

The Time Relationship between Stock option and Repurchase

Lu Deng

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By: Lu Deng

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Signed by the final Examining Committee:

Dr. Saif Ullah

Examiner

Dr. Denis Schweizer

Supervisor

Dr. Juliane Proelss

Supervisor

Approved by

Dr. Nilanjan Basu

Graduate Program Director

Dr. Anne-Marie Croteau

Dean of Faculty

Dr. Kathleen Boies

Associate Dean of Faculty

Date: August 1, 2020

Abstract

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This paper examines the time relationship between repurchases and stock option exercises in the firms. Firms with more option exercised in the last year and current year are more likely to make repurchase decision. On the one hand, repurchase can help alleviate dilution caused by past option exercises. On the other hand, managers match the expenses on repurchases with the payment of contemporaneous option exercises to realize the stable cash flow. Total options outstanding also affect the likelihood of repurchase decision, which means managers may consider expected future option exercises in decision-making. Once the decision is made, past, concurrent option exercises and expected future stock option exercises are also positively related to actual repurchase level (dollars spent on repurchase). Contemporaneous relation is the strongest in both regressions as previous paper suggests. We also find that executive options outstanding have a positive effect on the likelihood of repurchase decision and actual repurchase level. This paper also uses propensity score matching method to test the effects of repurchase activity and high option holdings (which ranks the 1st quartile with the same industry) on firms' profitability indicator ROA. We find that a high percentage of executive options, instead of a high holding of total stock options, has a positive effect on ROA in repurchasing firms.

Key words: repurchase, option exercise, undervaluation, takeover

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Table of Contents

1. INTRODUCTION	1
2. LITERATURE REVIEW	7
3. HYPOTHESES	12
3.1 TIME RELATIONSHIP BETWEEN REPURCHASE AND OPTION EXERCISE	12
3.2 CONTEMPORANEOUS RELATION HYPOTHESIS	14
3.3 REPURCHASE AND PERFORMANCE OF THE FIRMS	15
3.4 STOCK OPTION AND PERFORMANCE OF THE FIRMS	17
4. DATA AND METHODOLOGY	17
4.1 SAMPLE CONSTRUCTION AND INDUSTRY DISTRIBUTION	17
4.2 VARIABLE DENIFITIONS	19
4.3 DESCRIPTIVE STATISTICS	22
4.4 METHODOLOGY	23
5. RESULTS.....	27
5.1 RESULTS FOR MODEL I ON REPURCHASE DECISION	27
5.2 RESULTS FOR MODEL II ON REPURCHASE LEVEL	31
5.3 RESULTS FROM PROPENSITY SCORE MATCHING (PSM).....	34
5.4 ROBUSTNESS TESTS	36
6. CONCLUSION	36
REFERENCES.....	40
APPENDICES	45

1. Introduction

Stock repurchases have been one of the popular research topics in corporate finance in recent years with researchers paying more and more attention to the rapid growth of stock repurchase. Since the late 1970s, corporations engage increasingly to buy back shares as a way of distributing cash to shareholders in addition to tradition dividends. According to Jolls (1998), repurchase only accounted for 7.1 percent of total cash distributions in late 5 years of 1970s then it surged to 25.6 percent on average between 1992 and 1996. Balachandran (2008) finds that repurchase behavior became more concentrated after 1998 and it may be the consequence of deregulation of legislation in 1995.

The topic why firms repurchase stock has triggered interest of many researchers. Previous papers (Vermaelen, 1981; Jensen, 1986; Opler and Titman, 1996) try to find out the motives and they give the explanations such as excess capital distribution, undervaluation (signal effect) and optimal leverage ratio hypotheses. At the same time, researchers find that stock option grants are used increasingly by corporations.

The concurrent increase trend made the researchers to associate stock options with repurchases. Many empirical studies have documented the positive relationship between repurchase activity and stock option. Weisbenner (2000) finds a general link between share repurchases and past option grants. He thinks the overall size of the option program can be a predictor of share repurchases since repurchase can help alleviate the erosion to EPS caused by stock options. Jolls (1998) illustrates managerial stock option can significantly affect repurchase decision. In order to maximize the payoff of executive option, managers are more willing to choose repurchases over dividends because repurchases, unlike dividends, do not reduce the stock price. However, Kahle (2002) gives evidence that total options exercisable, rather than executive options, have explanatory power on level of actual repurchase and this may suggest that the market has recognized the self-interest motive of

managers in a repurchase. Bens et al. (2003) attribute the positive relationship between employee options (ESOs) and repurchase behavior to managers' financial reporting incentives to manage diluted EPS, given that EPS is the concern of investors and repurchase can decrease the shares in the market to improve the earning per share. Stock returns may be associated with repurchase activities and options. The concurrent use of repurchases and options can slow down the pace of expected stock retirements (firm repurchase shares and cancel them) by analysts' and investors' forecasts since repurchase and option exercises have an opposite effect on the number of common shares outstanding. Liang and Sharpe (1999) find this slow-down effect influences stock prices after calibrating the effect of expected retirements on valuation. On the other hand, repurchase can also be considered as a means of releasing signal of stock price undervaluation by management although some firms may buy back shares only for alleviating the dilution effect of option exercise on EPS (firms repurchase shares with paid-in capital rather than earnings), which makes market reaction to repurchase complicated and elusive. Therefore, many researchers (Dann, 1981; Vermaelen, 1981; Kahle, 2002) focus on the relationship between announcement-period returns and stock option of firms. Kahle (2002) documents a negative association regarding total options outstanding and stock returns since market can distinguish the motives of the buybacks, and recognizes that the repurchase used by firms may be just for funding total option exercise instead of releasing undervaluation signal; while he finds stock returns are positively related to executive options outstanding since executive options can align the interests of managers with those of shareholders and thus alleviate agency problem.

Most early studies investigate the quantitative relationship between repurchase activity and total or executive stock option, however, few research papers pay attention to the time relationship of repurchase and option exercises, that is, which would take place first. Moreover, although announcement-period returns to repurchase based on stock price changes have been the considered in the previous

empirical studies as we discussed above, few of them examined the performance comparison among firms with different magnitude of repurchase and option programs.

The timing of repurchase activity depends on the purposes of share buybacks. Jolls (1998) finds that corporate executive option holdings encourage subsequent repurchase decisions made by managers due to agency issues. Weisbenner (2000) provides evidence that ongoing repurchases are conducted over the whole life of an option (rather than when the option is exercised) in order to counter the dilution effect of past option grants on earning per share. Kahle (2002) further shows that repurchase can be used for funding upcoming stock option exercises, which suggests repurchases precede stock option exercises. By contrast, Griffin and Zhu (2010) examine the changes in common shares outstanding from the repurchase for 2005 through 2007 and they report that the contemporaneous relation between repurchase and option exercise is the strongest compared to sequential relation, indicating that firms are more likely to use the buyback to correspond with current option exercises. However, these results based on simple comparison among coefficients in three separate regressions could be a problematic way since the available data in the sample is limited and the period of 3 years is short in the study. Moreover, according to Jagannathan et al. (2000), change in shares outstanding could be an imperfect and indirect measure of repurchase when there is any redistribution of shares in the year.

In this paper, I use a large sample of all US companies listed on Compustat during 2000-2019 to further explore the time relationship between repurchase and stock option. To be specific, firms may repurchase to fund upcoming option exercises according to option-funding (pre-funding) hypothesis, or they may repurchase after option exercises to adjust EPS in an ex-post way. Besides, it is also possible that repurchase and option exercises are jointly determined by firms in the year. We will examine both the contemporaneous relation and sequential relation and to find out which relation is stronger. Regarding dependent variables, I focus on both the firm's

decision to repurchase shares and actual amount (level) instead of change in common shares outstanding. With the panel data, we would provide evidence for the contemporaneous relation hypothesis if the likelihood of repurchase decision or the magnitude of repurchase can be significantly affected by stock option exercise in the same year. By contrast, if firms take more ex-post repurchases to undo dilution effect when there are more options exercised in the year prior to buyback, sequential relation hypothesis would make sense in this case.

In addition, many previous studies support that firms conduct repurchase before stock options are exercised (pre-funding hypothesis). To examine this hypothesis, Griffin and Zhu (2010) directly use option exercises in the next year. However, since the dependent variable is current repurchase, it is not appropriate to explain the past with the knowledge in the future, in other words, we cannot predict the repurchase in year t with the option exercises occurring in year $t+1$. Thus, current stock option outstanding can be used as a good proxy for expected future option exercises. Bens et al. (2003) argue that unexercisable options can also affect managers' decisions to repurchase. Lin et al. (2009) document a positive effect of managerial options unexercisable on actual repurchases, Therefore, I choose stock option outstanding instead of current option exercisable to test the link between repurchase activity and expected future exercise. On the other hand, total option and executive option may affect repurchase incentive in a different way. Firms generally buy back shares in the market to avoid the dilution effects of total option exercise or to fund option exercises. Meanwhile, since repurchase, unlike dividends, would not affect the stock price, managers prefer to use repurchases over dividend when they hold a high level of stock option in order to increase their own option payoff. Thus, in our study, I distinguish between total option and executive option. In addition, I control other related variables which may affect repurchase activity (decision or actual amount).

The results show that both likelihood of repurchase decision and the amount of repurchase are mainly positively affected by latest and current option exercises. Firms

are more likely to make decision to repurchase and increase repurchase level when more option is exercised in the year prior to or the year of repurchase; this is also the case if there is more option outstanding to be exercised in the future. Our findings also provide evidence for a contemporaneous relationship between repurchase and stock option exercises. It is possible that firms determine stock option and repurchase jointly rather than sequentially (Griffin and Zhu, 2010). In addition, we also find that firms may use repurchase to undo the dilution effect resulting from past option exercises. The number of options exercised in last year could be a predictor of level of buyback in the current year. This suggests that ex-post repurchases are conducted to manage basic EPS or return on equity, which reflects managers' financial reporting incentive. Meanwhile, total option outstanding would be exercised in the future and thus firms with more outstanding options would increase repurchases in current year to manage dilutive EPS, which is consistent with pre-funding hypothesis. Overall, our results show that repurchase decisions are associated with past and current option exercises and actual repurchase amount are affected by past, current and expected future option exercise, suggesting that repurchases are both contemporaneously and sequentially related to stock option exercises.

We also find that the number of executive options outstanding would positively affect repurchase decision and repurchase level, which supports substitution hypothesis (agency hypothesis). As a payout policy, repurchase would not dilute the per-share value of the stock. At the same time, repurchase can be a signal released by insider to reveal that stock price is undervalued. Consistent with signal theory, Vermaelen (1981) and Dann (1981) have documented positive abnormal returns during the announcement period. In terms of this, repurchase would offer benefit to managers who hold stock options to exercise. Our results show that managers prefer to take repurchases and increase the actual repurchase amount when there is a large number of executive options because of self-interest motive, although the effect is less positive compared to that of total option.

Another analysis on performance in our study contributes to understanding the combined effect of payout policy and stock-based compensation on companies. To investigate whether firms are doing better / worse when they use different combinations of repurchase and stock option program, I use propensity score matching method to compare ROA in a) firms with share buyback and many stock options and b) companies with share buybacks but not many stock options and c) companies with no share buybacks but many options from the same industry for else being equal. Firms with “many” stock options are defined as those with options (normalized by common outstanding shares) ranking in the 1st quartile within the same industry.

By propensity score matching, we find that there is no significant difference in performance measured by ROA between a) firms with share buyback and many stock options and b) firms with share buybacks but not many stock options. Among companies that made decision to repurchase, a high holding of total employee options does not necessarily mean that companies perform better than those with low stock option. However, the firms with higher executive options generally have higher accounting performances. On the other hand, our analysis shows that firms with repurchase and many options achieve higher ROA than those only with many options. Repurchase is positively related to ROA in the firms with many options. This result could be explained by signal theory. Since repurchases are often conducted when managers get new favorable information regarding companies’ prospects and they estimate market prices have been undervalued due to information asymmetry. In this case, repurchase can be interpreted as a signal to show a good expectation by management. According to signal theory, it is not surprising that firms with many options as well as repurchase activities are more likely to perform better than those only with many options but without repurchase. It is also possible that repurchase can reflect an effective and active management since managers make repurchases in a flexible way to distribute cash as well as send mispricing signal at the right time by

analyzing real-time market information. Firms with such dynamic management may be competitive and perform better in terms of profitability in the market. On the other hand, firms with better profitability (higher ROA) have excess capital to distribute cash to shareholders by repurchases.

The remainder of this paper is structured as follows. Section 2 discusses the relevant literature on repurchases and stock options. Section 3 develops our hypothesis and specifies the regression model we used in the study. The data and the sample are presented and described in section 4. Section 5 reports our results and robustness is examined in section 6. Section 7 concludes the paper.

2. Literature Review

The past decades have witnessed a dramatic increase in repurchase activity, and thus many researchers focus on the various motives for buybacks in companies. It is necessary to include all these relevant variables when examining the time relationship between repurchases and stock option exercises.

Existing literature has provided empirical evidence and has given several reasons to explain why firms repurchase shares in the market.

First, excess capital hypothesis has explained repurchase activity as a distribution policy. Generally, firms would increase repurchases when they have more free cash flow or capital to distribute to shareholders (Jensen, 1986). As a substitute for dividends, repurchase has provided more benefit than traditional dividend payout because it has more flexibility and carries less obligation to investors (Liang and Sharpe, 1999; Brav et al., 2005). Jagannathan, Stephens and Weisbach (2000) find that firms prefer repurchases when they make temporary increase in cash flow while permanent increase is often positively related to dividends. Doan et al. (2011) show that Australian companies take advantage of the financial flexibility with repurchase to distribute non-permanent cash flows to shareholders. Moreover, firms conduct repurchases not on a regular basis as there is no future commitment or penalty

involved. In contrast, Guay and Harford (2000) find that the dividend-increasing firms are less likely to revert to levels prior to the cash flow shock. In addition, Brennan and Thakor (1990) find that a majority of shareholders support open market repurchases when there is a large distribution. Therefore, managers would consider stock repurchases as a better distribution policy compared to traditional dividends when firms have more excess cash flow.

Second explanation associates repurchase with stock price. A firm's stock may be undervalued in the market because of information asymmetry, and thus managers would repurchase mispriced shares to indicate that they believe the stock is undervalued (Dittmar, 2000). Repurchase announcement may be followed by future earnings surprises. Consistent with undervaluation hypothesis, Small (2014) finds that one of the similarities among global repurchases is positive excess returns in the short and long run. A recent study by Nemani (2018) suggests infrequent repurchasers are more likely to buy back shares to send signal of undervaluation and convey new favorable information about future prospect of firms. However, other studies (Chan et al., 2006; Balachandran et al., 2005) believe that companies buy back shares for manipulative purposes as repurchase can influence investors' perceptions of firms. These papers imply that managers would announce repurchases under pressure to stimulate share price.

Repurchase can also be related to firms' capital structure policy to achieve optimal leverage ratio (Dittmar, 2000). This explanation assumes that a firm may choose to repurchase shares from market when its current leverage ratio falls below the target level.

Regarding corporate control, firms repurchase shares to defend against takeover threat. Bagwell (1992) introduces upward-sloping supply curve to illustrate how repurchases increase the cost of unwanted takeover attempts. Doan et al. (2011) find that firms in Australia would be more likely to repurchase shares when managers estimate a higher probability of becoming takeover target. Thus, it is essential to consider repurchase

activity as a means of takeover deterrence.

Nevertheless, the surge in buybacks during the 1990s may result from other different motives. In addition to these traditional explanations for repurchases above, researchers find that the rapid growth of stock option program can also be related to this subject.

Most literature focus on the relationship between repurchases and managerial options because there is a self-interest motive for managers. Repurchases do not dilute per share value of stock, which can retain or increase payoff for managers when they exercise their stock options. Fenn and Liang (2001) find that repurchases are positively related to managerial stock options. Weisbenner (2000) thinks that stock options held by top executives and those held by employees have different effects on payout policy. However, the conclusions are various in different paper. Jolls (1998) finds that managers prefer to use repurchases over dividends when they hold a large amount stock options, while employee options do not affect repurchase decisions. However, she uses total option grants to proxy total options outstanding, which is an imperfect measure. Kahle (2002) studies the effects of executive options on repurchase decision and amount, and the results show that although both managerial options and employee options can influence repurchase decision, only total options exercisable have explanatory power on repurchase amount. In contrast, Lin et al. (2008) argue that managerial options exercisable have a significant effect on the magnitude of actual repurchases. Griffin and Zhu (2010) support that CEO stock options affect both the decision to repurchase and the dollar amount. Despite of differences, all of these past studies document evidence that managerial options have a positive effect on repurchase activity.

Besides self-interest incentives of maximizing payoff, Bens et al. (2003) find that managers buyback shares to manage diluted EPS rather than basic EPS. Since earning management is widely used in modern companies, this motive may explain why total options influence more than executive options. Dittmar (2003) uses total options to

proxy managerial options to study repurchase motives and he finds a positive relationship. Although some studies do not distinguish executive options and total options, most previous literature provided evidence for the positive relationship between repurchases and total stock options.

In recent years, many researchers focus on the association between buybacks and stock options, but few of them directly explore the timing of repurchase. Firms can repurchase shares from the market to fund expected future stock options or to anti-dilute after option exercises. It is possible that contemporaneous relation and sequential relation may exist at the same time.

In fact, most prior paper assumes that firms repurchase shares before stock options are exercised. Stock option outstanding or stock option exercisable is usually used as a main variable in most paper which examines the relationship between repurchase and stock option. These studies offer evidence that more options outstanding drive more buybacks. Weisbenner (2000) finds that firms buyback shares over the life of an option as grants have explanatory power for repurchase. As there is high correlation between grants and exercises (Rogers, 2013), grants may in fact reflect association between option exercises and repurchases. Similarly, Kahle (2002) thinks that firms with more options outstanding would use buybacks to prepare for expected future option exercises and avoid dilution in an ex-ante way.

However, these studies use the change in shares outstanding to research the combined outcomes of option exercise and repurchase, which is a problematic measure if any redistribution of shares is made during the year (Jagannathan et al., 2000; Rogers, 2013). On the other hand, they do not consider the probability that repurchases are conducted to alleviate the dilution resulting from past option exercises since option exercises in the year prior to repurchase (year $t-1$) are not included in the studies. Kahle (2002) fails to add past exercises in her paper, either. However, she includes repurchase dummy (dummy equals 1 when the firm repurchases in the year, otherwise 0) because repurchase decision is also an important part of buyback activity. In our

paper, we would test if the likelihood of repurchase decision made by managers and repurchase level can be affected by past, current and expected future stock option exercise volume.

Except for option funding hypothesis and undo dilution hypothesis above, there is another argument that firms use the payments from option exercises to repurchase shares in the market, which implies firms time repurchase to respond to concurrent option exercises. Griffin and Zhu (2010) examine the time relation between buybacks and stock options using the data from 2005 to 2007 and provide evidence that contemporaneous relation is the strongest. Although they include option exercises occurred in the last year to study the effect of past exercises, they use exercises in year $t+1$ instead of concurrent options outstanding to explain repurchases in year t . It is not appropriate to explain the past with the knowledge in the future. Moreover, option exercises in the year just following the repurchase cannot represent total option exercises in the future. In addition, changes in common shares outstanding may be an imperfect way to measure repurchase when there is any redistribution of shares. Despite this, their results show that firms may consider and determine the stock option and repurchases jointly, which provides support for contemporaneous relation hypothesis. They think that the rationale behind contemporaneous relation can be interpreted in two aspects. First, managers try to pursue their own benefit when they exercise options by increasing concurrent buybacks in the year. Secondly, managers prefer to match payments for option exercises with the benefit from repurchased shares. In addition, from firms' perspective, contemporaneous relation may suggest that firms consider matching cash proceeds from option payment with expense for repurchases to make cash flow more stable.

Rogers (2013) shows both total option grants and exercises are positively related to repurchase, which is consistent with option funding theory and contemporaneous relation hypothesis. He argues that repurchases in advance can be used as a hedging strategy because firms can lock the cost when stock options are granted. Nevertheless,

none of these studies considers including such variable as option exercises in the year prior to repurchase since firms may buy back shares to avoid the dilution due to past option exercises.

Most past studies focus on the stock return in announcement period (market price performance). Li and McNally (2007) find that repurchases occur after the poor stock performance, consistent with signal theory. Similarly, Isa and Lee (2014) claim that stock prices increase significantly after repurchase announcements in Malaysia. Balachandran et al. (2007) mention earnings performance during the buyback year, and they think that different performance trends may lead to different motives for repurchases.

Our theoretical contribution is the accounting performance comparison among firms with different programs of repurchases and stock options, which can supplement the previous research on marketing performance since we focus on profitability indicator instead of stock return. This contributes to understanding the relationship between repurchase and stock option program on internal operating efficiency given that past studies pay more attention to outside market reaction. Besides, in our study, we use propensity score matching (PSM) to estimate the effect of repurchases and stock options on firm's ROA (return on asset). PSM is a more accurate and favorable method to be used in observational study since it considers multiple financial characteristics when matching firms. This method distinguishes us from the prior studies which use traditional approaches to match firms by limited covariates.

3. Hypotheses

3.1 Time relationship between repurchase and option exercise

Firms can time repurchase before or after option exercises, and they can also conduct repurchase based on level of current exercises. These arguments are discussed and examined separately in the previous studies while few of them consider that the repurchase can be a joint outcome of past, current and expected future exercises. I

combine all these previous hypotheses and examine whether repurchase is simultaneously affected by all these option exercises at the different time.

According to *option-funding hypothesis*, repurchased shares can be used to fund expected future stock option exercises. Several prior studies give explanation on this hypothesis. Weisbenner (2000) presents evidence that firms gradually buyback shares over the life of options to undo the EPS erosion caused by past option grants. This implies repurchases precede option exercises. Bens et al. (2003) support option funding hypothesis by studying the incentives of managers in repurchase; they find that firms repurchase to manage diluted EPS instead of basic EPS. This finding suggests firms would buyback shares when the option is in-the-money (before the option is exercised) to improve diluted EPS rather than repurchase after the option is exercised to increase basic EPS. Rogers (2013) thinks that firms may hedge price risk by repurchases at the time when the stock options are granted. The paper of Sonika and Shackleton (2020) also gives evidence that driven by flexibility, firms would buyback shares early in an option schedule when options are out-of-money and unexercisable, which supports option funding hypothesis. Despite different motives, it is natural to expect that *firms time repurchases before the options are exercised*.

By contrast, it is also possible that *firms repurchase shares after stock options are exercised*. Since buybacks can decrease the denominator when calculating earnings per share, firms may use repurchase to improve financial ratios. Hribar et al. (2006) report that firms buyback shares from the market to match analysts' forecasts out of manipulation. On the other hand, as repurchase can substitute discretionary accruals in earnings management (Lin et al., 2009), firms may buyback shares to alleviate erosion to EPS caused by past option exercises. Following this line of thought, the latest option exercises would be more of interest since firms adjust financial ratios every year.

Sequential hypotheses states that firm repurchase before or after options, as we discussed above. However, Griffin and Zhu (2010) get the new finding that

repurchase and stock option exercises show a contemporaneous relation. This may suggest that firms repurchase in response to option exercises in the same year. We will discuss this relation in detail in the section 3.2.

Combing both sequential and contemporaneous relation hypotheses, we expect repurchase decision by firms can be an outcome simultaneously affected by these options exercised in the different time. In addition to repurchase decision, we are also interested in actual amount of repurchase. Previous studies (Kahle, 2002; Bens et al., 2003) also research repurchase activities of firms from these two different aspects. Kahle (2002) finds that managerial options only influence repurchase decision rather than actual amount of repurchase. Bens et al. (2003) argue that both repurchase decisions and repurchase level are affected by executives' incentives to manage diluted EPS instead of basic EPS since actual employee stock option (ESO) exercises do not influence repurchase decisions. In our paper, we study the effects of option exercises in the different time on repurchase decision as well as repurchase level. Hence, we replace the likelihood of decision to repurchase with repurchase level. Similarly, we expect the actual amount of repurchase in the year t is also a combined outcome of option exercises in the different time. We derive our first hypothesis focusing on repurchase decision as well as repurchase level:

H1: The likelihood of a repurchase decision as well as the actual dollar amount of repurchase (repurchase level) is simultaneously positively related to latest, contemporaneous and expected future option exercises.

3.2 Contemporaneous relation hypothesis

In the 3.1, we suggest that *firms may increase repurchases when there are more option exercises in the same year*. Employees only exercise if options are in-the-money so firms need to either purchase shares from the market at a higher price or issue new shares which would dilute per share value of stock. Since firms can receive the payment from the option exercises, they may use the proceeds to subsidize concurrent

buyback of shares. In this way, the cash flow would be more stable if the timing of repurchases match the option exercises from the perspective of the firms. Griffin and Zhu (2010) find that the contemporaneous relation between repurchases and option exercises is stronger than the sequential relation. From the perspective of executives, they explain such stronger contemporaneous relation as managers may match their outlay for option exercises with the benefit earned from repurchased shares. Although they use option exercises occurring in the next year following buybacks to proxy expected future option exercises, which is an imperfect measure, the paper provides support that firms may repurchases more in response to concurrent option exercises.

It is possible that firms repurchase shares in response to past, concurrent and expected future (not only upcoming ones) stock option exercises. Besides, as Griffin and Zhu (2010) suggest, option compensation and buyback may be mutually rather than sequentially determined. To examine this, we expect the concurrent option exercises in the same year of repurchase influence more than latest options (which can be represented by option exercise in the year prior to repurchase) and options to be exercised in the future (which can be proxied by options outstanding). Then, we derive our second hypothesis stating that

H2: The relation is stronger for contemporaneous option exercises as compared to latest option exercises and expected future option exercises (sequential relation).

3.3. Repurchase and performance of the firms

Apart from time relationship between repurchases and stock options, we also interested in the effect of joint use of repurchase and stock option program on firms' performance. Previous literature studies announcement-period return for repurchases and they focus on the association between repurchases and firms' price performance in the market. However, in this paper, we hypothesize that repurchase and stock options can be also associated with firms' accounting performance such as profitability indicator ROA. Share repurchases are typically a part of the payout

policy in companies. According to excess capital hypothesis (Easterbrook, 1984; Jensen, 1986; Dittmar, 2000), firms can retain or distribute excess cash to their shareholders when their capital surpass investment opportunities. If the firms profit more and have excess capital, they are more likely to be able to distribute funds to shareholders. Moreover, undervaluation arises when such earning increase is not reflected in the stock price. In this case, repurchased can be used not only for distributing funds but also for releasing undervaluation signal to the outside market. Following this line of thought, it is possible that firms that have a higher profitability are more likely to repurchase shares in the expectation that future share prices increase and thus more capital can be transferred to shareholders (distribution) as compared to firms with lower profitability. Alaagam (2019) finds that there is a positive significant relationship between ROA and short-term stock prices, which supports our argument. Moreover, Fitri et al. (2016) document a significant association between ROA and dividend payout ratio. It suggests that a higher profitability may affect the distribution in the company.

Besides, due to information asymmetry between insiders and outside shareholders, managers can get favorable news and predict there is earning surprise, but market does not aware of it (Dittmar, 2000). Thus, managers can repurchase shares to convey the information on good prospects of firms (Vermaelen, 1981; Dann et al., 1991; Bens et al., 2003). In this case, we can reasonably predict that positive earning surprises are typically followed by repurchase decision and thus repurchasing firms are more likely to perform better than those without repurchases.

As is shown in the literature part, there is an argument that firms repurchase shares to fight against hostile takeover (Bagwell, 1991), and thus it is possible that firms repurchases are just for defend themselves from being acquired by other firms, not for releasing optimism signal Repurchase, in this case, is not necessarily related with better performance (higher ROA). However, Jolls (1998) thinks that a higher level of stock option is a characteristic of well-run organizations; those organizations are less

vulnerable to takeover threats. Therefore, repurchases that occurred in the firms with a high level of stock options are more likely to be correlated with the motive of showing better prospects instead of takeover defense. Following this line of thought, we can reasonably associate firms' good operating performances with joint use of repurchases and stock option plans.

Summarizing we expect ROA to be higher for a) firms with share buyback and many stock options perform as compared to b) companies with no share buybacks but many options from the same industry for else being equal.

H3: Firms with share buyback and many stock options perform better in ROA than firms with no share buybacks but many options from the same industry for else being equal.

3.4. Stock option and performance of the firms

Stock option, as a kind of stock-based compensation, can mitigate agency problem because it aligns employees' (or managers') interests with shareholders and thus leads to higher management efficiency.

Since employees granted with stock options have the right to purchase shares at a specified price, they have the incentive to maintain or increase the stock prices to maximize their payoff. Thus, managers have an incentive to improve firm performance to positively influence stock performance. Consistent with this theory, Duffhues et al. (2002) report that firms' operating performance is positively related to stock option grants by investigating all the companies in the Netherlands. They also find that stock option grants would lead to higher firms' performances in the subsequent years. Sesil and Kroumova (2005) find that both small and large firms with broad-based stock options perform better than their peers without stock options. Therefore, we can infer that firms with stock options are more likely to do well, measured by accounting performance, than other companies without such option plans.

H4: Firms with share buyback and many stock options perform better in ROA than firms with share buybacks but not many stock options from the same industry for else being equal.

4. Data and Methodology

4.1 Sample Construction and industry distribution

The sample is gathered from all the US companies listed in Compustat database and by the Center for Research in Security Prices (CRSP) for fiscal year 2000 through fiscal year 2019. Financial institutions, transportation companies and utilities (SIC one-digit of 6 or 4) are excluded because they are highly regulated and their motive of repurchases could be different from other companies (Dittmar, 2000).

To obtain the data on the actual dollar amount of repurchase, I begin by collecting data on purchases of common stock and preferred stock from all the North American companies listed on Compustat, since Kahle et al. (2005) find that purchases of common stock (adjusted for changes in preferred stock) can accurately measure actual repurchases.. The main sample consists of 15,381 firms and 130,970 firm-year observations. Data on employee option exercise is taken from Compustat. For the total option outstanding in year t , I use the average number of total option outstanding at the beginning and end of the fiscal year t . The sample shrunk to 73,585 firm-year observations after removing the observations without available data on total options.

Executive options outstanding are computed as the sum of unexercised exercisable options and unexercised unexercisable options reported in Execucomp database for each year over all executives. In line with the literature, total executive options in year t are normalized by the number of common shares outstanding in year t .

We obtain firm data such as cash flow, market value, total asset and long-term debt from Compustat. Since a firm's repurchase behavior can be affected by outside takeover threat, takeover object is taken from Security Data Corporation's Merger and

Acquisition database (SDC). Data on institutional ownership as a percentage of common shares outstanding is collected from Thomson Reuters. Besides, monthly holding period stock returns (Ret) are taken from CRSP.

After combining data on repurchases with executive options data and other financial controls, I remove those observations for Canadian firms to get the final sample for US firms. Our final sample consists of 1,940 firms and 18,483 firm-year observations with no missing data on repurchase and options.

Table 1 presents the industry distribution of our final sample. Across 18,483 firm-year observations, business services industry has most of observations (14.5%). About 8.2% firm-year observations are from retail industry, followed by chips (8%), petroleum and natural Gas (5.7%) and pharmaceutical products (5.5%). The firm-year observations of these five industries account for over 40% of our sample.

— *Insert Table 1 about here* —

To test Hypothesis 3, we select repurchasing firm-year observations from the full sample. After combining the merged dataset with firm specific data, such as ROA, cash flow, market to book ratio, firm size, return and leverage, takeover, we are left with 12,412 firm-year observations.

Similarly, to test hypothesis 4, we select the firm-year observations with many options (options outstanding normalized by common outstanding shares rank in the 1st quartile within the same industry in the same year) in the full sample, along with the same firm-specific data. This left us with 4,891 firm-year observations.

4.2 Variable definitions

To study repurchase decisions made by firms, we use a dummy variable (*RepuDummy*) as the dependent variable to represent the repurchase activity. The value of dummy takes 1 if the firms conduct repurchase in the fiscal year t , and 0 otherwise.

For *repurchase level* in year t , we use the actual dollar amount in the year t

normalized by average market value of equity in year t ; average market value can be defined as the average of market value in the end of the fiscal year $t-1$ and in the end of fiscal year t . Compustat offers data on dollar amount for repurchases of the firms, however, the data may overstate actual repurchases outlay regarding common shares. (Stephens and Weisbach, 1998; Jagannathan et al., 2000). Weisbenner (2000) improves the measure by adjusting the dollars spent on repurchasing preferred stock in the calculation. Therefore, in this study, I follow his method and use the actual dollar volume of repurchase (purchase of preferred and common stock deducted by purchases of preferred stock) in fiscal year t normalized by average market value of the firm in fiscal year t .

The number of *total options exercised* ($OptEx_t$) in fiscal year t can be collected from Compustat ($Optexd$). Following Griffin and Zhu (2010), we can use this variable to estimate the contemporaneous relation between repurchase and concurrent option exercises.

The number of *total options outstanding* ($OutOpt_t$) in fiscal year t is equal to the average of options outstanding in the beginning of the fiscal year t and in the end of the fiscal year t . This variable can be used as a proxy for expected future option exercises.

Executive options outstanding ($ExecOptOut_t$) for each firm are calculated by adding the number of stock options held by each executive in the fiscal year t , taken from Execucomp database.

Employee options outstanding ($EmployeeOptOut_t$) for each firm in fiscal year t are non-executive options, the remaining part of total options outstanding after excluding executive options outstanding. All option data is normalized by common shares outstanding in responding year.

Following previous research, we include following financial control variables related to repurchase from Compustat Database for each year t :

1) The *level of cash flow*, this variable can measure the ability of firms to distribute excess capital. According to excess capital hypothesis, repurchase can be affected by the ability of firms to distribute funds, thus we control such effect in our analysis. 2) The market value to book value of assets (*MB ratio*) as a proxy of the investment opportunity for the firm (Weisbenner, 2000; Rogers, 2013; Sonika and Shackleton, 2020) can be calculated as market equity plus long-term debt plus debt in current liabilities plus preferred stock, divided by the book value of assets following Kahle (2002). We include this variable since firms faced with good investment opportunities may prefer invest capital in the market over repurchase to distribute. 3) The *firm size* can be used as an indicator of degree of information asymmetry (Vermaelen, 1981). According to undervaluation hypothesis, information asymmetry can lead to undervaluation favoring repurchases. 4) The *leverage ratio* measure firms' financial stress when they make decision to fund or invest in the market. Repurchase can be associated with this indicator as company policy made by management would take financial status into account.

According to takeover deterrence hypothesis, takeover threat motivates managers to repurchase to fight for control right of firms. Therefore, I include a *takeover dummy* which equals 1 if the firm is a target of takeover action in either the year before or the year of the repurchase, otherwise 0 following Dittmar (2000). The information can be taken from Security Data Corporation's Merger and Acquisition database (SDC).

Some researchers pay attention to the tax considerations in the study of repurchase. Grullon and Michaely (2000) think that firms use repurchase to reduce tax liability especially for individual shareholders. It is possible that tax status is highly related to distribution policy since there is tax differential between capital gains (repurchase) and dividends. Here I include *institutional ownership* to control the effect of tax status of firms, taken from Thomson Reuters.

We use *return* to measure the market performance of the specific stock. This variable serves to control the motive of repurchase due to price undervaluation since firms

with low stock return are more likely to face with undervaluation problem.

In order to examine the hypothesis 3 and hypothesis 4, we include *ROA* in our study. *ROA* (return on assets) is defined as net income divided by average total assets, and it typically indicates firms' profitability. High *ROA* suggests that firms perform well and produce more profits from its total assets, reflecting high operating efficiency of firms. This variable is included to help us compare accounting performance among firms with different strategy of repurchase and options.

Table 2 provides the detailed description and data sources for all explanatory and control variables.

— *Insert Table 2 about here* —

4.3 Descriptive Statistics

Table 3 provides summary statistics on the repurchase and option programs, as well as firm characteristics. Panel A, B and C give statistics on full sample, repurchasing and non-repurchasing subsamples respectively. All quantitative variables in the regression are winsorized at the 1- and 95-percentiles. Previous studies also use winsorization to reduce the effect of outliers (Bens, 2003; Balachandran, 2008).

— *Insert Table 3 about here* —

Across the 12,412 firm-year observations for repurchasing group, total option exercises ($OptEx_t$) represent on average 1 percent of common shares outstanding, which is higher than that in non-repurchasing group with 0.9 percent. However, the mean percentage of total option outstanding ($OutOpt_t$) for non-repurchasing group is 6.7 percent while this percent for repurchasing is 5.8. Besides, non-repurchasing group has a little higher holding of executive options outstanding ($ExecOptOut_t$) than repurchasing group, with means of 2.4 percent versus 1.8 percent and medians of 1.8 percent versus 1.3 percent, respectively. However, p value suggests that the univariate differences in mean for these options are significant and multivariate

results would be given in the next section,

In terms of return on assets (ROA), repurchasing group is significantly doing better than non-repurchasing group, according to Table 3, with means of 6.3 percent versus 0.9 percent and medians of 6.4 percent and 3.6 percent, respectively. ROA can reflect the profitability of firms. This significant difference between repurchasing group and non-repurchasing group may suggest that ROA could be positively related with repurchase in the firms.

Table 3 suggests, the repurchasing group have higher levels of cash flow (0.1) than non-repurchasing group (0.05) and the difference in means is significant. It may suggest that firms with higher levels of cash flow are more likely to conduct repurchase to distribute excess fund.

The size of repurchasing group is significantly larger than that of non-repurchasing group (means of 7.6 versus 6.9, respectively), which may indicate a general positive relationship between repurchase and firm size.

Besides, repurchasing group experience lower stock returns than non-repurchasing group (means of 0.1 and 0.14). This significant difference is also consistent with undervaluation hypothesis (Comment and Jarell, 1991; Dittmar, 2000). Firms with lower returns are more likely to repurchase shares from the market to release undervaluation signal.

We also find that repurchasing group has a significantly higher probability of being object of takeover (0.44) than non-repurchasing group (0.15). Firms faced with outside takeover threat are more likely to repurchase, which is consistent with takeover deterrence hypothesis.

4.4 Methodology

We use the panel data instead of cross-sectional panel data to examine our hypotheses. Some previous paper (Jolls, 1998; Weisbenner, 2000) use cross-sectional data,

however, Weisbenner (2000) suggests that the analysis of panel data allows researchers to control the fixed effect associated with firm-specific differences in the study.

To test our Hypothesis 1, that the likelihood of repurchase decision and volume is positively related to option exercises in the different time, we estimate logistic regressions (eq 1) with repurchase dummy and Tobit regression (eq 2) with repurchase volume (REP_t) as follows:

$$\begin{aligned} \text{RepuDummy}_{t,i} = & \alpha + \beta_1 \cdot \text{OptEx}_{t,i} + \beta_2 \cdot \text{OptEx}_{t-1,i} + \beta_3 \cdot \text{OptOut}_{t,i} + \beta_4 \cdot \\ & \text{ExecOptOut}_{t,i} + \beta_5 \cdot \text{ExecOptOut}_{t-1,i} + \beta_6 \cdot \Gamma_{t-1,i} + \delta_i + \theta_t + \varepsilon_{i,t} \end{aligned} \quad (\text{eq } 1)$$

$$\begin{aligned} \text{REP}_{t,i} = & \alpha + \beta_1 \cdot \text{OptEx}_{t,i} + \beta_2 \cdot \text{OptEx}_{t-1,i} + \beta_3 \cdot \text{OptOut}_{t,i} + \beta_4 \cdot \\ & \text{ExecOptOut}_{t,i} + \beta_5 \cdot \text{ExecOptOut}_{t-1,i} + \beta_6 \cdot \Gamma_{t-1,i} + \delta_i + \theta_t + \varepsilon_{i,t} \end{aligned} \quad (\text{eq } 2)$$

Where *RepuDummy*_{t,i} measures repurchase activity of firm *i* in fiscal year *t*. *OptEx*_{t,i} represents contemporaneous option exercises in fiscal year *t* for firm *i*, *OptEx*_{t-1,i} represents latest option exercises in fiscal year *t* – 1 for firm *i*, and *OptOut*_{t,i} represents the expected future option exercises in fiscal year *t* for firm *i*

If more options exercised this year encourage firms to make repurchase decision, we expect β_1 to be significantly positive. If firms consider repurchasing shares to do earning management since past option exercises increase shares and dilute value per share, then we expect β_2 to be positive.

Total option outstanding in year *t* is used as a proxy of expected future option exercises to examine whether firms consider expected future option exercise when they repurchase shares, which is of the topic of option funding hypothesis. If firms repurchase shares in response to expected future exercises, then we expect β_3 to be positive.

Griffin and Zhu (2010) use stock option exercise in year *t*+1 to represent expected future option exercises. However, I choose total stock option outstanding in fiscal

year t instead of option exercises in the year following repurchase (year $t+1$) because, on the one hand, firms with repurchase in year t cannot know the exact number of option exercises in the next year, on the other hand, the option exercises occurring in the following year cannot represent total future option exercises. Total exercisable stock options sometimes can be used to proxy expected future exercises; however, total stock option outstanding can be more representative since unexercisable option can be vested and exercised in the future. Moreover, previous studies show evidence that unexercisable options also have effect on repurchase activity (Bens et al., 2003; Lin et al., 2009).

If the contemporaneous relation is stronger as compared to latest or expected future relationship, β_1 should be statistically significantly larger as β_2 and β_3 .

According to the agency hypothesis, managers may initialize repurchases to pursue higher stock returns when they hold options, thus executive option outstanding ($ExecOptOut_{t,i}$) in year t for firm i is added to examine this effect. If managers prefer repurchase because of self-interest motive, we expect β_4 to be positive. Furthermore, managerial options are sticky in nature, thus executive option outstanding ($ExecOptOut_{t-1,i}$) in year $t - 1$ for firm i is also included in the analysis to control such effect.

$\Gamma_{t-1,i}$ is a vector of firm specific control variables including cash flow, firm size, market to book ratio, stock return, leverage, and institutional ownership as well as takeover dummy. These control variables are used to control and reflect other traditional motives of repurchase. θ_t year indicators as well as δ_i industry indicators are also included to control fixed effects in the regression. The repurchase can be influenced by policy implementation or adjustment in some years (for example, tax reform or new accounting standard adoption), and thus year indicators can be used to control such effect while industry indicators can control industry-specific effects on repurchase.

We use total option outstanding in fiscal year t ($OptOut_{t,i}$) to estimate expected future option exercises in eq (1), at the same time we control the managers' incentive by adding executive option outstanding ($ExecOptOut_{t,i}$). The effect of variable $OptOut_{t,i}$ on repurchase decision may be from ($ExecOptOut_{t,i}$). Therefore, we re-estimate expected future options exercises either by only including total option outstanding ($OptOut_{t,i}$) or by separating total option outstanding ($OptOut_{t,i}$) into executive option outstanding ($ExecOptOut_{t,i}$) and employee (non-executive) option outstanding ($EmployeeOptOut_{t,i}$). This leads to other versions for eq (1):

$$RepuDummy_{t,i} = \alpha + \beta_1 \cdot OptEx_{t,i} + \beta_2 \cdot OptEx_{t-1,i} + \beta_3 * OptOut_{t,i} + \beta_4 \cdot \Gamma_{t,i} + \delta_i + \theta_t + \varepsilon_{i,t} \quad (eq\ 3)$$

$$RepuDummy_{t,i} = \alpha + \beta_1 \cdot OptEx_{t,i} + \beta_2 \cdot OptEx_{t-1,i} + \beta_3 \cdot ExecOptOut_{t,i} + \beta_4 \cdot EmployeeOptOut_{t,i} + \beta_5 \cdot \Gamma_{t,i} + \delta_i + \theta_t + \varepsilon_{i,t} \quad (eq\ 4)$$

To test the relationship between repurchase volume and option exercises in the different time the $RepuDummy_{t,i}$ dummy is replaced by REP_t representing the dollar level of repurchase in fiscal year t. All other things being equal, a Tobit model is used to estimate eq (2) because many firms do not repurchase in some years.

The definition and calculation of REP_t are discussed in variable descriptions. Option variables and financial controls are defined as shown in Table 2.

Similarly, if firms consider past ($OptEx_{t-1,i}$), current ($OptEx_{t,i}$), expected future option exercises ($OptOut_{t,i}$) at the same time when they determine repurchase level for firm i in year t, then we expect the coefficients of total option exercise in year t (β_1) as well as in year t-1 (β_2) and total option outstanding in year t (β_3) would be significantly positive.

Besides, if the contemporaneous relation is still stronger as compared to latest or expected future relations, β_1 should be statistically significantly larger as β_2 and β_3 in eq (2).

To test the hypothesis 3 and 4, propensity score matching method (PSM¹) is used in Stata (psmatch). Traditional approaches match repurchasing observations with non-repurchasing observations by industry classification (Sic code) or single financial characteristic such as market value. By contrast, propensity score matching method can alleviate or eliminate selection bias in observational studies since it considers more comprehensive financial characteristics when matching firms. Thus, the results from propensity score approach is more accurate when estimating treatment effect for the observational data. This study uses cash flow, market to book ratio, firm size, stock return, leverage and takeover dummy to represent similar firm characteristics. The firm in the control group (non-repurchasing group) can be matched with another firm in the treatment group (repurchasing group) if they have a close score.

In our test for hypothesis 3, we select only firms with repurchases from our full sample (repurchasing subsample – Panel A in Table 3). Among these firm-year observations, we define firms with “many” stock options as those with options (normalized by common outstanding shares) ranking in the 1st quartile within the same industry (according to Fama French 48 industrial classifications) in the same year. Then we divide this subsample into two groups: 1) firms with repurchases and many stock options (high-level group) and 2) firms with repurchases but without many options. Propensity score matching in Stata allows us to test if a high level of stock options holdings (binary treatment variable) in the firm leads to a significant difference in mean ROA between high-level group and the matched subjects in non-high-level group. In other words, we can examine whether firms with share buyback and many stock options perform better in terms of profitability than companies with share buybacks but without many stock options. If stock options reduce the degree of agency issue, then we expect a significant positive coefficient for “many” options.

¹ A propensity score is the probability that a firm would take certain action considering its multiple characteristics

Similarly, in order to examine hypothesis 4, whether repurchase behavior has a positive effect on ROA, we select the firms with many stock options from the full sample and then divide them into repurchasing group and non-repurchasing group. We also use propensity score matching method to estimate treatment effect of repurchase on firms with many stock options outstanding. If the difference between mean ROA in repurchasing group and mean ROA for non-repurchasing subjects in the matched sample is significant according to the PSM result. We may be able to answer the question if 1) the firms with share buyback and many stock options perform better in ROA than 2) companies with no share buybacks but many options from the same industry for else being equal.

5. Results

5.1 Results for Model I on repurchase decision

Table 4 reports the results of Logistic regression on repurchase dummy. The estimates from Logistic models provide support for our hypotheses 1a and hypotheses 2.

— *Insert Table 4 about here* —

From the column (1), we find that both total option exercise ($OptEx_{t,i}$) and total option exercised in the last year ($OptEx_{t-1,i}$) are positively related to the likelihood of stock repurchases. Moreover, the magnitude of coefficient of current option exercises ($OptEx_{t,i}$) is significantly greater than that of latest ($OptEx_{t-1,i}$) and expected future option exercises ($OptOut_{t,i}$).

The results suggest that firms are more likely to make repurchase decision when a higher volume of option is exercised in the same year and last year or when a high volume of option outstanding is to be exercised in the expected future.

It is possible that dilution effect caused by latest and current option exercises is considered when management makes distribution decision. Lee and Alam (2004) document a positive association between the likelihood of stock repurchases and EPS

dilution, which supports undo-dilution hypothesis.

Although option exercises both in the year of repurchase and in the year prior to repurchase are positively associated with repurchase decision, we find that the contemporaneous relation is stronger than sequential relation as the difference between concurrent exercise and latest exercise is positive and significant at the 0.01 level, which is consistent with previous literature (Griffin and Zhu, 2010).

The result from Logistic regression also indicates that total options outstanding ($OptOut_{t,i}$) is positively related to likelihood of repurchase and the coefficient is significant at the 0.05 level. This may suggest more options outstanding would encourage firms to make decision to repurchase. Since option outstanding is a proxy of expected option exercises in the future. It is possible that firms repurchase shares to fund expected future option exercises, which is consistent with option-funding hypothesis.

Similarly, the coefficient of option exercised in the same year of repurchase ($OptEx_{t,i}$) is significantly larger than that of options outstanding ($OptOut_{t,i}$). It suggests that the repurchase decision is more affected by concurrent option exercises than expected future option exercises. This also gives support that contemporaneous relation is stronger than sequential relation.

In addition, executive option outstanding ($ExecOptOut_{t,i}$) has a positive effect on the probability of a repurchase decision-making. Since repurchase, unlike dividend, does not dilute per-share value, as a result, the stock price would not be affected in this case, managers who are granted with options are concerned about the payoff which depends on the stock price. Thus, in order to maintain per share value of the stock and maximize their own option payoffs, managers have incentives to distribute cash by repurchase instead of dividends for their own interest (Kahle, 2002; Voss, 2012). Our result is consistent with agency hypothesis.

Then we exclude executive option in the regression above, and the results in column (2) suggest that likelihood of repurchase decision is affected by past, concurrent and option outstanding in general, however, the effect of concurrent option exercises on repurchase decision is only significantly stronger than that of expected future option exercises. It is possible that we do not distinguish the effect of expected future option exercises and executive options on repurchase, and thus total option outstanding in this case combines the effect of the option funding and manager self-interest motive on repurchase. Then we separate total option outstanding in fiscal year t ($OptOut_{t,i}$) into executive option ($ExecOptOut_{t,i}$) and employee (non-executive) option ($EmployeeOptOut_{t,i}$), the results in column (3) show that the coefficient of concurrent option exercise is significantly larger than employee option outstanding.

Tradition motives still influence repurchase decision as Table 4 suggests. The coefficients of cash flow and firm size are significant and positive. This result indicates that firms with higher cash flow and large firms are more likely to repurchase. Firms would increase actual amount of repurchase when they have more funds available to distribute to their shareholders, which is consistent with excess capital hypothesis. Typically, large firms are less vulnerable to information asymmetry than small firms (Chae, 2005), which implies that they are less likely to release price undervaluation signal to the outside investors by repurchasing. On the other hand, firm size is often associated with cash available. Larger firms may have stronger ability in collecting fund and making a profit and thus they have more excess cash available, which can be used for buybacks.

Besides, takeover is positively related with repurchase dummy. Firms which are potential takeover targets are more likely to repurchase to defend themselves from being acquired, because repurchase typically increase the acquisition cost (Dittmar, 2000).

As we expect, both stock return and leverage are negatively related to the likelihood of repurchase. Firms experiencing high stock return are less likely to release

undervaluation signal by repurchase, which is consistent with undervaluation hypothesis. Firms repurchase when managers believe the stock price is undervalued. Huang et al. (2013) investigate insurance companies and find that stock undervaluation is followed by a positive market reaction to open market repurchase announcement. In addition, the coefficient on leverage is negative and significant at the 0.01 level. This result suggests that firms with lower leverage ratio are more likely to repurchase. Financial stress due to debt can stand in the way of distributing cash to shareholders. It is not surprising that firms under high financial stress are less willing to use repurchase to distribute funds. Another explanation links repurchases with capital structure, stating that firms repurchase shares with attempt to increase leverage ratio when firms are below the optimal or target ratio (Opler and Titman, 1996; Dittmar, 2000).

MB ratio is often used to proxy for investment opportunities. The coefficient is significant and positive, which is different from the argument that firms are less likely repurchase when they are faced with good investment opportunities (Weisbenner, 2000; Rogers, 2013). However, Teng and Hachiya (2011) find that Japanese firms with high MB ratio become more willing to increase repurchase as a result of regulatory reform. In addition, the coefficient of institutional ownership is insignificant, which may suggest tax differentials are not of their concern when managers make repurchase decision.

5.2 Results for Model II on repurchase level

Column (A) of Table 5 shows the results from estimating Tobit model (2).

— *Insert Table 5 about here* —

We find that total option exercised both in the year t ($OptEx_{t,i}$) and in the year $t-1$ ($OptEx_{t-1,i}$) and option outstanding ($OptOut_{t,i}$) have a significant positive relationship with repurchase level in the year t , which suggests that repurchase level increases with more latest, concurrent and expected future option exercises in the firm.

Moreover, the coefficient of total option exercised (0.43) is significantly greater than that of option exercises in the last year and that of total option outstanding at the 0.01 level, suggesting that contemporaneous relation is strongest in repurchase level. This result is similar with what we got in the analysis on likelihood of repurchase decision.

It is reasonable to find out such similar time relationship between repurchase level and option exercises.

Options exercised in the year prior to repurchase ($OptEx_{t-1,i}$) positively affect the level of repurchase in the year, although the coefficient of this variable is less than that of concurrent option exercises. This finding may suggest that managers would adjust the level of repurchase according to option exercises in the past. If much option is exercised in the last year, which caused an increase in the number of shares in the market, then firms may consider conducting more repurchases to counter such effect. It is understandable that firms take certain action such as buybacks in an ex-post way to alleviate dilution caused by past option exercises, given the fact that the time difference exists in firms' decision-making.

This is a new finding that repurchase level of firms would be positively influenced by latest option exercises since most of previous studies focus on the option-funding hypothesis, which supports that firms repurchase to fund the upcoming option exercises and avoid expected future earnings dilution.

In our analysis on repurchase level, we also find evidence for option funding hypothesis. The number of total outstanding option ($OptOut_{t,i}$) is positively related to the amount of repurchase. This finding is not surprising since firms would consider the effect of expected future option exercises when they make plans on repurchase. Previous literature (Bens et al., 2003) think that firms focus on diluted EPS rather than basic EPS. Diluted EPS would be ruined since the grants of options. Therefore, managers would time repurchase before actual option exercises to reduce common shares outstanding and avoid such dilution effect. Weisbenner (2000) supports

option-funding hypothesis and finds that ongoing repurchase over the life of an option is often the way for firms to offset the dilution to EPS caused by stock option grants. This is also consistent with our result that firms would increase repurchase level in the year when they expect more option to be exercised in the future.

We find that contemporaneous relation is strongest in repurchase level, similar to that in repurchase decision. In other words, firms repurchase more in response to current option exercises instead of past or expected future exercises.

It is possible that firms contemporaneously repurchase to meet the concurrent exercise of option, because they try to avoid dilution resulting from option exercise in the same year. By repurchasing shares from market, earning per share in the year would not decrease sharply. Since earning per share affects executives' compensation, managers are motivated to manage EPS for their bonus plan payments (Guidry et al., 1999). Moreover, financial analysts and investors also attach much importance to EPS because it can be used as an indicator to assess a firm's performance. In this case, it is no surprising that companies buy back shares to counter the dilution on EPS. Bens et al. (2003) think that executives focus on diluted EPS instead of basic EPS. However, our result provides evidence that managers are also concerned with basic EPS and they manage it by matching repurchase with concurrent option exercise to control the total number of shares in the market.

Another explanation for contemporaneous relation between repurchase level and option exercises is that managers try to stabilize cash flow in the firm. Firms may use the proceeds of option exercises for financing the repurchase. Although repurchase typically causes a reduction in paid-in capital instead of earnings, this may affect the level of future earnings because cash on hand is reduced (Weisbenner, 2000). In addition, a drop in the cash sometimes would influence the interest earnings. By matching the proceeds of option exercises with the expenses on repurchase, the cash on hand in the firm will be more stable in this case. From the employees' perspective, contemporaneous relationship between repurchase level and option exercised in the

same year implies that employees are more willing to match their payment of option exercise with the concurrent benefit from repurchased shares.

Table 5 also indicates that managers would increase the actual amount of repurchases when they hold more options. Managers would adjust the repurchase level according to executive option holdings to pursue their benefit.

After investigating the latest, current and expected future option exercises, the results show that both the likelihood of repurchase decision and the repurchase level are positively affected by all of these option exercise in different time. This provides evidence that firms make repurchase decision and adjust repurchase level after the comprehensive consideration for option exercises at different time. Moreover, the number of concurrent option exercise is a more important factor relative to that of latest and expected future ones. In addition, a higher managerial option holding leads to higher probability of repurchase decision as well as a high repurchase level.

As for financial controls, traditional motives have an explanatory power on repurchase level from Table 5. The results are similar to the first model concerning repurchase decision. We find cash flow, firm size and takeover are positive related to repurchase level, while stock return and leverage have a negative relationship in the actual amount of repurchase.

However, the coefficient of market-to-book ratio is not significant in repurchase level, which suggests MB ratio does not significantly affect the actual amount of repurchase. The coefficient of institutional ownership is positive and significant. This result indicates that tax incentives or tax differentials between income tax (dividends) and capital gains tax (repurchase) do not essentially change the repurchase plan for the firms. Firms with more individual shareholders do not show the preference for repurchase, instead firms with higher institutional ownership are more likely to repurchase.

5.3 Results from Propensity Score Matching (PSM)

Panel A of Table 6 reports the results from propensity score matching, by comparing performances (measured by ROA in this part) between repurchasing firms with many stock option and repurchasing firms without many stock options (for else being equal).

— *Insert Table 6 about here* —

We find that the coefficient of dummy on “many” options is insignificantly different from zero. This result may suggest that return on total assets (ROA) of firms with repurchases would not be affected by a high holding of stock options.

Previous studies report that stock option program helps align the incentives of employees with those of shareholders and thus improve firms’ performances (profitability) in some degree. However, profitability is more related with efficiency of the upper management so total employee outstanding in the analysis may not be a good proxy. Thus, in repurchasing firms, an increase in the number of total option outstanding may not lead to a significant improvement in performance.

To study further, we set a “many managerial option” dummy which takes one if percentage of managerial option is in the 1st quartile within the same industry, otherwise zero. The result is shown in panel B of Table 6. By propensity score matching, we find that the coefficient of “many managerial option” dummy is significant and positive, and this supports that managerial options rather than total options have a positive effect on firms’ performance.

Apart from the effect of “many” options, we also investigate the effect of repurchases on performances among firms with many options. In other words, we compare ROA in firms with both share buyback and many stock options and companies with no share buybacks but many options from the same industry for else being equal.

Panel C of Table 6 shows the result by using propensity score matching method for this comparison. We find that for firms with many options, repurchase has a positive effect on ROA as the coefficient of repurchase dummy is positive, significantly

different from zero.

Firms with many options are generally those which align interest of employees with that of shareholders. As we discussed above, profitability can be more associated with the efficiency of a firm's management. As a flexible distribution method, repurchase can also be used to release undervaluation signal and undo dilution from option exercises for firms, and such firms typically are run by an active and dynamic management. Thus, repurchase behavior can reflect an effective discretionary of management which may lead to a better performance for such firms.

Besides, repurchase announcements are usually followed by positive market reaction. Previous studies (Ikenberry et al., 2000) find that positive returns are associated with favorable subsequent events. It is also possible that firms repurchase shares when they get favorable news and expect an upcoming earning surprise. In this case, it is understandable that firms with buybacks are more likely to perform better than firms without buybacks for else being equal. However, the causality can be studied further since firms with better performances typically are more likely have excess capital to conduct repurchases.

5.4 Robustness tests

We ran several robustness tests of the regressions when we define or measure the repurchase level and some financial controls in a different method. It shows that the foregoing conclusions we draw do not materially change after these robustness tests.

First, we redefined repurchase level in the regression as the dollar volume of repurchases divided by a) market value of equity at the end of year t (Rep_1t) and b) the current year end market value of equity at the beginning of year t (Rep_2t), respectively. The results are given in the Table 5. The column (B) and (C) report that the general conclusions on option exercises at different time estimating from these two regressions are similar to results in column (A). Although the magnitude of coefficient of concurrent option exercise ($OptEx_t$) is less significantly different from

that of latest exercise ($OptEx_{t-1}$) when we redefine repurchase level with Rep_2_t , it has a significantly stronger effect than the expected future option exercise ($OutOpt_t$).

Second, we measured firm size by the natural log of market value of equity instead of the natural log of total assets.

Third, we re-estimate the model by using value-weighted stock return in the calendar year prior to the repurchase to proxy for stock price misvaluation.

Fourth, we used the values of financial controls measured in the same year of repurchases to replace the lag values of them.

The general results are still robust to these alternatives and changes.

6. Conclusion

Traditional explanations for repurchase motives include excess capital hypothesis, undervaluation hypothesis, optimal leverage ratio hypothesis and takeover deterrence hypothesis (Dittmar, 2000). Since 1990s, repurchase activities have been increasing rapidly. At the same time, stock options are also widely used in the firms as a kind of stock-based compensation. Therefore, some researchers link the growth of option programs in the firms with the surge in buybacks.

Although previous studies give explanations for general quantitative relationship between repurchase and options, few of them focus on how firms time repurchase in response to option exercises. Option-funding hypothesis implies that firms buyback shares to meet the option exercises in the future, while undo dilution hypothesis suggests that repurchase can be used to counter the dilution to EPS caused by past option exercises. Besides, it is likely that firms repurchase shares in response to concurrent option exercises. However, few of researches test all of these hypotheses in one regression model. It is possible that repurchase is simultaneously affected by option exercises in different time.

In this paper, we study repurchases and stock options in all US firms listed on

Compustat database and CRSP between 2000 and 2019 to further examine the time relationship between repurchases and stock options.

We study the effect of option exercises at different time on the likelihood of decision to repurchase made by firms. Option exercised in the year prior to or the year of the repurchase and option outstanding have a positive relationship with the likelihood of repurchase decision. Moreover, contemporaneous relation is stronger than sequential relation, which may suggest that firms would consider concurrent option exercises more when they make the repurchase decision.

Our results also show that the level of repurchase within the firms is positively associated with the volume of past, current and expected future option exercises. Firms would increase the actual amount of repurchase in the year to counter the dilution on earning per share caused by options exercises in the last year. Also, the positive relation between repurchase level and total options outstanding suggests that firms would use repurchase to fund stock options to be exercised in the expected future. Similarly, the strongest link between actual amount of buybacks and option exercises in the same year indicates that firms would pay more attention to concurrent option exercises than past option exercises and expected future option exercises when deciding the actual level of repurchases in the year.

The stronger contemporaneous relation exists both in repurchase decision and repurchase level, which may suggest that firms use repurchases to avoid dilution effect of option exercises and to manage real-time EPS. Another explanation is that proceeds of option exercises in the same year can be used to fund repurchases, by doing so, cash available within the firms would not reduce suddenly and the cash flow would be more stable from companies' level. For managers, they may prefer to match the payment of concurrent option exercise with benefit from repurchased shares (Griffin and Zhu, 2010).

Our finding that executive options are positively related to repurchases is also

consistent with substitution hypothesis. Managers are motivated to use repurchases rather than dividends, because repurchases typically do not reduce the value of executive options while dividends would dilute the per share value of stock and decrease the price. All these results are robust to the other alternatives to financial controls and repurchase.

Our theoretical contribution in this paper is that we use propensity score matching to compare the accounting performance of a) companies with share buyback and many stock options b) companies with share buybacks but not many stock options and c) companies with no share buybacks but many options from the same industry for else being equal. We find that repurchasing firms with many options do not perform better than similar firms without many options. However, a high holding of managerial options has a significant and positive effect on ROA. This finding shows that profitability of firms may be more related to upper management since executive stock options can help align the interests of managers with those of shareholders, which result in better performances for firms.

On the other hand, our analysis suggests that firms with both many options and repurchase do better than firms only with many options in the control group in terms of ROA. Due to information asymmetry, repurchases conducted by insiders can be used to release undervaluation signal to the market conveying favorable news or showing optimism of management, and thus buybacks are often followed by earning surprises. This may explain why repurchases are associated with better ROA in the firms. It is also possible that firms with better performances are more likely to repurchase because such firms may have excess capital to buyback shares in the market.

Further studies can examine causal relationship between firms' performances and repurchase activities to investigate whether firms with better performances are more likely to repurchase because of their adequate funds or whether repurchases can in effect help firms do better in profitability.

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Appendices

Table 1: Sample distribution

This table shows industry distribution of our sample of 18,483 firm-year observations from 2000 to 2019 according to Fama-French 48 industry classification. Obs. is the number of firm-year observations. N is the number of firms.

Economic Sector	Obs.	Percent (%)	N	Economic Sector	Obs.	Percent (%)	N
Agriculture	63	0.34	7	Electrical Equipment	293	1.59	28
Food Products	431	2.33	43	Automobiles, Trucks	417	2.26	36
Candy Soda	77	0.42	7	Aircraft	171	0.93	15
Beer Liquor	94	0.51	8	Chemicals	655	3.54	65
Tobacco Products	46	0.25	5	Defense	92	0.5	8
Recreation	114	0.62	11	Precious Metals	50	0.27	6
Entertainment	262	1.42	28	Mines	102	0.55	9
Printing, Publishing	155	0.84	20	Coal	58	0.31	7
Consumer Goods	490	2.65	45	Petrol, Natural Gas	1,048	5.67	114
Apparel	399	1.83	36	Personal Services	326	1.76	29
Healthcare	437	2.36	50	Business Services	2,672	14.46	299
Medical Equipment	737	3.99	84	Computers	790	4.27	96
Pharmaceutical Products	1,021	5.52	124	Electronic Equipment-chips	1,469	7.95	149
Shipbuilding, Railroad Equipment	54	0.29	5	Measuring, Control Equipment	484	2.62	50
Rubber and Plastic Products	115	0.62	11	Construction Materials	503	2.72	44
Textiles	78	0.42	7	Shipping Containers	105	0.57	9
Business Supplies	285	1.54	31	Wholesale	783	4.24	77
Construction	355	1.92	32	Retail	1,513	8.19	155
Steel Works Etc	336	1.82	36	Restaurants, Hotels, Motels	472	2.55	52
Fabricated Products	23	0.12	3	Other	89	0.48	11
Machinery	879	4.76	88	Total	18,483	100	1,940

Table 2: Variable definitions and data sources

This table presents description/calculation methods and the sources of all explanatory variables and financial controls in our study. All values of quantitative variables in model (1) and model (2) are winsorized at the 1st and 95th percentiles.

Variable	Description	Source
$RepuDummy_t$	Dummy variable takes the value 1 if firm repurchase in fiscal year t, and 0 otherwise.	Compustat
AvgMKV	Average of market value in fiscal year t, calculated as average of previous year ending and current year ending market value. [(MKV _{t-1} + MKV _t) / 2]	Compustat
AvgAT	Average of total assets in fiscal year t, calculated as average of previous fiscal year ending and current fiscal year ending total assets. [(AT _{t-1} + AT _t) / 2]	Compustat
Rep _t	Level of actual repurchase volume in fiscal year t in dollar volume, defined as purchase of stock minus decreases in preferred stock divided by average market value in fiscal year t, ([prstk _t -prstkpc _t] / AvgMKV _t).	Compustat
Rep_1 _t	Rep_1 _t is the alternative to repurchase level (Rep _t), which is defined as dollar volume _t normalized by market value in the ending of fiscal year t ([prstk _t -prstkpc _t] /MKV _t).	Compustat
Rep_2 _t	Rep_2 _t is the alternative to repurchase level(Rep _t), which is defined as dollar volume _t normalized by market value in the ending of fiscal year t-1 ([prstk _t -prstkpc _t] /MKV _{t-1}).	Compustat
ROA	Return on assets, a measure of accounting performance, denotes the profitability of the firm, calculated as net income divided by average total assets (NI _t / AvgAT _t).	Compustat
$OptEx_t$	This variable represents total <i>options exercises in the fiscal year t</i> , defined as number of total employee option exercises in the fiscal year t divided by the number of common outstanding shares in the fiscal year t (Optexd _t / Csho _t).	Compustat
$OptEx_{t-1}$	This variable represents total <i>options exercises in the fiscal year t-1</i> , defined as number of total employee option exercises in the fiscal year t divided by the number of common outstanding shares in the fiscal year t-1 (Optexd _{t-1} / Csho _{t-1}).	Compustat
$OptOut_t$	<i>Option outstanding in fiscal year t</i> is a proxy of expected future option exercises, defined as the average of total options outstanding in the beginning of the fiscal year t and in the end of fiscal year t ((Optosby _t + Optosey _t)/2), divided by the number of common outstanding shares in year t.	Compustat
$ExecOptOut_t$	<i>Executive option outstanding in fiscal year t</i> , defined as the number of executive option outstanding (Opt_Unex_Exer_Num +Opt_Unex_Unexer_Num) in fiscal year t divided by the number of common outstanding shares in fiscal year t.	Execucomp

Table 2 (Continued)

variable	Description	Source
$ExecOptOut_{t-1}$	<i>Executive option outstanding in fiscal year t-1</i> is defined as the number of executive option outstanding in fiscal year t-1 divided by the number of common outstanding shares in fiscal year t-1.	Execucomp
$EmployeeOptOut_t$	<i>Employee option outstanding (non-managerial option) in fiscal year t</i> , defined as total option outstanding in fiscal year t minus executive option outstanding in fiscal year t scaled by the number of common shares outstanding in fiscal year t.	Compustat Execucomp
Cash flow	The level of cash flow in fiscal year t is calculated as operating income before depreciation minus capital expenditures, divided by book value of total assets (AT) in fiscal year t, $([Oibdp_t - CapEx_t]/AT_t)$.	Compustat
Market-to Book ratio	MB ratio in fiscal year t represents investment opportunities, calculated as market value in $(Mkvalt + Dltt + Dlc + Pstk)$ in fiscal year t divided by book value of total assets in fiscal year t.	Compustat
Firm size	Firm size in year t is defined as natural logarithm of total assets in fiscal year t.	Compustat
Return	holding period return in fiscal year t is calculated by multiplying the holding period return for each month (Ret) for the fiscal year t.	CRSP Database
Leverage	Leverage ratio in year t is defined as long-term debt (Dltt) divided by total assets for the fiscal year t.	Compustat
Takeover	Takeover dummy in year t takes the value 1 if the company is a target of takeover in the fiscal year t or t-1, and 0 otherwise.	SDC
Institutional ownership	The percentage of shares held by institutions, defined as number of shares of institution divided by common shares outstanding.	Thomson Reuters
“Many” option	A dummy variable which takes the value 1 if total options normalized by common outstanding shares is in the 1st quartile within the same industry in fiscal year t, and 0 otherwise.	Compustat
“Many” managerial option	A dummy variable which takes the value 1 if the percent of managerial options is in the 1st quartile within the same industry in fiscal year t, and 0 otherwise.	Execucomp
Industry indicators	Dummies according to Fama French 48 classifications for industry are used to control industry fixed effects. The dummy value takes the value 1 if the firm is from a particular industry and it takes 0 when the firm is not from the particular industry.	Compustat
Year indicators	Year dummy variables can be used to control annual fixed effects. For example, V2009 equals 1 if the data is from the fiscal year 2009, 0 if not.	Compustat

Table 3: Descriptive statistics

The table shows means, medians and standard deviation (SD), minimum (Min) and maximum (Max) for all sample firms used in the study. Panel A and B are differentiated between repurchasing and non-repurchasing groups respectively, with p-value for a two-sided difference in means as shown in panel (B).

Total sample (n=18,483)						
	Mean	Median	SD	Min	Max	
RepuDummy _t	0.672	1	0.470	0	1	
Rep	0.022	0.006	0.030	0	0.143	
Rep_1	0.023	0.006	0.033	0	0.171	
Rep_2 _t	0.022	0.006	0.030	0	0.134	
OptEx _t	0.010	0.006	0.010	0.00	0.136	
OptOut _t	0.061	0.051	0.048	0.00	0.312	
ExecOptOut _t	0.020	0.015	0.019	0.00	0.330	
EmployeeOptOut _t	0.041	0.032	0.035	0.00	0.159	
Cash flow	0.082	0.090	0.102	-0.78	0.288	
Market-to-book ratio	3.180	2.915	5.663	-104.55	32.177	
Size	7.390	7.355	1.534	3.20	10.643	
Return	0.110	0.090	0.395	-0.92	2.085	
Leverage	0.185	0.166	0.165	0.00	0.745	
Institutional ownership	0.804	0.841	0.186	0.03	1.133	
Takeover	0.345	0.000	0.475	0.00	1	
ROA	0.433	0.056	0.175	-10.19	2.61	
Panel A: Repurchasing subsample (n=12,412)						
	Mean	Median	SD	Min	Max	
OptEx _t	0.010	0.007	0.010	0.00	0.048	
OptOut _t	0.058	0.048	0.047	0.00	0.216	

ExecOptOut _t	0.018	0.013	0.018	0.00	0.084	
EmployeeOptOut _t	0.039	0.030	0.035	0.00	0.159	
Cash flow	0.100	0.101	0.087	-0.78	0.288	
Market-to-book ratio	3.365	3.087	6.049	-104.55	32.177	
Size	7.641	7.614	1.474	3.32	10.643	
Return	0.097	0.085	0.357	-0.92	2.085	
Leverage	0.184	0.167	0.161	0.00	0.671	
Institutional ownership	0.816	0.846	0.168	0.028	1.133	
Takeover	0.439	0	0.496	0.00	1.000	
ROA	0.063	0.064	0.102	-1.23	1.541	

Panel B: Non-repurchasing subsample (n=6,071)

	Mean	Median	SD	Min	Max	p-value
OptEx _t	0.009	0.005	0.01	0.00	0.136	0.46
OptOut _t	0.067	0.057	0.05	0.00	0.312	0.30
ExecOptOut _t	0.024	0.018	0.02	0.00	0.330	0.37
EmployeeOptOut _t	0.042	0.035	0.035	0.00	0.159	0.00
Cash flow	0.047	0.068	0.12	-0.78	0.268	0.00
Market-to-book ratio	2.805	2.595	4.76	-104.55	21.46	0.00
Size	6.879	6.793	1.53	3.20	10.58	0.00
Return	0.140	0.107	0.47	-0.92	2.08	0.01
Leverage	0.187	0.164	0.17	0.00	0.745	0.42
Institutional ownership	0.777	0.824	0.22	0.028	1.133	0.01
Takeover	0.152	0.152	0.36	0.00	1.000	0.00
ROA	0.003	0.036	0.26	-10.19	2.611	0.00

Table 4: Results for repurchase decision

This table presents the results of Logistic regression on repurchase decision using panel data in our study. The dependent variable in the regression is binary variable (*RepuDummy*) which takes the value 1 if any repurchase occurs in the fiscal year t and 0 if not. Option holdings are scaled by common shares outstanding. See Table 2 for definitions of variables. Standard errors are shown in parentheses. ***, **, * denote significance at the 1%, 5%, 10% levels, respectively.

	Dependent variable= <i>RepuDummy</i> _{t}		
	(1)	(2)	(3)
OptEx _{t}	22.367*** (3.90)	16.640*** (3.68)	22.291*** (3.91)
OptEx _{$t-1$}	13.156*** (3.37)	13.504*** (3.36)	13.165*** (3.37)
OptOut _{t}	2.253** (1.11)	1.956** (0.778)	
ExecOptOut _{t}	13.487*** (3.63)		15.618*** (3.40)
ExecOptOut _{$t-1$}	-15.699*** (3.50)		-15.523*** (3.45)
EmployeeOptOut _{t}			2.277** (1.13)
Cash flow _{$t-1$}	4.524*** (0.318)	4.598*** (0.318)	4.526*** (0.318)
Market-to-book ratio _{$t-1$}	0.012*** (0.004)	0.012*** (0.004)	0.012*** (0.004)
Firm size _{$t-1$}	0.326*** (0.022)	0.341*** (0.021)	0.327*** (0.022)
Return _{$t-1$}	-0.160** (0.078)	-0.154** (0.078)	-0.160** (0.078)
Leverage _{$t-1$}	-2.223*** (0.188)	-2.268*** (0.187)	-2.222*** (0.188)
Institutional ownership _{$t-1$}	-0.069 (0.153)	-0.063 (0.152)	-0.068 (0.153)
Takeover	1.454*** (0.060)	1.459*** (0.060)	1.455*** (0.060)
Industry Indicator	Yes	Yes	Yes
Year Indicator	Yes	Yes	Yes
Obs	18,483	18,483	18,483
Pseudo R ²	0.21	0.20	0.21
VIF Max	7.15	2.05	7.02
VIF Mean	2.60	1.47	2.39

Table 5: Results for repurchase level

This table presents the results of Tobit regression for model (2). The dependent variable in Column (A) is repurchase level in fiscal year t (REP_t), calculated as the actual amount of repurchase divided by average market value of firm in fiscal year t . Average market value is the average of market value at the beginning and at the end of the fiscal year t . The alternative to repurchase level REP_{1t} (REP_{2t}) is defined as actual repurchase amount divided by market value in the end of the fiscal year t (in the end of the fiscal year $t-1$), and the results are shown in Column (B) and Column (C). Standard errors are shown in parentheses. ***, **, * denote significance at the 1%, 5%, 10% levels, respectively.

	Column (A)	Column (B)	Column (C)
	REP_t	REP_{1t}	REP_{2t}
OptEx _t	0.427*** (0.040)	0.243*** (0.044)	0.600*** (0.039)
OptEx _{t-1}	0.0137*** (0.034)	0.212*** (0.038)	0.070** (0.034)
OptOut _t	0.071*** (0.011)	0.090*** (0.012)	0.057*** (0.011)
ExecOptOut _t	0.315*** (0.038)	0.342*** (0.043)	0.310*** (0.0038)
ExecOptOut _{t-1}	-0.317*** (0.037)	-0.340*** (0.041)	-0.314*** (0.036)
Cash flow _{t-1}	0.045*** (0.003)	0.045*** (0.003)	0.0450*** (0.003)
Market-to-book ratio _{t-1}	-0.00005 (0.000)	-0.00004 (0.000)	-0.00004 (0.000)
Size _{t-1}	0.004*** (0.000)	0.004*** (0.000)	0.004*** (0.000)
Return _{t-1}	-0.003*** (0.001)	-0.002*** (0.001)	-0.0030*** (0.001)
Leverage _{t-1}	-0.018*** (0.002)	-0.019*** (0.002)	-0.0170*** (0.002)
Institutional ownership _{t-1}	0.005*** (0.001)	0.006*** (0.001)	0.0040** (0.001)
Takeover	0.017*** (0.002)	0.018*** (0.002)	0.0170*** (0.002)
Industry Indicator	Yes	Yes	Yes
Year Indicator	Yes	Yes	Yes
Obs	18,483	18,483	18,483
χ^2	3605.05	3432.61	3671.69
Prob> χ^2	0.00	0.00	0.00
VIF Max	7.15	7.15	7.15
VIF Mean	2.60	2.60	2.60

Table 6: Results of Propensity Score Matching

This table shows the comparison results of ROA by propensity score matching (PSM). The dependent variable is return on assets (ROA). The sample used in panel A and panel B consists of all repurchasing firms in full sample. The treatment variable in Panel A is “many” option dummy, which equals 1 if the number of total options normalized by common outstanding shares falls in the 1st quartile within the same industry and 0 otherwise. The treatment variable in Panel B is “many” managerial option dummy, which equals 1 if the percent of managerial options falls in the 1st quartile within the same industry and 0 otherwise. The sample used in Panel C comprises all firms with many options in the full sample. The treatment variable in Panel C is repurchase dummy which takes 1 if repurchase occurs in year t, 0 otherwise.

Panel A					
“many” options dummy (1 vs 0)	Coef.	Std.Err.	z	P> z	Number of obs used
	-0.0026	0.00202	-1.28	0.200	9,038
Panel B					
“many” managerial options dummy (1 vs 0)	Coef.	Std.Err.	z	P> z	Number of obs used
	0.0048	0.00260	1.84	0.066	9,038
Panel C					
RepuDummy (1 vs 0)	Coef.	Std.Err.	z	P> z	Number of obs used
	0.0154	0.00917	1.68	0.093	3,388