economics*, *57*(3), 385–415.

Harrell Jr, F. E. (2015). *Regression modeling strategies: with applications to linear models, logistic and ordinal regression, and survival analysis*. Springer.

Himmelberg, C. P., Hubbard, R. G., & Palia, D. (1999). Understanding the determinants of managerial ownership and the link between ownership and performance. *Journal of financial economics*, *53*(3), 353–384.

Hribar, P., Jenkins, N. T., & Johnson, W. B. (2006). Stock repurchases as an earnings

management device. *Journal of Accounting and Economics*, *41*(1-2), 3–27.

Ikenberry, D., Lakonishok, J., & Vermaelen, T. (1995). Market underreaction to open market share repurchases. *Journal of financial economics*, *39*(2-3), 181–208.

Ikenberry, D., Lakonishok, J., & Vermaelen, T. (2000). Stock repurchases in canada: Performance and strategic trading. *The Journal of Finance*, *55*(5), 2373–2397.

Ittner, C. D., Lambert, R. A., & Larcker, D. F. (2003). The structure and performance consequences of equity grants to employees of new economy firms. *Journal of Accounting and Economics*, *34*(1-3), 89–127.

Jagannathan, M., Stephens, C. P., & Weisbach, M. S. (2000). Financial flexibility and the choice between dividends and stock repurchases. *Journal of financial Economics*, *57*(3), 355–384.

Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *The American economic review*, *76*(2), 323–329.

Jensen, M. C., & Murphy, K. J. (1990). Performance pay and top-management incentives. *Journal of political economy*, *98*(2), 225–264.

Kahle, K. M. (2002). When a buyback isn'ta buyback: Open market repurchases and employee options. *Journal of Financial Economics*, *63*(2), 235–261.

Kamma, S., Kanatas, G., & Raymar, S. (1992). Dutch auction versus fixed-price self-tender offers for common stock. *Journal of Financial Intermediation*, *2*(3), 277–307.

Knott, A. M. (2019). Why the tax cuts and jobs act (tcja) led to buybacks rather than investment. *Forbes*. Retrieved 2019-10-20, from `https://www.forbes.com/sites/annemarieknott/2019/02/21/why-the-tax-cuts-and-jobs-act-tcja-led-to-buybacks-rather-than-investment/#27a7070037fb`

Lakonishok, J., & Vermaelen, T. (1990). Anomalous price behavior around repurchase tender offers. *The Journal of Finance*, *45*(2), 455–477.

Lang, L. H., Stulz, R., & Walkling, R. A. (1991). A test of the free cash flow hypothesis: The case of bidder returns. *Journal of Financial Economics*, *29*(2), 315–335.

Lie, E. (2002). Do firms undertake self-tender offers to optimize capital structure? *The Journal of Business*, *75*(4), 609–639.

Louis, H., Sun, A. X., & White, H. (2010). Insider trading after repurchase tender offer announcements: Timing versus informed trading. *Financial Management*, *39*(1), 301–322.

McNally, W. J., Smith, B. F., & Barnes, T. (2006). The price impacts of open market repurchase trades. *Journal of Business Finance & Accounting*, *33*(5-6), 735–752.

Mehran, H. (1995). Executive compensation structure, ownership, and firm performance. *Journal of financial economics*, *38*(2), 163–184.

Merton, R. C., et al. (1973). Theory of rational option pricing. *Theory of Valuation*, 229–288.

Moore, D. (2018). Managerial self-interest and strategic repurchases: Evidence from equity vesting schedules.

Persons, J. C. (1994). Signaling and takeover deterrence with stock repurchases: Dutch auctions versus fixed price tender offers. *The journal of finance*, *49*(4), 1373–1402.

Pettit, R. R., Ma, Y., & He, J. (1996). Do corporate insiders circumvent insider trading regulations? the case of stock repurchases. *Review of Quantitative Finance and Accounting*, *7*(1), 81–96.

Peyer, U. C., & Vermaelen, T. (2008). The nature and persistence of buyback anomalies. *The Review of Financial Studies*, *22*(4), 1693–1745.

PRNewswire. (2019). S&p 500 q4 2018 buybacks set 4th consecutive quarterly record at $223 billion; 2018 sets record $806 billion. *PRNewswire*.

Raynor Jr, W. J. (1983). Caliper pair-matching on a continuous variable in case-control studies. *Communications in Statistics-Theory and Methods*, *12*(13), 1499–1509.

Smith Jr, C. W., & Watts, R. L. (1992). The investment opportunity set and corporate financing, dividend, and compensation policies. *Journal of financial Economics*, *32*(3), 263–292.

Stephens, C. P., & Weisbach, M. S. (1998). Actual share reacquisitions in open-market repurchase programs. *The Journal of finance*, *53*(1), 313–333.

Vermaelen, T. (1981). Common stock repurchases and market signalling: An empirical study. *Journal of financial economics*, *9*(2), 139–183.

Windmeijer, F. A. (1995). Goodness-of-fit measures in binary choice models. *Econometric Reviews*, *14*(1), 101–116.

Yermack, D. (1995). Do corporations award ceo stock options effectively? *Journal of financial economics*, *39*(2-3), 237–269.

Zhang, H. (2005). Share price performance following actual share repurchases. *Journal of Banking & Finance*, *29*(7), 1887–1901.