TWO ESSAYS ON STOCK REPURCHASES

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TWO ESSAYS ON STOCK REPURCHASES

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Abstract:

My dissertation comprises two chapters. The first chapter examines the information content of actual share repurchase within the context of informed options trading, while the second chapter examines the impact of EPS-motivated share repurchase on stock price crash risk.

The first chapter studies the information content of actual share repurchase within the context of informed options trading. I find that pre-repurchase options tradings complement the information conveyed by actual repurchases, and predict higher and more volatile stock return and operating performance. The pre-repurchase use of bullish directional strategy (measured by call options to stock volume ratio) predicts higher abnormal return and operating performance; the pre-repurchase use of volatility strategy (measured by at-the-money options to stock volume ratio) predicts higher abnormal volatility and operating performance volatility. Institutional ownership mitigates the information asymmetry of pre-repurchase options trading.

The second chapter investigates whether EPS-motivated share repurchase affects stock price crash risk. This study finds that firms with a higher level of EPS-motivated share repurchase are associated with higher ex-ante (expected) crash risk. Stock liquidity reduces repurchase cost and further increases the expected crash risk. Institutional ownership and analyst coverage discipline managers from conducting EPS-motivated share repurchase and weakens its positive impacts on expected crash risk.

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CHAPTER I

DOES OPTIONS TRADING COMPLEMENT INFORMATION CONVEYED BY SUBSEQUENT STOCK REPURCHASE ACTIVITY?

1. Inroduction

The last three decades have witnessed a dramatic increase in the use of open market share repurchase since the Securities and Exchange Commission (SEC) adopted Rule 10b-18 in 1984, and the total value of share repurchases (led by open market share repurchase) exceeded that of dividends in 2000 (Grullon and Michaely, 2002). According to the survey evidence in Brav et al. (2005), many managers favor repurchases because repurchases are viewed as being more flexible than dividends. Specifically, managers can decide if, when, and how many shares to buy back based on stock price and free cash flow. Many motivations have been ascribed to repurchases (Dittmar, 2000; DeAngelo et al., 2009) ranging from signaling to tax/investor preference to takeover defense to capital structure adjustment to equity compensation dilution. Based on their extensive review, DeAngelo et al. (2009) favor an asymmetric information framework where repurchase firms have superior information and can time the market by buying back stocks when the shares are undervalued. In testing the various theories, empirical research has largely focused on repurchase announcements. However, recent evidence documents that firms do not always follow through on their repurchase announcements.

Evidence shows that on average, only 73 percent of announced shares are repurchased, and in 9 percent of the cases firms do not buy any of the shares originally announced. This calls into question the credibility and the nature of the information conveyed by buy-back announcements. The focus instead should be on actual repurchases. Oded (2009) constructs an optimal execution model of stock repurchase and proves that actual executions of repurchases convey information about the firm value, and traders can infer such information from the actual repurchases. Bonaime and Ryngaert (2013) find that actual share repurchases predict persistent positive abnormal returns, and that concurrent net insider stock buyings complement the information conveyed by actual repurchases.

The current paper studies the information content of actual share repurchase within the context of informed options trading. I find that pre-repurchase options tradings complement the information conveyed by actual repurchases, and predict higher and more volatile stock return and operating performance. Additionally, both stock and options volumes are higher in pre-repurchase quarters, indicating the presence of informed tradings. Consistent with the notion that informed traders prefer options over stock due to the implicit leverage of options (Easley et al., 1998), options volume increases more than stock volume does prior to actual repurchases. Moreover, the pre-repurchase use of bullish directional strategy by options traders (measured by call options to stock volume ratio) predicts higher post-repurchase abnormal return and operating performance. This evidence suggests that actual repurchases and pre-repurchase options tradings convey favorable complementary information about post-repurchase stock return and operating performance. The pre-repurchase use of volatility strategy by options traders (measured by at-the-money options to stock volume ratio) predicts higher post-repurchase stock volatility and operating performance volatility. One possible reason for the increase in firm risk is the increase in leverage caused by actual repurchases. Besides, I find that institutional holdings mitigate the information asymmetry of pre-repurchase options tradings. These findings are robust to difference-in-difference analysis using 2003 Modification to SEC Rule 10b-18 as an exogenous policy shock. A placebo test using random repurchase quarters further validates my results.

I extend Bonaime and Ryngaert (2013) in four important aspects. First, I study not only the stock returns but also the stock volatility after actual repurchases. According to Ikenberry and Vermaelen (1996), repurchases are positively related to the stock volatility, because higher stock volatility implies a higher likelihood of buying back the stock at a lower price. Therefore, actual share repurchases convey information about stock volatility. Second, I study not only the post-repurchase stock returns but also the post-repurchase operating performances. Campbell and Shiller (1988) construct a rational expectations model and proves that stock return and stock volatility depend on the growth and volatility of future operating performance. Consequently, it is important to study both firm stock and firm operating performance. Third, I investigate pre-repurchase options tradings instead of insider stock tradings. There are three main advantages of using options tradings for the current study. First, like corporate insiders, outsiders can have superior information as well, because some outsiders can obtain superior information from the insiders (Manove, 1989; Eyssell and Arshadi, 1993). Therefore, using insider stock tradings as a proxy for informed tradings may underestimate the magnitude of informed tradings. Second, options trading is more likely to be informed than stock trading. Theoretical and empirical studies confirm that informed traders prefer options over stock due to the embedded leverage of options (Biais and Hillion, 1994; Easley et al., 1998; Cao, 1999). Third, investigating options tradings allows me to disentangle the information about the stock return from that about stock volatility. Specifically, a trader may buy call (put) options if she predicts that the price of the underlying stock will rise (fall); a trader may buy at-the-money options if she predicts that the volatility of the underlying stock will rise. Consequently, by examining which types of options are traded prior to actual repurchases, I can infer what options traders know about the post-repurchase stock return and stock volatility.

The current paper also relates to the studies about informed options tradings prior to corporate events, including analyst recommendations (Hayunga and Lung, 2014; Lin and

Lu, 2015), merger and acquisition announcements (Cao et al., 2005; Jayaraman et al., 2001; Augustin et al., 2015; Chan et al., 2015), earnings announcements (Jin et al., 2012), dividend change announcements (Zhang, 2018), and repurchase announcements (Hao, 2016). These papers focus on how options tradings affect stock returns around corporate events, while the current paper explores the information content of actual repurchase in both the valuation dimension (stock return and operating performance) and the risk dimension (stock volatility and operating performance volatility). Moreover, even though the existing studies suggest that informed traders prefer options over stock, most do not consider stock tradings when investigating options tradings. The current study uses OS, the options to stock volume ratio, to explicitly account for the trading choice between options and stock (Roll et al., 2010). More importantly, the current paper is the first one to decompose the OS measure into components corresponding to the directional strategy and volatility strategy that options traders may use. Besides, the current study extends the literature about corporate governance by examining the role of institutional ownership in mitigating the information asymmetry of options tradings prior to actual repurchases.

The remainder of the paper proceeds as follows. Section 2 reviews related literature and develops hypotheses. Section 3 describes the sample and variables. Section 4 reports the results. Section 5 addresses robustness concerns and Section 6 concludes.

2. Literature Review and Hypothesis Development

Based on a sample of 185 announcements of open market share repurchase programs, Bartov (1991) finds that analysts revise up earnings forecasts for announcing firms. Further, the earnings of the announcing firms increase during the announcement year, suggesting that repurchase announcements may convey favorable information about future operating performance. Using a much larger sample of 4,443 repurchase announcements, Grullon and Michaely (2004) document positive abnormal returns following repurchase announcements, indicating that investors perceive repurchase announcements as good news. Compared to dividends, repurchases are more flexible by design. Specifically, actual repurchase quantities can differ substantially from announced amounts due to fluctuations in stock prices and investment opportunities (Stephens and Weisbach, 1998; Bonaime, 2012). Therefore, repurchase announcements may be considered "cheap talk" without financial commitments. Lie (2005) examines the completion rates of repurchase announcements, and finds that both the operating performance improvements and the positive announcement abnormal returns are limited to the firms that buy back shares during the announcement quarter. These findings suggest that actual repurchases may convey more credible information than repurchase announcements. Therefore, the current paper focuses on the information content of actual repurchases as opposed to repurchase announcements.

The actual repurchase model of Oded (2009) demonstrates that when firms buy back stocks on the open market, the actual executions will convey favorable information about the firm value and drive up stock prices. This theoretical evidence, coupled with the aforementioned empirical findings, suggests that actual repurchases may convey favorable information about future stock return and operating performance.

According to the free cash flow hypothesis of payouts, it is optimal for a firm lacking growth opportunity to distribute free cash flows to its stockholders. Therefore, payouts induced by free cash flows should reduce the risk of negative-NPV investments, and thus reduce the total risk of the firm. Grullon and Michaely (2002) and DeAngelo et al. (2006) confirm the free cash flow hypothesis of payouts by showing that compared to young firms, mature firms are more likely to pay dividends. However, more recent evidence finds that an increasing number of US firms do not generate sufficient free cash flows to fund their repurchases internally, but choose to raise capital to finance the repurchases (Farre-Mensa et al., 2018). This evidence contradicts the free cash flow hypothesis that assumes payouts should be funded by free cash flows. As a result, actual repurchases may increase firm risk, because repurchases consume cash and increase leverage (Chen and Wang, 2012). Since higher leverage is associated with higher risk, especially for financially constrained firms (Myers and Majluf, 1984), I argue that actual repurchases convey information about higher firm risk. Further, this higher risk is reflected in higher stock volatility and operating performance volatility following actual repurchases. Based on these considerations, I propose the first hypothesis:

- **H1a**: Actual share repurchases are associated with higher post-repurchase stock return and operating performance.
- **H1b**: Actual share repurchases are associated with higher post-repurchase stock volatility and operating performance volatility.

Bonaime and Ryngaert (2013) find that insider stock buyings increase in repurchase quarters, and net insider stock buyings are positively associated with post-repurchase abnormal returns. This evidence indicates the presence of informed tradings around actual repurchases, and suggests that the informed tradings may complement the information conveyed by actual repurchases. Therefore, ignoring the informed tradings may underestimate the information content of actual repurchases. Based on these considerations, I examine the information content of actual repurchase within the context of pre-repurchase informed tradings. Unlike Bonaime and Ryngaert (2013), I study the informed tradings in pre-repurchase quarters instead of repurchase quarters, because some tradings in the repurchase quarters may happen after actual repurchases and may not be considered informed. Focusing on the pre-repurchase quarters allows me to have a clear identification of informed tradings. Furthermore, I assess the information content of actual repurchases in both the valuation dimension (stock return and operating performance) and the risk dimension (stock volatility and operating performance volatility).

Specifically, I examine pre-repurchase options tradings instead of stock tradings mainly because options tradings are more likely to be informed than stock tradings. Informed traders prefer options over stock due to the implicit leverage of options (Easley et al., 1998). Options are much cheaper than the underlying stocks, and the informed traders can exploit this leverage effect to achieve higher returns. If trading costs (fees, commissions, taxes, liquidity costs, price impacts, etc.) were absent, informed traders would trade options exclusively. However, options, on average, have higher trading costs than stock. Therefore, the informed traders face a trade-off between the leverage effect of options and the low trading costs of stock. When the informed traders migrate from stock to options, the increased demand for options will drive up the options' prices and reduce the leverage effect. Additionally, the increase in options trading volume makes it difficult for informed traders to hide their identity (Kyle, 1985). Consequently, the informed traders will continue to migrate from stock to options until the benefits of the leverage effect can no longer justify the increase in trading costs. When informed traders are present, this mechanism will lead to an increase in both the stock volume and options volume, and the increase in the options volume will be larger than that in the stock volume. Therefore, both the stock volume and options volume will rise prior to actual repurchase, a corporate informational event. Following Roll et al. (2010), I define OS as the options to stock volume ratio to account for the relative change in the options volume and stock volume. OS explicitly measures informed traders' preference of options over stock. Since the increase in options volume is larger than that in stock volume, OS should also rise prior to actual repurchases. Based on these considerations, I conjecture the second hypothesis:

- **H2a**: Both the stock volume and options volume are higher in pre-repurchase quarters.

- **H2b**: OS, the options to stock volume ratio, is higher in pre-repurchase quarters.

Although the theoretical literature about informed trading, such as Kyle (1985) and Glosten and Milgrom (1985), emphasizes the difference between informed and uninformed agents, trading itself is driven by traders with convictions, whether or not they have superior information. Existing studies hypothesize two main explanations for why a trader would trade stock or options. First, the trader may have superior information about a forthcoming corporate event. Second, the trader may have different opinions on the same public information from other traders. Depending on whether the corporate events are predictable, evidence on tradings can be interpreted differently (Christophe et al., 2010). Tradings prior to pre-scheduled events, such as earnings and dividends announcements, may be driven by both superior information and different opinions. Unlike dividends, actual repurchases are not pre-scheduled and difficult for traders to predict its timing and magnitude (Jagannathan et al., 2000). Since actual repurchases are difficult to predict, the pre-repurchase tradings are more likely to be driven by superior information than by different opinions. Therefore, actual repurchases provide a clear setup to examine the information content of options tradings prior to corporate events.

Prior studies confirm that options tradings convey information about the underlying stocks (Choy and Wei, 2012; Hu, 2014). Existing studies have constructed various measures of informed options tradings, such as options trading volume (Chan et al., 2002), options implied volatility (Bali and Hovakimian, 2009; Cremers and Weinbaum, 2010; Xing et al., 2010; Bollerslev et al., 2011), and options implied skewness (DeMiguel et al., 2013). I use options volume to measure informed options tradings for three reasons. First, options volume directly measures the intensity of options tradings and is publicly observable to most traders. Meanwhile, options implied volatility and skewness may measure other factors besides informed tradings, and are difficult to comprehend for most traders. Second, options volume does not rely on any assumptions about the price processes of underlying stocks, and thus does not introduce any model risks. For example, the options implied volatility and skewness calculated using Black and Scholes (1973) model and Heston and Nandi (2000) model are different. Third, options volume allows me to link options tradings to specific trading strategies that informed traders may use.

In the current study, I consider two commonly used options trading strategies, i.e., directional strategy and volatility strategy. To link options tradings to directional strategy and volatility strategy, I further decompose OS in two dimensions — strike price and moneyness. This decomposition allows me to disentangle the information about the stock return from that about stock volatility. Specifically, when an informed trader has superior information about stock return, she will use the directional strategy; when she has superior information about stock volatility, she will use volatility strategy. Therefore, by examining which trading strategy is used, I can understand what informed traders know about the future stock return and stock volatility.

The most straightforward and cost-efficient implementation of the directional strategy is to buy call options or put options. Specifically, the price of call options will go up (down) when the stock price goes up (down); the price of put options will go up (down) when the stock price goes down (up). A trader may buy call (put) options if she predicts that the price of the underlying stock will rise (fall). Therefore, I decompose OS into CALLOS and PUTOS, corresponding to the call options to stock volume ratio and the put options to stock volume ratio, respectively. I focus on CALLOS because call options, on average, have higher liquidity than put options, which makes them more cost-efficient for informed traders. Moreover, actual repurchases tend to convey favorable information about the post-repurchase stock return. Therefore, informed traders are more likely to use the bullish directional strategy (buy call options) than the bearish directional strategy (buy put options) prior to actual repurchases.

Higher CALLOS in pre-repurchase quarters may indicate the use of bullish directional strategy by informed traders who have superior information about the post-repurchase stock return. Therefore, I propose that higher pre-repurchase CALLOS should predict higher post-repurchase stock returns. Since stock return depends on future operating performance (Campbell and Shiller, 1988), higher CALLOS should also predict higher operating performance after actual repurchases. Based on these considerations, I propose the third hypothesis:

- **H3:** Pre-repurchase CALLOS, the call options to stock volume ratio, is positively associated with post-repurchase stock return and operating performance.

The most straightforward and cost-efficient implementation of the volatility strategy is to buy at-the-money (ATM) options. Specifically, the price of at-the-money options will go up (down) when stock volatility goes up (down). A trader may buy at-the-money options if she predicts that the volatility of the underlying stock will rise. I define ATMOS as the at-the-money options to stock volume ratio. Higher ATMOS in pre-repurchase quarters may indicate the use of volatility strategy by informed traders who have superior information about the post-repurchase stock volatility. Therefore, I propose that higher pre-repurchase ATMOS should predict higher stock volatility after actual repurchases. Since stock volatility depends on operating performance volatility (Campbell and Shiller, 1988), higher ATMOS should also predict higher operating performance volatility after actual repurchases. Based on these considerations, I argue that:

- **H4:** Pre-repurchase ATMOS, the at-the-money options to stock volume ratio, is positively associated with post-repurchase stock volatility and operating performance volatility.

Corporate governance plays a critical role in maintaining a transparent information environment around corporate events. Institutional ownership improves corporate governance by providing external monitoring. Institutional holdings mitigate the information asymmetry around corporate events (Gillan and Starks, 2000; McCahery et al., 2016). Higher institutional holdings improve stock price informativeness and reduce the incentives and profits of informed tradings (Boehmer and Kelley, 2009). Based on these findings, I propose the last hypothesis:

- **H5:** Institutional holdings mitigate the information asymmetry of pre-repurchase options tradings.

3. Sample and Variable Construction

In constructing the sample, I use Compustat quarterly data for firm quarters from January 1996 to December 2017. Following Billett and Xue (2007), I remove financials and utilities (SIC in 4900-4949 or 6000-6999), as these firms are in regulated industries and tend to have unreliable repurchase data. To eliminate firms that have just raised capital via initial public offerings, I remove companies without closing stock price data in at least eight of the prior nine quarters. I also eliminate firms with less than 10,000 shares outstanding or with a market capitalization of less than or equal to $2 million in the prior quarter due to low stock liquidity (Brockman et al., 2008). I delete firms with a negative book value at the beginning of the fiscal quarter since these firms may have covenants that restrict share repurchase.

As a first pass, I calculate the amount of actual share repurchase as the Compustat quarterly purchase of common and preferred stock (adjusted for the fact that this variable is cumulative) minus any decrease in preferred stock (Grullon and Michaely, 2002). Banyi et al. (2008) identify this measure as the most accurate proxy for actual common shares repurchased, especially for firms with high levels of employee stock option exercises. To take into account variation in firm size, I divide the amount of actual repurchase by the firm's total assets and denote the ratio as REP. Following Bonaime and Ryngaert (2013), I create a dummy variable, REPDUM, that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise, to distinguish repurchase quarter from non-repurchase quarter. I define quarters with REPDUM equal to 1 (0) as repurchase (non-repurchase) quarters. Banyi et al. (2008) find that eliminating firms with common stock repurchases equaling less than 1% of market capitalization improves the accuracy of the repurchase measure since many small values of "Purchases of Common and Preferred Stock" are solely due to preferred buybacks. The 1% cutoff also ensures that the buybacks are non-trivial.

Following Grullon and Michaely (2002), I include three control variables related to actual repurchase, i.e., firm size (SIZE), market-to-book ratio (MB), and firm leverage (LEV). Firm size is measured by the percentile rank of a firm's market cap among firms listed on NYSE (Fama and French, 1995). Firm leverage is calculated as long-term debt scaled by total assets.

I use institutional holdings as a proxy for corporate governance (Gillan and Starks, 2000; McCahery et al., 2016) and obtain the data from Thomson-Reuters 13F. For each firm, I aggregate all shares held by institutional investors to calculate institutional holdings for each firm quarter. I eliminate firm quarters with missing institutional holdings information. I define INSOWN as the proportion of stocks owned by institutional investors.

I obtain stock and options trading volume information from OptionMetrics. OptionMetrics provides the daily number of contracts traded for each individual option on US-listed stocks along with the associated bid and ask prices. With these data, I can aggregate the total daily options volume for each firm by multiplying the total contracts traded in each option by the end-of-day quote midpoints and then aggregating across all options listed on the stock (I account for the fact that each contract is for 100 shares of stock). I define STOCKVOL (OPTIONVOL) as the natural log of quarterly stock (options) volume. I confine the sample to stocks with valid stock and options volume information for at least 4 consecutive quarters. I also eliminate stocks with a price lower than $1 as calculating returns on these stocks may be problematic due to bid-ask bounce.

Following Roll et al. (2010), I define the relative trading activity in options and stock, OS, as the natural log of options to stock volume ratio:

$$OS = ln(\frac{OPTIONVOL}{STOCKVOL}). \tag{1}$$

To link options volume to the bullish directional strategy and volatility strategy that informed traders may use, I further decompose OS in two dimensions — strike price and moneyness. I first define CALLOS as a proxy for the use of bullish directional strategy, calculated as the natural log of call options to stock volume ratio:

$$CALLOS = ln(\frac{OPTIONVOL|CALL}{STOCKVOL}). \tag{2}$$

I next define ATMOS as a proxy for the use of volatility strategy, calculated as the natural log of at-the-money options to stock volume ratio:

$$ATMOS = ln(\frac{OPTIONVOL|ATM}{STOCKVOL}). \tag{3}$$

Since informed traders choose to trade stock and options conditional on the trade-off between the leverage effect of options and the lower trading costs of stock, I include several control variables. I define STOCKILLIQ (OPTIONILLIQ) as the stock (options) illiquidity measured by the relative bid-ask spread (Roll, 1984). I use DELTA, which measures the sensitivity of option price to the change of underlying stock price, as a proxy for the leverage effect of options. I also include borrowing cost (BOWCOST), proxied by the risk-free rate, since the leverage effect of options is more valuable when borrowing is more costly.

I use buy-and-hold abnormal return (BHAR) to assess the change in stock return due to actual repurchase. Following Barber and Lyon (1997), I estimate BHAR as the difference of stock return between repurchase quarter and matching non-repurchase quarter. The matching firm quarter is constructed by identifying all firm quarters in the same SIZE decile as the repurchase firm in the repurchase quarter. I then select the 20 firm quarters that are closest in MB (market-to-book ratio) to the repurchase quarter, and assign equal weights to each firm quarter at the beginning of the quarter. The stock return of matching non-repurchase quarter is calculated as the mean stock return of the 20 firm quarters.

I use abnormal volatility of stock return (RETABV) to measure the change in stock volatility due to actual repurchase. Following Hilliard and Savickas (2002), I choose a volatility event-study methodology based on the GARCH(1, 1) model. I use daily stock returns to calculate quarterly stock volatility, and then use the quarterly volatility to estimate the quarterly abnormal volatility. I apply an estimation window of 12 quarters to calculate predicted volatility, and the abnormal volatility equals the ratio of actual volatility to predicted volatility.

I use return on assets (ROA), calculated as net income scaled by total assets, to measure firm operating performance (Lie, 2005). I use the standard deviation of ROA

(ROAV) to measure operating performance volatility (Michaely et al., 2018). For each year, ROAV equals the standard deviation of the 4 quarterly ROA in that year.

Figure 1 demonstrates how I design the timeline for actual share repurchase. I measure actual repurchase in Quarter 0, and define Quarter -1 as the pre-repurchase quarter and Quarter 1 as the first post-repurchase quarter. Post-repurchase windows include the 12 quarters following Quarter 0. Year 1 begins at Quarter 1, Year 2 at Quarter 5, and Year 3 at Quarter 9. ROA (ROAV) in Year 1 is the mean (standard deviation) of ROA in Quarter 1 to Quarter 4. ROA (ROAV) in Year 2 is the mean (standard deviation) of ROA in Quarter 5 to Quarter 8. ROA (ROAV) in Year 3 is the mean (standard deviation) of ROA in Quarter 9 to Quarter 12. BHAR in Year 1 is the geometric mean of BHAR in Quarter 1 to Quarter 4. BHAR in Year 2 is the geometric mean of BHAR in Quarter 5 to Quarter 8. BHAR in Year 3 is the geometric mean of BHAR in Quarter 9 to Quarter 12. RETABV in Year 1 is the mean of RETABV in Quarter 1 to Quarter 4. RETABV in Year 2 is the mean of RETABV in Quarter 5 to Quarter 8. RETABV in Year 3 is the mean of RETABV in Quarter 9 to Quarter 12.

Table 1 presents the summary statistics of the main explanatory and dependent variables of the current study. The average STOCKVOL is 117% higher than the average OPTIONVOL, consistent with options being cheaper than stock. The standard deviation of OPTIONVOL is about 60% higher than that of STOCKVOL, consistent with the notion that options tradings are more likely to be informed because the timing and magnitude of new information are volatile (Easley et al., 1998). The mean (standard deviation) of CALLOS is 116% (153%) higher than that of ATMOS, suggesting that options traders are more likely to use the bullish directional strategy than the volatility strategy. On average, firms in my sample buy back 0.5 % of the total shares in one quarter (2% in one year) and show high variation in the amount of actual repurchase, highlighting the flexibility of share repurchase. The average OPTIONILLIQ is about 52 times higher than the average STOCKILLIQ, consistent with options being less liquid than stock. The average quarterly (annual) ROA is 0.8% (3.2%), and the average ROAV is 1.5%. On average, institutional investors hold 41.4% of the stocks in my sample.

4. Empirical Results

4.1. Information Content of Actual Share Repurchase

This section examines the information content of actual share repurchase in both the valuation dimension (stock return and operating performance) and the risk dimension (stock volatility and operating performance volatility). Following Grullon and Michaely (2004) and Lie (2005), I test if and how actual repurchases predict post-repurchase abnormal return and operating performance. To assess the persistence of this predictive power, I investigate multiple post-repurchase windows ranging from Quarter 1 to Year 3. I first test the association between actual repurchase (REPDUM) and post-repurchase buy-and-hold abnormal return (BHAR). Results in Panel A of Table 2 suggest that repurchase quarters are associated with significantly higher post-repurchase buy-and-hold abnormal returns. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. Therefore, the coefficient of REPDUM measures the difference in BHAR between repurchase quarters (REPDUM = 1) and non-repurchase quarters (REPDUM = 0). This difference increases from 0.193% in Quarter 1 to 0.411% in Quarter 2 and declines to 0.268% in Quarter 3 and becomes insignificant in Quarter 4, consistent with the notion that quarterly repurchase data may take one quarter to be reported and thus more traders have access to the disclosed actual repurchase information in Quarter 2. Annual post-repurchase BHAR shows a similar pattern of decline. The difference in the annual BHAR between repurchase and non-repurchase quarters peaks in Year 1 and declines in Year 2 and Year 3. Similar to Bonaime and Ryngaert (2013), I find persistent positive abnormal returns following actual repurchases. Additionally, MB is negatively related to BHAR in 6 of the 7 post-repurchase windows, consistent with the findings of Ikenberry et al. (1995) that repurchase abnormal return positively correlates with stock undervaluation.

Since stock return depends on firm operating performance (Campbell and Shiller, 1988), I next test the association between actual repurchase (REPDUM) and post-repurchase operating performance (ROA). Consistent with the findings of Lie (2005), the results in Panel B of Table 2 suggest that repurchase quarters are followed by significant improvements in operating performance. In all post-repurchase windows, REPDUM has a significantly positive coefficient. Specifically, the ROA in Quarter 1 (Year 1) of repurchase quarters is, on average, 0.264 (0.156) higher than that of non-repurchase quarters. This difference peaks in Quarter 1 and drops to 0.06 in Year 3. Additionally, I find that firms with a larger size, higher market-to-book ratio, and lower leverage, tend to have higher post-repurchase ROA, consistent with the findings of Grullon and Michaely (2004).

I further investigate if and how actual repurchases predict post-repurchase stock volatility and operating performance volatility. I first test the association between actual repurchase (REPDUM) and post-repurchase abnormal volatility (RETABV). Results in Panel A of Table 3 suggest that repurchase quarters are associated with significantly higher post-repurchase abnormal volatility. In all post-repurchase windows, REPDUM is positively associated with RETABV. Specifically, the RETABV in Quarter 1 (Year 1) of repurchase quarters is, on average, 0.107 (0.115) higher than that of non-repurchase quarters. In Year 3, this difference drops to 0.073 (1% significance level). Further, firms with a smaller size, higher market-to-book ratio, and higher leverage, tend to have higher post-repurchase RETABV, consistent with the findings of Fama and French (1995).

Since stock volatility depends on the volatility of firm operating performance (Campbell and Shiller, 1988), I next test the association between actual repurchase (REPDUM) and post-repurchase operating performance volatility (ROAV). The results in Panel B of Table 3 demonstrate that repurchase quarters are followed by significantly higher operating performance volatility. In all post-repurchase windows, REPDUM has a significantly positive coefficient. Specifically, the ROAV in Year 1 (Year 2) of repurchase quarters is, on average, 4.4 (5.8) percent points higher than that of non-repurchase quarters. Interestingly, this difference grows to 0.066 in Year 3. One possible reason for this result is that stock volatility is a leading indicator of operating performance volatility. As a result, it takes more time for operating performance volatility to decline to a normal level.

Taken together, the results in Table 2 and Table 3 provide support for Hypothesis 1. I find that firm operating performance significantly improves after actual repurchase, and the stock market responds positively to actual repurchase. My findings are consistent in spirit with those of Lie (2005), who documents significant operating performance improvements following repurchase announcements. In terms of post-repurchase abnormal return, my findings are similar to those of Grullon and Michaely (2004), who find positive abnormal returns following repurchase announcements. However, the current paper focuses on actual repurchases instead of repurchase announcements, and finds more persistent results than the existing papers. This evidence confirms that actual repurchases convey more credible information than repurchase announcements. Alternatively, the persistent predictive power of actual repurchase on post-repurchase abnormal return may suggest market underreaction (Ikenberry et al., 1995). My findings that actual repurchases predict higher abnormal volatility and operating performance volatility contradict the prior studies that suggest share repurchases reduce firm risks by mitigating the agency cost of free cash flows (Grullon and Michaely, 2004). One potential explanation for my findings is that actual repurchases reduce cash holdings and increase firm leverage, and thus increase firm risk (Chen and Wang, 2012; Myers and Majluf, 1984). Moreover, recent evidence shows that an increasing number of firms choose to raise capital to finance their repurchases, which further increases firm leverage and risk (Farre-Mensa et al., 2018). The current study, using more recent data (1996-2017 compared to 1980-1997 in Grullon and Michaely, 2004), suggests that actual repurchases convey information of higher firm risk instead of lower firm risk. This change in the information content of actual repurchase may be caused by the new trend of firms financing repurchase with external capital by issuing stocks and bonds. Alternatively, my results may suggest that the actual repurchase and repurchase announcement convey different information about firm risk.

4.2. Pre-repurchase Options Trading

Building on my findings that actual repurchases convey information in both the valuation dimension (stock return and operating performance) and the risk dimension (stock volatility and operating performance volatility), this section examines options tradings prior to actual repurchase to assess the presence of informed tradings. Since informed traders choose to trade stock and options conditional on the trade-off between the leverage effect of options and the lower trading costs of stock, I first examine both the pre-repurchase stock and options volumes, and then investigate the pre-repurchase options to stock volume ratio. Figure 2 demonstrates that the overall repurchase intensity (measured by the total number of repurchase firms in the US) highly correlates with stock and options market volumes prior to 2012. Since 2012, the options market volume no longer correlates with the total number of repurchasing firms. This deviation may be caused by the notable decline in stock market volatility. Specifically, the VIX index declines by more than 300% from 38.52 at the end of 2011 to 9.22 at the end of 2017, reducing the profit opportunities of trading on volatility in the options market. Consistent with the findings of Bliss et al. (2015), the overall repurchase intensity falls sharply during the 2008 financial crisis. However, the stock market volume only shows a moderate decline during the same period. The panic selling of stocks during the financial crisis may have partially offset the decline in stock market volume.

To eliminate concerns about time-series dependence, I compare the stock volume (STOCKVOL) and options volume (OPTIONVOL) in repurchase quarters versus non-repurchase quarters in Figure 3. Panel A and Panel B show that the mean STOCKVOL and mean OPTIONVOL are higher in repurchase quarters (REPDUM = 1) than in non-repurchase quarters (REPDUM = 0). Panel C and Panel D show that the 25% quantile and 75% quantile of OPTIONVOL and STOCKVOL are higher in repurchase quarters than in non-repurchase quarters. Overall, Figure 2 and Figure 3 illustrate that the repurchase quarters tend to have higher trading volumes in both stock and options.

Based on the observations in Figure 2 and Figure 3, I continue to quantitatively examine how the amount of actual repurchase (REP) affects pre-repurchase stock volume (STOCKVOL) and options volume (OPTIONVOL). I follow Bonaime and Ryngaert (2013) to segment the test results on the value of REPDUM. Panel A of Table 4 tests the full sample, while Panel B (Panel C) focuses on the subsample with REPDUM equal to 0 (1). Univariate results in column 1 of Panel A, B, and C show that REP is positively related to STOCKVOL at a 1% significance level. After I add more control variables in column 2 and column 3, the sign and significance of this relationship remain unchanged. My results suggest that stock traders may have superior information about the forthcoming actual repurchases, because the timing and magnitude of actual repurchases are difficult to predict. Moreover, I find that STOCKILLIQ is negatively associated with STOCKVOL, consistent with the notion that higher stock illiquidity makes it more costly to trade stock.

I next test how the amount of actual repurchase (REP) affects pre-repurchase options volume (OPTIONVOL) in Table 5. In the 8 of 9 specifications, REP has a significantly positive coefficient. When I control for SIZE, MB, and LEV and focus on the non-repurchase quarters, REP shows no significant impact on OPTIONVOL. This evidence suggests that the REP in non-repurchase quarters, which measures the trivial buybacks of preferred stocks, conveys less credible information than the REP in repurchase quarters. Column 1 of Panel C shows that 1 unit increase in REP is associated with 7.312 units increase in OPTIONVOL. When I control for SIZE, MB, and LEV, 1 unit increase in REP is associated with 7.142 units increase in OPTIONVOL. These results suggest that options traders may have superior information about the forthcoming actual repurchases, because the timing and magnitude of actual repurchases are difficult to predict. I also find that OPTIONILLIQ is negatively related to OPTIONVOL, consistent with the fact that higher options illiquidity makes it more costly to trade options.

Based on the findings in Table 4 and Table 5, I explicitly test how the amount of actual repurchase (REP) affects traders' choice between stock and options (OS) in the pre-repurchase quarters. As shown in Panel A of Table 6, REP has no significant impact on OS when the panel regression tests are conducted on the full sample. When I confine the tests to repurchase quarters in Panel C, I find that REP has significantly positive coefficients for all the three specifications, suggesting that the increase in options volume is higher than that in stock volume when a firm buys back a nontrivial amount of shares. Univariate results in column 1 of Panel C show that a one standard deviation increase in REP is associated with a 0.09 standard deviation increase in OS. In column 2 of Panel C, I control for SIZE, MB, and LEV, and find that a one standard deviation increase in REP is associated with a 0.08 standard deviation increase in OS. These results confirm that informed traders prefer options over stock due to the implicit leverage of options. Additionally, OPTIONILLIQ has a coefficient of -1.195 at a 1% significance level, consistent with the fact that higher options illiquidity reduces the leverage benefit of options trading. Surprisingly, when I focus on non-repurchase quarters in Panel B, the signs of the coefficients of REP become negative. This evidence confirms that the method of Banyi et al. (2008) of eliminating firms with common stock repurchases equaling less than 1% of market capitalization improves the accuracy of the repurchase measure. The trivial buyback of preferred stock may add noise to the measure of actual repurchase (Bonaime and Ryngaert, 2013).

To link options tradings to the bullish directional strategy and volatility strategy that informed traders may use, I further decompose OS in two dimensions — strike price and moneyness. I define CALLOS (ATOMOS) as a proxy for the use of bullish directional strategy (volatility strategy), calculated as the natural log of call (at-the-money) options to stock volume ratio. I further test the association between the amount of actual repurchase (REP) and pre-repurchase use of bullish directional strategy (CALLOS) and present the results in Table 7. These results are similar to those in Table 6. In Panel C, I focus on the repurchase quarters and find that REP shows positive impacts on CALLOS for all the three specifications. Univariate results in column 1 of Panel C show that a one standard deviation increase in REP is associated with a 0.08 standard deviation increase in CALLOS. In column 2, I control for SIZE, MB, and LEV, and find that a one standard deviation increase in REP is associated with a 0.07 standard deviation increase in CALLOS. These results suggest that some options traders use the bullish directional strategy in the pre-repurchase quarters. The result in column 3 shows that a one standard deviation increase in DELTA is associated with a 0.15 standard deviation increase in CALLOS, consistent with the idea that higher leverage effect of options makes options trading more attractive to informed traders.

I further test the association between the amount of actual repurchase (REP) and pre-repurchase use of volatility strategy (ATMOS) and present the results in Table 8. The results are different from those in Table 6 and Table 7. In the 7 of 9 specifications, REP shows positive impacts on ATMOS. Univariate results in column 1 of Panel C show that a one standard deviation increase in REP is associated with a 0.18 standard deviation increase in ATMOS. In column 2 of Panel C, I control for SIZE, MB, and LEV, and find that a one standard deviation increase in REP is associated with a 0.15 standard deviation increase in ATMOS. These results suggest that some options traders use the volatility strategy in the pre-repurchase quarters.

Overall, these results provide support for Hypothesis 2 and indicate that informed traders may use both the bullish directional strategy and the volatility strategy prior to actual repurchase. Both the stock and options volumes rise in the pre-repurchase quarters, and this evidence suggests the presence of informed trading since the timing and magnitude of actual repurchase are difficult to predict without superior information. Furthermore, the evidence that OS positively correlates with the amount of actual repurchase suggests that traders may prefer options over stock due to the leverage effect of options. Additionally, I find pre-repurchase CALLOS and ATMOS rise when firms buy back a nontrivial amount of stocks, suggesting the use of bullish directional strategy and volatility strategy.

4.3. Information Content of Pre-repurchase Options Trading

In the previous section, I identify the use of bullish directional strategy and volatility strategy that options traders use in the pre-repurchase quarters. In this section, I further explore the information content of the pre-repurchase options tradings. Specifically, I test if the pre-repurchase options tradings can predict post-repurchase stock return and stock volatility.

I first examine if and how the pre-repurchase use of bullish directional strategy (CALLOS) predicts post-repurchase abnormal return (BHAR) and operating performance (ROA). Table 9 presents the results of portfolio analysis examining the association between pre-repurchase CALLOS and post-repurchase BHAR (Panel A) and ROA (Panel B). I sort post-repurchase BHAR (Panel A) and ROA (Panel B) by the pre-repurchase CALLOS. The last column in Panel A (Panel B) shows that the portfolio of firms with the highest CALLOS has significantly higher average BHAR (ROA) than the portfolio of firms with the lowest CALLOS. Panel A shows that the difference in BHAR between the highest (quintile 5) and the lowest (quintile 1) CALLOS groups declines over the 3 years after the actual repurchase. These results suggest that the pre-repurchase use of bullish directional strategy conveys favorable information about future stock return and operating performance.

I next examine if and how the pre-repurchase use of volatility strategy (ATMOS) predicts post-repurchase abnormal volatility (RETABV) and operating performance volatility (ROAV). Table 10 presents the results of portfolio analysis examining the association between pre-repurchase ATMOS and post-repurchase RETABV (Panel A) and ROAV (Panel B). I sort post-repurchase RETABV (Panel A) and ROAV (Panel B) by the pre-repurchase ATMOS. The last column in Panel A (Panel B) shows that the portfolio of firms with the highest ATMOS has significantly higher average RETABV (ROAV) than the portfolio of firms with the lowest ATMOS. These results suggest that the pre-repurchase use of volatility strategy conveys information of higher firm risk following actual repurchases.

I continue to test these associations with panel regression models. To eliminate the noise of trivial buybacks of preferred stock (Banyi et al., 2008), I confine the test samples to the repurchase quarters (REPDUM = 1). Additionally, using the subsample of repurchase quarters creates implicit interaction effects between actual repurchase and the explanatory variables. I present these results in Table 11 and Table 12. Panel A of Table 11 shows that CALLOS has positive impacts on BHAR in the 6 of 7 post-repurchase windows. Specifically, a one standard deviation increase in CALLOS leads to 0.032 standard deviation increase in BHAR in Quarter 1, 0.031 in Quarter 2, and 0.07 in Quarter 3. Panel B of Table 11 shows that CALLOS has positive impacts on ROA in the 6 of 7 post-repurchase windows. Specifically, a one standard deviation increase in CALLOS leads to a 0.2 standard deviation increase in BHAR in Year 1, 0.1 in Year 2, and 0.06 in Year 3. These results suggest that the pre-repurchase use of bullish directional strategy complements the information conveyed by actual repurchase.

I find similar results in Table 12. Panel A of Table 12 shows that ATMOS has positive impacts on RETABV in all the 7 post-repurchase windows. Specifically, a one standard deviation increase in ATMOS leads to a 0.07 standard deviation increase in RETABV in Quarter 1, 1.5 in Quarter 2, and 1.93 in Quarter 3. Panel B of Table 12 shows that ATMOS has positive impacts on ROAV in all the 3 post-repurchase windows. Specifically, a one standard deviation increase in ATMOS leads to a 1.5 standard deviation increase in BHAR in Year 1, 1.80 in Year 2, and 1.98 in Year 3. These results suggest that the pre-repurchase use of volatility strategy complements the information conveyed by actual repurchase.

Overall, my results confirm Hypothesis 3 and Hypothesis 4, and prove that pre-repurchase options tradings complement the information conveyed by actual repurchases in both the valuation dimension (stock return and operating performance) and the risk dimension (stock volatility and operating performance volatility). The pre-repurchase bullish directional strategy has positive returns because higher actual repurchases are followed by higher abnormal returns; the pre-repurchase volatility strategy has positive returns because higher actual repurchases are followed by higher abnormal volatility. Consequently, my results suggest that not only are the pre-repurchase options tradings informed, but they complement the information conveyed by actual repurchases.

4.4. Institutional Ownership and Information Content of Pre-repurchase Options Trading

Institutional ownership, as an important source of corporate governance, plays a critical role in alleviating information asymmetry (Gillan and Starks, 2000; McCahery et al., 2016). Based on my findings that pre-repurchase options tradings complement the information conveyed by actual repurchases, I further investigate the role of corporate governance in this information environment. In this section, I use institutional ownership (INSOWN) as a proxy for corporate governance, and test if the external monitoring provided by institutional investors can reduce the information content of pre-repurchase options tradings. I present the results in Table 13 and Table 14. The regression models in Table 13 (Table 14) extends those in Table 11 (Table 12) with an interaction term between CALLOS (ATMOS) and INSOWN. Panel A of Table 13 shows that higher institutional holdings reduce the predictive power of the pre-repurchase use of bullish directional strategy on post-repurchase abnormal return. Specifically, in the 5 of 7 post-repurchase windows, the interaction term has significantly negative coefficients, reducing the net effect of CALLOS on post-repurchase BHAR. I find similar results in Panel B of Table 13, the negative coefficient of the interaction term offsets CALLOS's impacts on post-repurchase ROA. Panel A of Table 14 shows that higher institutional holdings reduce the predictive power of the pre-repurchase use of volatility strategy on post-repurchase abnormal volatility. Specifically, in the 5 of 7 post-repurchase windows, the interaction term has significantly negative coefficients, reducing the net effect of ATMOS on post-repurchase RETABV. I find similar results in Panel B of Table 14, the negative coefficient of the interaction term offsets ATMOS's impacts on post-repurchase ROAV in Year 1 and

Year 2.

Overall, my findings support Hypothesis 5. Institutional investors are able to provide effective external monitoring that reduces the information content of pre-repurchase options tradings. In other words, the pre-repurchase use of bullish directional strategy and volatility strategy will have lower returns when the repurchase firm has higher institutional holdings. Institutional ownership makes it more difficult to trade on superior information prior to actual repurchases. My findings confirm the role of corporate governance in mitigating information asymmetry around corporate events.

5. Robustness Check

To address the concerns of unobserved factors and spurious effects, I use the 2003 modification to SEC Rule 10b-18 as a natural experiment to assess the robustness of my findings. On December 17, 2003, the Securities and Exchange Commission modified Rule 10b-18 of the Securities Exchange Act of 1934 to require all repurchasing firms to report the total number of shares repurchased, the average price paid per share, the number of shares purchased as part of a publicly announced repurchase plan, and the maximum number (or approximate dollar value) of shares remaining under other plans. This regulation, which applies to all quarterly and annual filings for periods ending on or after March 15, 2004, reduces the information asymmetry of actual repurchases, because it enhances information disclosure of repurchases, which benefits uninformed traders. The 2003 modification to Rule 10b-18 provides a unique opportunity for the current paper to construct a difference-in-difference analysis.

My methodology is similar in spirit to that of Borochin and Yang (2017). I start by creating three dummy variables, i.e., HCALLOS, HATMOS, and HDISC. HCALLOS equals 1 if a firm has above-median CALLOS in a given quarter and equals 0 otherwise. HATMOS equals 1 if a firm has above-median ATMOS in a given quarter and equals 0 otherwise. Following Bonaime (2015), I define HDISC (high disclosure period) as a dummy variable that equals 1 if the observation is from Year 2004 Quarter 1 to

Year 2017 Quarter 4 and equals 0 otherwise. My design of difference-in-difference analysis is based on these three dummy variables. The 2003 modification to Rule 10b-18 can be considered an exogenous policy shock, because individual firms are unlikely to cause this regulatory change to happen. Moreover, HCALLOS and HATMOS indicate higher degrees of information asymmetry in the pre-repurchase quarters, because more options tradings may imply a higher probability of informed tradings. Therefore, the 2003 modification to Rule 10b-18, which improves the quality of information disclosure of repurchases, should have larger impacts on firms with higher information asymmetry (HCALLOS equal to 1 and HATMOS equal to 1).

I present the results of the difference-in-difference analysis in Table 15 and Table 16. Panel A of Table 15 shows that the interaction term between HCALLOS and HDISC has significantly negative impacts on BHAR in the 6 of 7 post-repurchase windows, suggesting that the 2003 modification to Rule 10b-18 reduces the profitability of the pre-repurchase use of bullish directional strategy, because the negative coefficients reduce the net effect of HCALLOS on BHAR. I observe similar results in Panel B of Table 15. The interaction term between HCALLOS and HDISC has significantly negative impacts on ROA in all the 7 post-repurchase windows.

Panel A of Table 16 shows that the interaction term between HATMOS and HDISC has significantly negative impacts on RETABV in all the 7 post-repurchase windows, suggesting that the 2003 modification to Rule 10b-18 reduces the profitability of the pre-repurchase use of volatility strategy, because the negative coefficients reduce the net effect of HATMOS on RETABV. I observe similar results in Panel B of Table 16. The interaction term between HATMOS and HDISC has significantly negative impacts on ROAV in Year 1 and Year 2.

Overall, these results confirm that my findings are not driven by unobservable factors or spurious effects. The 2003 modification to Rule 10b-18 reduces the information advantage of options traders in the pre-repurchase quarters. This effect is more prominent among firms with a higher degree of information asymmetry.

Furthermore, I conduct a placebo test to address robustness concerns. I randomly assign the value of 0 or 1 to the variable REPDUMR and retest Hypothesis 1 using this random variable REPDUMR in place of REPDUM. I present the placebo test results in Appendix. REPDUMR no longer predicts post-repurchase abnormal return, operating performance, abnormal volatility, or operating performance volatility. These results confirm that my findings are not driven by random comovement of the dependent and explanatory variables.

6. Conclusion

The current paper studies the information content of actual share repurchase within the context of informed options trading. I document that pre-repurchase options tradings complement the information conveyed by actual repurchases, and predict higher and more volatile stock return and operating performance. Furthermore, the pre-repurchase use of bullish directional strategy (measured by call options to stock volume ratio) predicts higher post-repurchase abnormal return and operating performance. This evidence suggests that actual repurchases and pre-repurchase options tradings convey favorable complementary information about post-repurchase stock return and operating performance. The pre-repurchase use of volatility strategy (measured by at-the-money options to stock volume ratio) predicts higher post-repurchase stock volatility and operating performance volatility. One possible reason for the increase in firm risk is the increase in leverage caused by actual repurchases. Moreover, I find that institutional ownership alleviates the information asymmetry of pre-repurchase options tradings.

In sum, my evidence suggests that options tradings complement the information conveyed by actual share repurchase. In a broader sense, the information content of corporate events can be fully understood only within the context of informed tradings, and options tradings provide a unique setup to study the nature of the information conveyed by corporate events.

CHAPTER II

EPS-MOTIVATED SHARE REPURCHASE AND STOCK PRICE CRASH RISK

1. Introduction

Over the last two decades, share repurchase has emerged as the dominant payout channel, offering a more flexible means of returning excess cash to investors for public firms (Bens et al., 2003; Almeida et al., 2016). Between 2008 and 2017, 466 of the S&P 500 companies spent around $4 trillion on share repurchase, equal to 53 percent of profits. The total amount of share repurchase exceeded that of dividends in 2001 (Grullon and Michaely, 2002). The sheer amount of share repurchase and the noticeable shift in the preference of the payout method have sparked discussions about the potential of this trend. Classical financial theories maintain that large and mature firms, compared to small and young firms, tend to have higher profitability and fewer investment opportunities. Therefore, payouts, either via share repurchase or dividends, may alleviate the potential agency conflict induced by excessive cash holdings (Jensen, 1986; Grullon and Michaely, 2004; DeAngelo, et al., 2006). Consequently, the surging amount of share repurchase should indicate more prudent investment and better corporate governance of public firms. However, observers hold mixed opinions on the prevalence of stock buyback.

On the one hand, share repurchase is deemed as being more flexible than dividends, which is valuable to small and financially constrained firms (Ikenberry and Vermaelen, 1996; Grullon and Michaely, 2002). On the other hand, investors and regulators are concerned that managers may use share repurchase as an earnings management tool. Specifically, managers may use share repurchase to inflate earnings per share (EPS) by reducing the number of shares outstanding (Bens et al., 2003). Hribar et al. (2006) document the extensive use of EPS-motivated share repurchase. Managers may use share repurchase to manipulate EPS, and earnings management, as a bad news hoarding behavior, is positively associated with stock price crash risk (Hutton et al., 2009). Does EPS-motivated share repurchase affect stock price crash risk? This paper attempts to answer this question by studying the empirical link between EPS-motivated share repurchase and stock price crash risk. We argue that managers may use share repurchase to boost EPS to delay the release of negative information when the EPS would have remained stagnant or declined in the absence of the repurchase. However, such bad news hoarding activity is costly and will eventually be unsustainable. When the managers release the accumulated bad news, it causes a great downward adjustment to the stock prices.

This paper examines the impacts of EPS-motivated share repurchase on both ex-post and ex-ante (expected) stock price crash risk. We find no evidence that EPS-motivated share repurchase affects ex-post stock price crash risk. Meanwhile, we find that EPS-motivated share repurchase significantly increases expected stock price crash risk, which is measured by implied volatility skew in the options market. Moreover, EPS-motivated repurchase predicts significantly higher expected crash risk in 1-4 quarters following the current fiscal quarter, indicating the persistent impacts of EPS-motivated repurchase. This paper also investigates the interplay between EPS-motivated share repurchase and stock liquidity and its impacts on expected crash risk. Consistent with the findings of Brockman et al. (2008), this paper finds that higher stock liquidity encourages managers to use share repurchase to manipulate EPS and hence increases expected crash risk. This evidence confirms that stock liquidity is an important factor to consider when managers buy back stocks. Besides, this paper studies the role of corporate governance in the EPS-motivated share repurchase - expected crash risk relation and find that corporate governance, proxied by institutional ownership and analyst coverage, significantly reduces the expected crash risk induced by EPS-motivated repurchase. This evidence suggests that corporate governance can maintain the stability of the stock market by reducing investors' expected crash risk.

This paper contributes to the literature in several ways. First, it relates to the extensive studies on share repurchase. This literature suggests that firms buy back stocks to signal undervaluation (Ikenberry et al., 1995; Brockman and Chung, 2001; Peyer and Vermaelen, 2005), to signal strong future performance (Lie, 2005), to boost employee incentives (Babenko, 2009), to mitigate the dilutive effects of stock option exercises (Kahle, 2002; Bens et al., 2003), to defend takeover (Bagwell, 1991), to distribute excess cash (Dittmar, 2000; Grullon and Michaely, 2004), etc. This paper builds on existing findings of EPS-motivated share repurchase (Bens et al., 2003; Hribar et al., 2006; Almeida et al., 2016) and links it with stock price crash risk within the bad news hoarding framework. Second, this paper extends research on stock price crash risk. These studies document that stock price crash risk is associated with short interest of stock (Callen and Fang, 2015), CEO overconfidence (Kim et al., 2016), CEO age (Andreou et al., 2017), stock liquidity (Chang et al., 2017), institutional ownership (An and Zhang, 2013; Callen and Fang, 2013), earnings smoothing (Chen et al., 2017), ownership-control wedge (Hong et al., 2017), transparency of financial statements (Hutton et al., 2009), tax avoidance (Kim et al., 2011), etc. This paper identifies EPS-motivated share repurchase as a new form of bad news hoarding behavior that increases stock price crash risk.

The remainder of the paper proceeds as follows. Section 2 reviews related literature and develops hypotheses. Section 3 describes the sample and variables. Section 4 reports the results, and Section 5 concludes.

2. Literature Review and Hypothesis Development

2.1. EPS-motivated Share Repurchase

Existing studies show that firms manage reported earnings to produce positive profits, to avoid earnings decreases, and to meet or exceed analysts' earnings expectations (Hayn, 1995; Burgstahler and Dichev, 1997; Degeorge et al., 1999; Burgstahler and Eames, 2002). The most salient of these earnings benchmarks is analysts' EPS forecasts (Brown and Caylor, 2005). Managers admit that they are motivated to beat analysts' quarterly EPS forecasts to build credibility and preserve their reputation with capital markets, to maintain or increase the firm's stock price, and to avoid the uncertainty created by missing the forecast (Graham et al., 2005).

Share repurchases reduce the number of shares outstanding, which allows managers to boost EPS without increasing earnings. Using share repurchase to manipulate EPS is flexible because managers can choose whether and when to buy back stocks (Cook et al., 2003). Moreover, SEC does not require public firms to provide details about the timing, price, or volume of their repurchase transactions in real time. The impact on the number of shares outstanding, coupled with the limited visibility to investors, makes share repurchase an effective EPS manipulation tool. Various studies have confirmed this notion. Bens et al. (2003) show that managers use share repurchase to sustain EPS growth when dilutive employee stock options are exercised. Hribar et al. (2006) find the extensive use of EPS-motivated stock repurchases among firms that would have missed analysts' forecasts without the repurchase. Myers et al. (2007) demonstrate that firms reporting at least 20 consecutive quarters of non-decreasing EPS appear to strategically time stock repurchases to avoid EPS declines. Farrell et al. (2014) show that share repurchases are prevalent as a mechanism to increase EPS and that debt-financing constraints discourage the use of EPS-motivated repurchases. Cheng et al. (2015) find that a firm is more likely to conduct stock buyback when its CEO's bonus directly depends on EPS. Almeida et al. (2016) find that the probability of share repurchases that increase EPS is significantly higher for firms that would have just missed the EPS forecast in the absence of the repurchases. Finally, Brav et al. (2005) report that over 76% of the CEOs, CFOs, and treasurers who responded to their survey on dividend and stock buyback policies said that increasing EPS is an "important" or "very important" consideration in their firms' stock repurchase decisions.

2.2. Stock Price Crash Risk

2.2.1. Ex-post Stock Price Crash Risk

Jin and Myers (2006) propose a theoretical framework linking bad news hoarding behavior to crash risk. Specifically, managers control the disclosure of information about the firm to the public and a threshold level exists at which managers will stop withholding bad news. The lack of full transparency concerning managers' investment and operating decisions and firm performance allows managers to capture a portion of cash flows in ways not perceived by outside investors. Covering losses caused by a temporary bad performance by hiding firm-specific bad news, managers attempt to recover the losses with improved earnings in the future. However, if a sufficiently long run of bad news accumulates to a critical threshold level without a material improvement in firm operating performance, managers will choose to give up, and all of the negative firm-specific shocks become public at once. This disclosure causes a corresponding crash — a large negative outlier in the distribution of stock returns. Existing empirical evidence confirms that bad news hoarding behavior is positively associated with crash risk. Jin and Myers's (2006) cross-country evidence indicates that firms in more opaque countries are more likely to experience stock crashes. Hutton et al. (2009) find firm-level evidence of a positive relation between accrual manipulation and crash risk. Kim et al. (2011) document that corporate tax avoidance is positively related to firm-specific stock price crash risk. Callen and Fang (2013) find that equity ownership by transient institutions is positively related to future crash risk. Andreou et al. (2017) demonstrate that firms with younger CEOs are more likely to experience stock price crashes. Chang et al. (2017) find that stock liquidity induces managers to withhold bad news, fearing that its disclosure will lead to selling by transient investors, which increases future stock price crash risk.

2.2.2. Ex-ante Stock Price Crash Risk

Besides ex-post stock price crash risk, ex-ante or expected stock price crash risk has attracted interest in emerging literature. Investors' expected crash risk can be indicated by the options implied volatility skew curve (Bates, 1991; Dumas et al., 1998; Pan, 2002). This skew curve, discovered since the crash of October 1987, refers to the skew pattern when the volatilities implied by observed option prices are plotted against strike prices (Rubinstein, 1994). The skew curve suggests that the implied volatility of low strike price options, especially OTM (out-of-the-money) put options, is higher than that of high strike price options, especially ATM (at-the-money) call options. This asymmetric volatility implies that OTM put options are more expensive than ATM call options, which deviates from the Black and Scholes (1973) option pricing model. Existing studies have proposed various explanations for this asymmetry, but the overall skew curve is widely deemed to reflect investors' expectations of future crash risk, as well as their aversion to such crash risk (Bates 1991; Dumas et al., 1998; Pan 2002). Rubinstein (1994) attributes the implied volatility skew to investors' crash-aversion following the crash of 1987. Bollen and Whaley (2004) propose a buying pressure model and argue that when investors obtain the likelihood of a negative event, the demand for OTM put options increases relative to ATM call options, resulting in volatility skew. Bates (2000) argues that the implied volatility skew reflects investors' perception that a significant price decline in the underlying asset is more likely. OTM put options provide explicit portfolio insurance against substantial downward movements in the market, and have been traded at high prices relative to ATM call options.

Kim and Zhang (2014) document that financial reporting opacity significantly increases the expected crash risk. Kim et al. (2016) find that expected crash risk decreases with financial statement comparability, and this negative relation is more pronounced in an environment where managers are more prone to withhold bad news. Kim et al. (2019) find a significant increase in a firm's expected crash risk after an exogenous drop in analyst coverage and suggest analyst coverage disciplines managers from hoarding bad news.

2.3. Link between EPS-motivated Share Repurchase and Stock Price Crash Risk

Bad news hoarding behaviors affect not only stock price crash risk but also the expected stock price crash risk. Expected crash risk reflects investors' ex-ante perception of future crash risk and their aversion to such crash risk. This paper argues that managers may use share repurchase, as an EPS manipulation tool, to hoard bad news at risk of stock price crash because a stagnant EPS or a declining EPS is considered bad news for a firm and may hurt the managers' reputation and career prospects (Graham et al., 2005). Therefore, EPS-motivated share repurchase, as a bad news hoarding behavior, may increase ex-post and ex-ante stock price crash risk. Based on these considerations, the first hypothesis follows (stated in the alternative form):

H1: Firms with a higher level of EPS-motivated share repurchase are associated with higher stock price crash risk.

2.4. Stock Liquidity

Brockman et al. (2008) find that higher stock liquidity encourages the use of share repurchases over dividends. Unlike dividends, share repurchase involves trading stocks in the open market. When managers buy back stocks, the buying actions will drive up stock price and make repurchases more costly. As such, a manager needs to consider the price impact of share repurchase when she plans to use repurchase to boost EPS. When stock liquidity is high, the manager is more likely to use share repurchase to boost EPS due to lower costs of share repurchase. When stock liquidity is low, the manager may consider other cheaper earnings management tools, such as accrual manipulation. Therefore, stock liquidity impacts stock price crash risk by affecting the costs of EPS-motivated share repurchase. Based on these considerations, the second hypothesis follows:

H2: The association between EPS-motivated share repurchase and stock price crash risk is more pronounced among firms with higher stock liquidity.

2.5. Corporate Governance

Bad news hoarding behaviors occur when managers pursue short-term stock price growth at risk of long-term stock price crash. Moreover, EPS-motivated share repurchases consume the cash that could otherwise finance future investments. Effective corporate governance curbs short-termism by aligning the interests of managers and stockholders over a long run (Holmstrom, 1979). Sanjai and Bolton (2008) confirm that corporate governance adds value to a firm in the long run. Xie et al. (2003) find that corporate governance significantly reduces managers' earnings management behavior. Existing literature links institutional ownership and analyst coverage to corporate governance. Institutional investors provide corporate governance via external monitoring. Chung et al. (2002) find that institutional investors reduce opportunistic earnings management by providing external monitoring. Schmidt and Fahlenbrach (2017) find that reduced external monitoring from institutional investors worsens corporate governance. McCahery et al. (2016)' survey shows prevalent behind-the-scenes intervention as well as governance-motivated exit of institutional investors. Gillan and Starks (2000) find that shareholder proposals sponsored by institutions gain substantially more support than proposals sponsored by individuals, suggesting the governance role of institutional investors. Yu (2008) find that firms followed by more analysts manage their earnings less. Lehmann (2019) find that an increase in governance analyst coverage results in increased governance quality, improved liquidity, and improved investor breadth. Sun and Liu (2011) find that analyst coverage is positively associated with accounting conservatism.

This paper argues that corporate governance, proxied by institutional ownership and analyst coverage, discipline managers from using EPS-motivated share repurchase to hoard bad news and thus reduce the stock price crash risk induced by EPS-motivated repurchase. Based on these considerations, the third hypothesis follows:

H3: The association between EPS-motivated share repurchase and stock price crash risk is less pronounced among firms with better corporate governance.

3. Variable Construction and Sample

3.1. EPS-motivated Share Repurchase

Stock repurchase has a confounding impact on EPS that is determined by the relative magnitude of two opposing effects: a numerator effect and a denominator effect. The effect of a repurchase on the EPS denominator is straightforward. Stock repurchases that occur at the beginning of the period are deducted from shares outstanding for the full period, whereas repurchases that occur at the end of the period have no effect on the EPS denominator that period. In other words, the EPS denominator either decreases or remains unchanged as a result of the repurchase and its timing during the period.

The effect of a repurchase on the EPS numerator arises because buying back shares requires a cash payout, and this outlay decreases earnings by the amount of any foregone return on cash used (or interest expense incurred on cash borrowed) for repurchases. Stock repurchases increase EPS only when the foregone return (or interest expense incurred) on the cash paid out is less than the firm's earnings-to-price ratio at the time of the buyback (Bens et al., 2003; Hribar et al., 2006).

Following the methodology used by Hribar et al. (2006) and Almeida et al. (2016), we define a fiscal quarter as EPS-motivated share repurchase quarter ($EPS\_REP = 1$) when the frim would have a stagnant or declining EPS without the repurchase in the fiscal quarter. Suppose that shares are repurchased at a price P per share using cash that was previously earning an after-tax return r per period. A fiscal quarter is considered EPS-motivated repurchase quarter only when the inverse price-to-earnings ratio at the time of the buyback is greater than the foregone return on cash used for repurchases:

$$\frac{EPS_0}{P} > r \tag{4}$$

For example, if a firm earns 3% after taxes on cash, stock repurchases are EPS-motivated only when the price-to-earnings ratio at the time of the buyback is less than 33.3; i.e., the earnings-to-price ratio is above 3%. A repurchase occurring at any higher PE ratio will actually reduce EPS for this firm because the cost of the repurchase will outweigh the reduction in shares outstanding.

3.2. Stock Price Crash Risk

3.2.1. Ex-post Stock Price Crash Risk

Following Chen et al. (2001), we use the negative skewness of firm-specific daily returns over the fiscal quarter (Negative_Skewness) as our first measure of stock price crash risk. Specifically, we calculate Negative_Skewness for a given firm in a fiscal by taking the negative of the third moment of firm-specific daily returns for each sample quarter and dividing it by the standard deviation of firm-specific daily returns raised to the third power. Specifically, for each firm i in quarter t, we compute Negative_Skewness as:

$$Negative\_Skewness = \frac{-n(n-1)^{\frac{3}{2}} \sum r_{it}^3}{(n-1)(n-2)(\sum r_{it}^2)^{\frac{3}{2}}} \tag{5}$$

Following Kim et al. (2011), our second measure of stock price crash risk is the number of negative extreme return days over a fiscal quarter. A firm-specific daily return 3.2 standard deviations below the mean firm-specific daily return over the fiscal quarter is considered negative extreme, with 3.2 chosen to generate a frequency of 0.1% in the normal distribution.

3.2.2. Expected Stock Price Crash Risk

The steepness of the options implied voaltility skew curve has been widely used as a proxy of investors' expected crash risk. Consistent with existing studies (Bollen and

Whaley, 2004; Xing et al., 2010; Van Buskirk, 2011; Kim and Zhang, 2014; Kim et al., 2016; Kim et al., 2019), this paper measures the implied volatility skew ($IV\_Skew_{i,t}$) of stock i's option as the difference between the implied volatility of an OTM put on day t ($IV_{i,t}^{OTMP}$) and that of an ATM call ($IV_{i,t}^{ATMC}$) on the same day:

$$IV\_Skew_{i,t} = IV_{i,t}^{OTMP} - IV_{i,t}^{ATMC} \tag{6}$$

When there are multiple put or call option contracts for stock i on a particular day t, we calculate the weighted average of the implied volatilities for the put or call options, using the option open interest (OPEN_INT) as weight:

$$IV\_Skew_{i,t} = \frac{\sum_j Open\_INT_j \times IV_{i,t,j}^{OTMP}}{\sum_j Open\_INT_j} - \frac{\sum_k Open\_INT_k \times IV_{i,t,k}^{ATMC}}{\sum_k Open\_INT_k} \tag{7}$$

OTM puts are defined as put options with a delta value between 0.375 and 0.125, and ATM calls are defined as call options with a delta value between 0.375 and 0.625. We average the daily $IV\_Skew_{i,t}$ over the 1-quarter period after the fiscal year-end to calculate quarterly implied volatility skew.

3.3. Stock Liquidity, Institutional Ownership, Analyst Coverage, and Control Variables

Following Brockman et al. (2008), we use stock turnover (Stock_Turnover) to measure stock liquidity. Stock turnover is calculated as the average daily stock turnover over the fiscal quarter. Institutional ownership (Institution_Ownership) is the proportion of stocks of the firm owned by institutional investors. Following Kim et al. (2019), to isolate the effect of EPS-motivated share repurchase on expected crash risk from the effect of other factors, we include several firm-specific controls, including the ATM implied volatility level (ATM_IV), firm size (Size), firm leverage (Leverage), market-to-book ratio (MB), earnings volatility (Earnings_VOL), cash flow volatility (Cash_VOL), sales volatility (Sales_VOL), market beta (Beta), volatility of stock returns (Total_VOL), idiosyncratic volatility of stock returns (Idiosyncratic_VOL), and quarterly stock returns (RET).

Following Schmidt and Fahlenbrach (2017), we collect information of quarterly institutional ownership from Thomas Reuters 13F. The institutional investors include investment advisers, banks, insurance companies, broker-dealers, pension funds, and corporations. Following Yu (2008), we calculate the number of analysts following a company from IBES.

Firm size is the log of the market value of equity. Firm leverage is total long-term debt divided by total assets. Earnings volatility is the standard deviation of earnings before extraordinary items (scaled by total assets) over the past 20 quarters. Cash volatility is the standard deviation of operating cash flows (scaled by total assets) over the past 20 quarters. Sales volatility is the standard deviation of sales revenue (scaled by total assets) over the past 20 quarters. Market beta is estimated using daily stock and market returns over the fiscal quarter. Idiosyncratic volatility is standard deviation of firm-specific daily returns over the fiscal quarter. Firm-specific daily return is estimated using Fama French 4 Factor model.

3.4. Sample

The sample period is from year 1996 to 2018. We collect daily option data (including delta, opening interest, and implied volatility) from OptionMetrics' Ivy DB, daily stock return data from the Center for Research in Security Prices (CRSP), and quarterly financial data from Compustat. Consistent with Kim and Zhang (2019), we apply various filters for OptionMetrics including: (i) the implied volatility of the option is not missing and is between 0.03 and 2.00; (ii) the open interest of the option is not missing and is greater than zero; (iii) the total volume of option contracts is not missing; (iv) the best offer price is equal or greater than the best bid price and the best bid price is not zero; (v) at least 60 trading days are available within the fiscal year; and (vi) the value of the option delta is between 0.375 and 0.625 for call option or between 0.375 and 0.125

for put option. We apply filters for Compustat and the CRSP, including: (i) the book value of total assets and the book value of equity are greater than zero; (ii) the year-end share price is greater than $1; (iii) the SIC code is not missing and is not between 6000 and 6999 (the financial industry is excluded); and (iv) the CRSP daily price and volume data are available for at least six months during the fiscal year period. Following Kim et al. (2019), we require all firm quarters in our sample to have non-missing information of institutional holdings and analyst coverage.

According to the summary statistics of Table 17, 0.5 percent of the firm quarters in the sample are identified as an EPS-motivated share repurchase quarter. An average firm buys back 0.6 percent of shares outstanding per fiscal quarter (2.4 percent per fiscal year). The mean Negative_Skewness is about -0.19 and, on average, 0.273 trading day has firm-specific daily return below 3.2 standard deviations from its mean over the fiscal quarter. The mean implied volatility skew is 0.044, suggesting that investors, on average, have a positive expected crash risk. A typical firm in the sample turns over all shares outstanding by about 10 times per fiscal quarter (about 40 times per year). On average, about 70% of common shares in the sample are held by institutional investors, and an average firm has about ten covering analysts.

4. Empirical Results

4.1. Effects of EPS-motivated Share Repurchase on Stock Price Crash Risk

We start by testing the effects of EPS-motivated share repurchase on stock price crash risk. The ex-post stock price crash risk is measured by $Negative\_Skewness$ and $Extreme\_ND$. The baseline empirical model regresses $Negative\_Skewness$ and $Extreme\_ND$ on three explanatory variables, including the indicator of EPS-motivated repurchase quarter (EPS_REP), amount of actual share repurchase (REP), and their interaction term. The interaction term $EPS\_REP \times REP$ measures the amount of EPS-motivated share repurchase. The coefficient β_1 indicates the association between the amount of EPS-motivated share repurchase and stock price crash risk that is proxied by $Negative\_Skewness$ and $Extreme\_ND$. We specify the regression equation:

$$\begin{aligned}
Negative_Skewness_{i,t} = \beta_1 EPS_REP_{i,t-1} \times REP_{i,t-1} + \beta_2 EPS_REP_{i,t-1} + \\
\beta_3 REP_{i,t-1} + \\
\sum_{q=4}^{m} \beta_q (q^{th} ControlVariables_{i,t-1}) + \epsilon_i + \theta_t \\
Extreme_ND_{i,t} = \beta_1 EPS_REP_{i,t-1} \times REP_{i,t-1} + \beta_2 EPS_REP_{i,t-1} + \\
\beta_3 REP_{i,t-1} + \\
\sum_{q=4}^{m} \beta_q (q^{th} ControlVariables_{i,t-1}) + \epsilon_i + \theta_t \quad (8)
\end{aligned}$$

According to the results in the first row of Table 18, the amount of EPS-motivated share repurchase has weak effects on $Negative\_Skewness$ and no effect on $Extreme\_ND$. This evidence suggests that when managers use share repurchase to boost EPS, that will not affect the ex-post stock price crash risk.

4.2. Effects of EPS-motivated Share Repurchase on Expected Stock Price Crash Risk

We continue to test the effects of EPS-motivated share repurchase on expected stock price crash risk. The expected stock price crash risk is measured by IV_Skew. The baseline empirical model regresses IV_Skew on three explanatory variables, including the indicator of EPS-motivated repurchase quarter (EPS_REP), amount of actual share repurchase (REP), and their interaction term. The interaction term $EPS\_REP \times REP$ measures the amount of EPS-motivated share repurchase. The coefficient β_1 indicates the association between the amount of EPS-motivated share repurchase and stock price crash risk that is proxied by IV_Skew. We specify the regression equation:

$$IV\_Skew_{i,t} = \beta_1 EPS\_REP_{i,t-1} \times REP_{i,t-1} + \beta_2 EPS\_REP_{i,t-1} + \beta_3 REP_{i,t-1} + \sum_{q=4}^{m} \beta_q (q^{th} ControlVariables_{i,t-1}) + \epsilon_i + \theta_t \quad (9)$$

According to the results in the first row of Table 19, the coefficient β_1 remains significant and positive for all four specifications, suggesting that EPS-motivated share repurchase significantly increases investors' perceived stock price crash risk. Moreover, the results of β_1 in the third row of Table 19 show that the amount of total share repurchase significantly reduces expected crash risk. This evidence is consistent with the notion that share repurchase can provide price support to stocks, thus lowering the crash risk (Liu and Swanson, 2016). Large firms, on average, tend to have lower expected crash risk. This should be no surprise because large firms tend to hold more diversified assets than small firms, and investors perceive large firms as being safer than small firms (Fama and French, 1992). Highly leveraged firms are associated with high expected crash risk. Firm leverage increases financial risk and hence increases expected crash risk (Myers, 1984). Moreover, the results show that the total volatility of stock returns increases expected crash risk, while the idiosyncratic volatility reduces expected crash risk. One possible explanation is that idiosyncratic volatility may offer certain degrees of insurance against crash risk and hence lowers investors' perception of crash risk (Chen and Petkova, 2012). The inclusion of various control factors does not change the sign and significance of the coefficient of the interaction term $EPS\_REP \times REP$. The results in Table 19 partially support our first hypothesis that share repurchase reduces expected crash risk while EPS-motivated share repurchase increases expected crash risk.

Since the identification of EPS-motivated share repurchase is not straightforward, investors may underreact to this information (Kadiyala and Rau, 2004). We not only test whether EPS-motivated share repurchase affects expected crash risk but also test whether investors underreact to the use of EPS-motivated share repurchase by managers. Building on our previous analysis in Table 19, we test whether the amount of EPS-motivated share repurchase has persistent effects on the stock price crash risk in the following four fiscal quarters. Table 20 presents the results of the panel regressions that examine how EPS-motivated share repurchase affects future expected crash risk. We measure future expected crash risk by IV_Skew in 1-4 quarters following the current fiscal quarter. The coefficient of the interaction term $EPS\_REP \times REP$ remains significant and positive for all quarters, suggesting that EPS-motivated share repurchase has long-lasting impacts on the expected crash risk. One possible explanation of this evidence is that investors may underreact to the use of EPS-motivated repurchase by managers. Such underreaction may be caused by the time needed to process the information of share repurchase and identify the use of EPS-motivated repurchase.

4.3. Effects of Stock Liquidity on Expected Stock Price Crash Risk Induced by EPS-motivated Share Repurchase

Since stock liquidity is an important factor for repurchase decisions (Brockman et al., 2008), we continue to test the interplay between stock liquidity and EPS-motivated share repurchase and its effects on expected crash risk. Based on the regression specification in Equation 9, we include another interaction term to test the impacts of stock liquidity (measured by $Stock\_Turnover$):

$$\begin{aligned} IV\_Skew_{i,t} = \beta_1 EPS\_REP_{i,t-1} \times REP_{i,t-1} \times Stock\_Turnover_{i,t-1} + \\ \beta_2 EPS\_REP_{i,t-1} \times REP_{i,t-1} + \beta_3 Stock\_Turnover_{i,t-1} + \\ \beta_4 EPS\_REP_{i,t-1} + \beta_5 REP_{i,t-1} + \\ \sum_{q=6}^{m} \beta_q (q^{th} ControlVariables_{i,t-1}) + \epsilon_i + \theta_t \end{aligned} \quad (10)$$

β_1 measures the effects of stock liquidity on the EPS-motivated share repurchase - expected crash risk association. According to the results in Table 21, the interaction term $EPS\_REP \times REP$ still has significant positive effects on expected crash risk, which confirms the results of Table 20. Moreover, β_1 has a significant and positive coefficient for all specifications. This evidence suggests that stock liquidity strengthens the EPS-motivated share repurchase - expected crash risk association. Higher stock liquidity encourages the use of EPS-motivated share repurchase and hence further increases the expected crash risk. This evidence is consistent with the findings of Brockman et al. (2008) that higher stock liquidity leads to lower costs of share repurchase.

We further test whether the impacts of stock liquidity on the predictive power of EPS-motivated share repurchase on future expected crash risk can persist beyond the current fiscal quarter. The results in Table 22 confirm that the positive association between EPS-motivated share repurchase and future expected crash risk is more pronounced among firms with higher stock liquidity. Overall, the results in Table 21 and Table 22 support our second hypothesis that higher stock liquidity encourages the use of EPS-motivated share repurchase and hence increases expected crash risk.

4.4. Effects of Corporate Governance on Expected Stock Price Crash Risk Induced by EPS-motivated Share Repurchase

In this section, we continue to test the interplay between corporate governance and EPS-motivated share repurchase and its effects on expected crash risk. Based on the regression specification in Equation 9, we include another interaction term to test the impacts of corporate governance (measured by $Institution\_Ownership$):

$$\begin{aligned} IV\_Skew_{i,t} = {} & \beta_1 EPS\_REP_{i,t-1} \times REP_{i,t-1} \times Institution\_Ownership_{i,t-1} + \\ & \beta_2 EPS\_REP_{i,t-1} \times REP_{i,t-1} + \beta_3 Institution\_Ownership_{i,t-1} + \\ & \beta_4 EPS\_REP_{i,t-1} + \beta_5 REP_{i,t-1} + \\ & \sum_{q=6}^{m} \beta_q (q^{th} ControlVariables_{i,t-1}) + \epsilon_i + \theta_t \end{aligned} \tag{11}$$

The coefficient of interest is β_1 for this regression model since it measures the change in expected crash risk for a one-unit change in the interplay between institutional ownership and EPS-motivated share repurchase. According to the results in Table 23, institutional ownership has weak impacts on the EPS-motivated share repurchase - expected crash risk association.

We further examine the effects of institutional ownership on the expected crash risk induced by EPS-motivated share repurchase. The results in Table 24 suggest that institutional ownership does not have significant impacts on the EPS-motivated share repurchase - expected crash risk association in the four quarters following the current fiscal quarter.

We further test the interplay between corporate governance and EPS-motivated share repurchase and its effects on expected crash risk using an alternative measure of corporate governance. Based on the regression specification in Equation 9, we include another interaction term to test the impacts of stock liquidity (measured by $Analyst$):

$$\begin{aligned} IV\_Skew_{i,t} = \beta_1 EPS\_REP_{i,t-1} \times REP_{i,t-1} \times Analyst_{i,t-1} + \\ \beta_2 EPS\_REP_{i,t-1} \times REP_{i,t-1} + \beta_3 Analyst_{i,t-1} + \\ \beta_4 EPS\_REP_{i,t-1} + \beta_5 REP_{i,t-1} + \\ \sum_{q=6}^{m} \beta_q (q^{th} ControlVariables_{i,t-1}) + \epsilon_i + \theta_t \end{aligned} \quad (12)$$

β_1 measures the effects of analyst coverage on the EPS-motivated share repurchase - expected crash risk association. According to the results in Table 25, the interaction term $EPS\_REP \times REP$ still has significant positive effects on expected crash risk, which confirms the results of Table 20. Moreover, β_1 has a significant and negative coefficient for all specifications. This evidence suggests that analyst coverage weakens the EPS-motivated share repurchase - expected crash risk association. Higher analyst coverage disciplines managers from using EPS-motivated share repurchase and hence reduces the expected crash risk. This evidence is consistent with the findings of Yu (2008) that firms followed by more analysts manage their earnings less.

We further test whether the impacts of analyst coverage on the predictive power of EPS-motivated share repurchase on future expected crash risk can persist beyond the current fiscal quarter. The results in Table 26 confirm that the positive association between EPS-motivated share repurchase and future expected crash risk is less pronounced among firms with higher analyst coverage. Overall, the results in Table 25 and Table 26 support our third hypothesis that higher analyst coverage reduces the use of EPS-motivated share repurchase and hence reduces expected crash risk.

5. Conclusion

We find that EPS-motivated share repurchase positively relates to expected crash risk, which is measured by implied volatility skew in the options market. Additionally, EPS-motivated repurchase predicts significantly higher expected crash risk in 1-4 quarters after the current fiscal quarter. We also study the interplay between EPS-motivated share repurchase and stock liquidity and its impacts on expected crash risk. Consistent with the findings of Brockman et al. (2008), we find that higher stock liquidity encourages managers to use share repurchase to manipulate EPS and hence increases expected crash risk. Besides, this paper studies the role of corporate governance in the EPS-motivated share repurchase - expected crash risk relation and find that corporate governance, proxied by institutional ownership and analyst coverage, significantly reduces the expected crash risk induced by EPS-motivated repurchase. This evidence suggests that corporate governance can maintain the stability of the stock market by curbing bad news hoarding behavior.

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Figure 1: Number of Repurchase Firms and Aggregate Stock and Options Volumes

This figure shows the number of repurchase firms (Panel A), aggregate stock market trading volume (Panel B), and aggregate options market trading volume (Panel C) from 1996 to 2017. I follow Banyi et al. (2008) to consider firms that buy back more than 1% of total shares in a given quarter as repurchase firms. Aggregate stock market trading volume is the sum of trading volumes of all the stocks in my sample, and aggregate options market trading volume is the sum of trading volumes of all the options in my sample. The firms in the sample are publicly traded US operating firms excluding financials and utilities with options volume information available for at least four consecutive quarters.

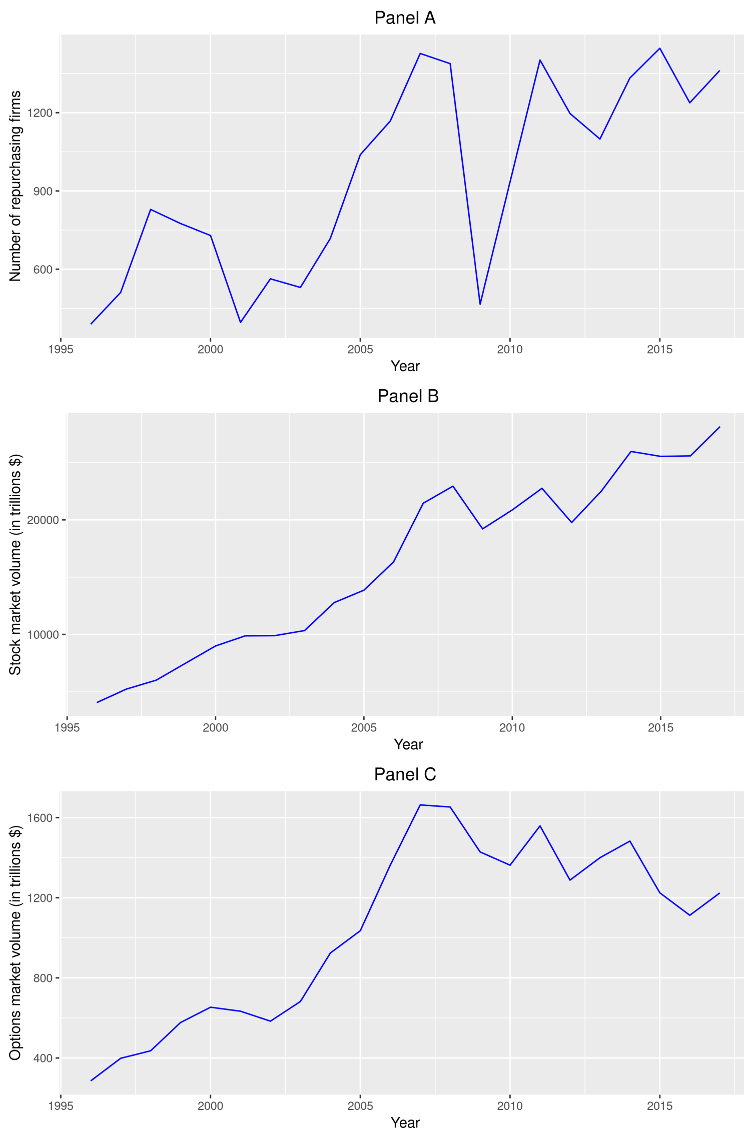

Figure 2: Stock and Options Volumes in Repurchase versus Non-repurchase Quarters

This figure compares the STOCKVOL and OPTIONVOL in repurchase and non-repurchase quarters. STOCKVOL (OPTIONVOL) is the natural log of stock (options) trading volume. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. I follow Banyi et al. (2008) to define quarters with REPDUM equal to 1 as repurchase quarters and quarters with REPDUM equal to 0 as non-repurchase quarters to account for preferred buybacks. Panel A compares the distribution of STOCKVOL in repurchase and non-repurchase quarters; Panel B compares the distribution of OPTIONVOL in repurchase and non-repurchase quarters. Panel C shows boxplots comparing the quintiles of STOCKVOL in repurchase and non-repurchase quarters; Panel D shows boxplots comparing the quintiles of OPTIONVOL in repurchase and non-repurchase quarters.

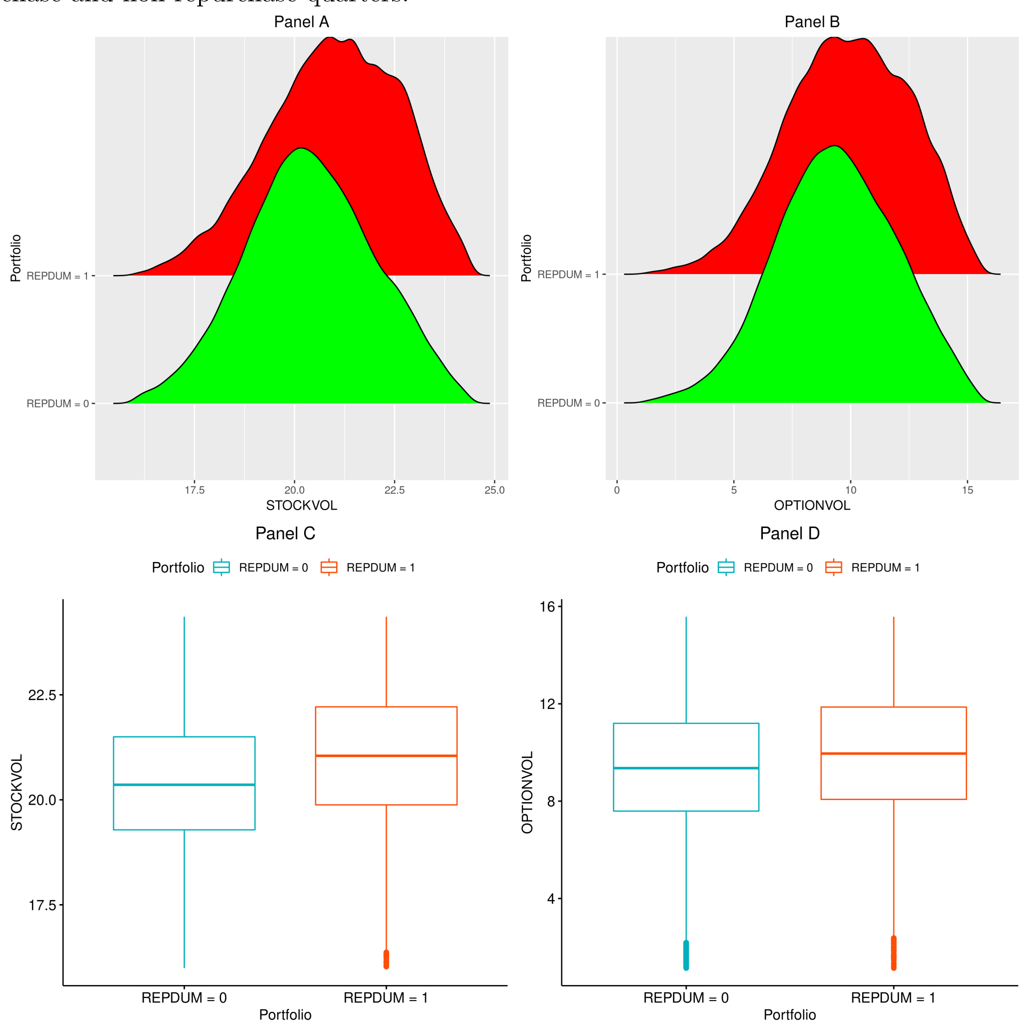

Table 1: Summary Statistics

This table presents the summary statistics of the main explanatory and dependent variables. STOCKVOL (OPTIONVOL) is the natural log of stock (options) trading volume. OS is the natural log of the ratio of options volume to stock volume. CALLOS (ATMOS) is the natural log of the ratio of call (at-the-money) options volume to stock volume. REP is the actual amount of share repurchase scaled by total assets. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. SIZE is the percentile rank of market cap among firms listed on NYSE. MB is the market-to-book ratio, and LEV is the firm leverage calculated as long-term debt scaled by total assets. STOCKILLIQ (OPTIONILLIQ) is the stock (options) illiquidity measured by the relative bid-ask spread. BOWCOST is the borrowing cost measured by the risk-free rate. DELTA measures the sensitivity of options price to the change of underlying stock price. BHAR is the buy-and-hold abnormal return calculated as the difference of stock return between repurchase quarter and matching non-repurchase quarter. ROA is the return on assets. RETABV is the abnormal volatility of stock return. ROAV is the standard deviation of ROA. INSOWN is the proportion of stocks owned by institutional investors. All variables are winsorized at the 1% and 99% levels.

	Mean	Std.Dev	Min	Q1	Median	Q3	Max	Skewness	Kurtosis
STOCKVOL	20.474	1.614	15.993	19.357	20.449	21.616	24.359	-0.043	-0.435
OPTIONVOL	9.436	2.578	1.139	7.658	9.435	11.300	15.577	-0.122	-0.332
OS	0.042	0.058	0.000	0.006	0.020	0.053	0.604	3.168	14.523
CALLOS	0.026	0.038	0.000	0.004	0.012	0.033	0.357	3.169	14.074
ATMOS	0.012	0.015	0.000	0.002	0.006	0.016	0.111	2.356	6.940
REP	0.005	0.013	0.000	0.000	0.000	0.003	0.097	3.591	14.831
REPDUM	0.146	0.353	0.000	0.000	0.000	0.000	1.000	2.003	2.012
SIZE	0.639	0.235	0.061	0.467	0.669	0.836	1.000	-0.434	-0.734
MB	3.185	3.261	0.057	1.440	2.268	3.751	32.229	3.301	17.656
LEV	0.194	0.181	0.000	0.020	0.162	0.311	0.847	0.828	0.049
STOCKILLIQ	0.005	0.008	-0.001	0.001	0.001	0.004	0.089	3.221	12.798
OPTIONILLIQ	0.267	0.126	0.026	0.175	0.240	0.330	0.963	1.136	1.386
BOWCOST	0.007	0.008	0.000	0.000	0.003	0.017	0.025	0.647	-1.270
DELTA	0.514	0.063	0.375	0.473	0.508	0.547	0.775	0.767	1.171
BHAR	-0.015	0.091	-0.339	-0.063	-0.012	0.036	0.302	-0.115	1.140
ROA	0.008	0.030	-0.213	0.002	0.011	0.022	0.095	-2.441	11.448
RETABV	0.026	0.013	0.008	0.016	0.022	0.032	0.089	1.406	2.359
ROAV	0.015	0.024	0.000	0.003	0.007	0.016	0.226	3.980	20.387
INSOWN	0.414	0.247	0.000	0.381	0.455	0.587	0.975	-0.474	3.801

Table 2: Effects of Actual Share Repurchase on Abnormal Return and Operating Performance

This table presents results from panel regressions that examine how actual share repurchases affect BHAR (Panel A) and ROA (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3. BHAR is the buy-and-hold abnormal return calculated as the difference of stock return between repurchase quarter and matching non-repurchase quarter. ROA is the return on assets. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. SIZE is the percentile rank of market cap among firms listed on NYSE. MB is the market-to-book ratio, and LEV is the firm leverage calculated as long-term debt scaled by total assets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

Panel A

	Dependent variable:						
	BHAR						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
REPDUM	0.193**	0.411***	0.268***	0.105	0.977***	0.133**	0.060*
	(0.087)	(0.086)	(0.085)	(0.084)	(0.116)	(0.014)	(0.031)
SIZE	−0.332*	0.644***	0.572***	0.488***	1.314***	1.443***	0.748***
	(0.191)	(0.189)	(0.187)	(0.185)	(0.256)	(0.251)	(0.244)
MB	−0.263***	−0.062***	−0.054***	−0.028**	−0.376***	−0.018	−0.067***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.019)	(0.019)	(0.018)
LEV	0.632*	0.158	0.314	−0.331	0.436	−1.972***	−0.181
	(0.357)	(0.353)	(0.348)	(0.345)	(0.477)	(0.468)	(0.456)
Observations	96,670	96,670	96,670	96,670	96,670	96,670	96,670
Adjusted R^2	0.011	0.007	0.006	0.008	0.171	0.162	0.158

Panel B

	Dependent variable:						
	ROA						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
REPDUM	0.264***	0.142***	0.135***	0.085***	0.156***	0.119***	0.104***
	(0.025)	(0.026)	(0.026)	(0.021)	(0.015)	(0.013)	(0.011)
SIZE	−0.921***	−1.408***	−1.541***	−1.232***	−1.275***	−1.563***	−1.625***
	(0.055)	(0.057)	(0.057)	(0.047)	(0.033)	(0.028)	(0.024)
MB	0.166***	0.147***	0.131***	0.108***	0.138***	0.113***	0.091***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.002)	(0.002)	(0.002)
LEV	−2.320***	−1.684***	−1.562***	−1.431***	−1.749***	−1.071***	−0.685***
	(0.103)	(0.106)	(0.107)	(0.088)	(0.061)	(0.051)	(0.045)
Observations	96,610	96,611	96,610	96,670	96,670	96,670	96,670
Adjusted R^2	0.333	0.320	0.320	0.400	0.586	0.667	0.727

Table 3: Effects of Actual Share Repurchase on Abnormal Volatility and Operating Performance Volatility

This table presents results from panel regressions that examine how actual share repurchases affect RETABV (Panel A) and ROAV (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3. RETABV is the abnormal volatility of stock return. ROAV is the standard deviation of ROA. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. SIZE is the percentile rank of market cap among firms listed on NYSE. MB is the market-to-book ratio, and LEV is the firm leverage calculated as long-term debt scaled by total assets. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

Panel A

	Dependent variable:						
	RETABV						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
REPDUM	0.107***	0.128***	0.125***	0.098***	0.115***	0.092***	0.073***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.006)	(0.005)	(0.004)
SIZE	−0.114***	−0.056***	−0.049***	−0.021	−0.056***	−0.020*	0.018*
	(0.019)	(0.018)	(0.018)	(0.018)	(0.013)	(0.011)	(0.009)
MB	0.012***	0.020***	0.018***	0.016***	0.017***	0.014***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
LEV	0.372***	0.337***	0.297***	0.301***	0.326***	0.284***	0.248***
	(0.035)	(0.034)	(0.034)	(0.034)	(0.024)	(0.020)	(0.018)
Observations	96,569	96,574	96,574	96,563	96,670	96,670	96,670
Adjusted R^2	0.631	0.628	0.623	0.623	0.733	0.773	0.795

Panel B

	Dependent variable:		
	ROAV		
	[Year 1]	[Year 2]	[Year 3]
REPDUM	0.044***	0.058***	0.066***
	(0.016)	(0.016)	(0.015)
SIZE	0.581***	0.987***	1.229***
	(0.034)	(0.035)	(0.034)
MB	−0.008***	−0.016***	−0.010***
	(0.003)	(0.003)	(0.002)
LEV	−0.075	−0.171***	−0.014
	(0.064)	(0.065)	(0.063)
Observations	96,670	96,670	96,670
Adjusted R^2	0.324	0.447	0.540

Table 4: Effects of Actual Share Repurchase on Stock Volume

This table presents results from panel regressions that examine how actual share repurchases affect STOCKVOL in the pre-repurchase quarter. STOCKVOL is the natural log of stock trading volume. REP is the actual amount of share repurchase scaled by total assets. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. SIZE is the percentile rank of market cap among firms listed on NYSE. MB is the market-to-book ratio, and LEV is the firm leverage calculated as long-term debt scaled by total assets. STOCKILLIQ is the stock illiquidity measured by the relative bid-ask spread. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

	Panel A: Full Sample			Panel B: REPDUM = 0			Panel C: REPDUM = 1		
	STOCKVOL								
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
REP	6.767***	3.187***	2.667***	14.038***	4.736***	3.713***	4.337***	4.644***	4.278***
	(0.195)	(0.167)	(0.157)	(0.452)	(0.388)	(0.367)	(0.302)	(0.262)	(0.243)
SIZE		1.973***	1.608***		2.003***	1.645***		1.815***	1.435***
		(0.009)	(0.009)		(0.010)	(0.010)		(0.022)	(0.022)
MB		0.093***	0.088***		0.097***	0.091***		0.058***	0.052***
		(0.001)	(0.001)		(0.001)	(0.001)		(0.002)	(0.002)
LEV		−0.867***	−0.704***		−0.895***	−0.738***		−0.531***	−0.371***
		(0.021)	(0.020)		(0.023)	(0.022)		(0.058)	(0.054)
STOCKILLIQ			−0.398***			−0.392***			−0.408***
			(0.003)			(0.003)			(0.007)
Observations	157,881	157,881	157,881	134,752	134,752	134,752	21,938	21,938	21,938
Adjusted R^2	0.736	0.809	0.830	0.724	0.800	0.821	0.827	0.875	0.893

Table 5: Effects of Actual Share Repurchase on Options Volume

This table presents results from panel regressions that examine how actual share repurchases affect OPTIONVOL in the pre-repurchase quarter. OPTIONVOL is the natural log of options trading volume. REP is the total amount of actual share repurchase scaled by total assets. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. SIZE is the percentile rank of market cap among firms listed on NYSE. MB is the market-to-book ratio, and LEV is the firm leverage calculated as long-term debt scaled by total assets. OPTIONILLIQ is the options illiquidity measured by the relative bid-ask spread. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

	Panel A: Full Sample			Panel B: REPDUM = 0			Panel C: REPDUM = 1		
	OPTIONVOL								
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
REP	5.403***	2.046***	1.277***	10.057***	0.878	2.568***	7.312***	7.142***	4.313***
	(0.341)	(0.327)	(0.280)	(0.788)	(0.757)	(0.648)	(0.566)	(0.554)	(0.486)
SIZE		1.896***	2.219***		1.937***	2.243***		1.786***	2.122***
		(0.017)	(0.015)		(0.019)	(0.016)		(0.047)	(0.042)
MB		0.106***	0.069***		0.108***	0.069***		0.079***	0.057***
		(0.002)	(0.001)		(0.002)	(0.001)		(0.004)	(0.004)
LEV		−0.488***	−0.083**		−0.474***	−0.084**		−0.744***	−0.143
		(0.041)	(0.036)		(0.045)	(0.039)		(0.122)	(0.107)
OPTIONILLIQ			−8.891***			−8.927***			−8.482***
			(0.038)			(0.041)			(0.112)
Observations	157,881	157,881	157,881	134,752	134,752	134,752	21,938	21,938	21,938
Adjusted R^2	0.692	0.720	0.794	0.684	0.713	0.790	0.770	0.789	0.839

Table 6: Effects of Actual Share Repurchase on Options to Stock Volume Ratio

This table presents results from panel regressions that examine how actual share repurchases affect OS in the pre-repurchase quarter. OS is the natural log of the ratio of options trading volume to stock trading volume. REP is the total amount of actual share repurchase scaled by total assets. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. SIZE is the percentile rank of market cap among firms listed on NYSE. MB is the market-to-book ratio, and LEV is the firm leverage calculated as long-term debt scaled by total assets. STOCKILLIQ (OPTIONILLIQ) is the stock (options) illiquidity measured by the relative bid-ask spread. BOWCOST is the borrowing cost measured by the risk-free rate. DELTA measures the sensitivity of options price to the change of underlying stock price. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

	Panel A: Full Sample			Panel B: REPDUM = 0			Panel C: REPDUM = 1		
	OS								
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
REP	0.068	0.063	0.021	−0.282**	−0.339**	−0.249*	0.412***	0.393***	0.279***
	(0.052)	(0.083)	(0.052)	(0.138)	(0.138)	(0.135)	(0.059)	(0.060)	(0.058)
SIZE		0.034**	0.092***		0.038***	0.094***		0.044***	0.098***
		(0.016)	(0.006)		(0.007)	(0.007)		(0.015)	(0.016)
MB		0.004***	−0.001*		0.004***	−0.001**		0.004***	0.0002
		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)
LEV		0.063*	0.119***		0.081***	0.132***		−0.100***	0.013
		(0.037)	(0.014)		(0.016)	(0.016)		(0.037)	(0.037)
STOCKILLIQ			1.742***			2.029***			−1.009*
			(0.224)			(0.249)			(0.550)
OPTIONILLIQ			−1.244***			−1.243***			−1.195***
			(0.016)			(0.018)			(0.042)
BOWCOST			−0.226			−0.499*			1.720***
			(0.226)			(0.256)			(0.496)
DELTA			0.051**			0.050*			0.011
			(0.025)			(0.027)			(0.062)
Observations	158,339	158,339	158,339	133,782	133,782	133,782	23,365	23,365	23,365
Adjusted R^2	0.460	0.460	0.483	0.461	0.462	0.484	0.523	0.524	0.546

Table 7: Effects of Actual Share Repurchase on Call Options to Stock Volume Ratio

This table presents results from panel regressions that examine how actual share repurchases affect CALLOS in the pre-repurchase quarter. CALLOS is the natural log of the ratio of call options trading volume to stock trading volume. REP is the total amount of actual share repurchase scaled by total assets. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. SIZE is the percentile rank of market cap among firms listed on NYSE. MB is the market-to-book ratio, and LEV is the firm leverage calculated as long-term debt scaled by total assets. STOCKILLIQ (OPTIONILLIQ) is the stock (options) illiquidity measured by the relative bid-ask spread. BOWCOST is the borrowing cost measured by the risk-free rate. DELTA measures the sensitivity of options price to the change of underlying stock price. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

	Panel A: Full Sample			Panel B: REPDUM = 0			Panel C: REPDUM = 1		
	CALLOS								
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
REP	−0.011	−0.033	−0.063*	−0.136	−0.238***	−0.185**	0.226***	0.191***	0.123***
	(0.034)	(0.034)	(0.034)	(0.089)	(0.089)	(0.087)	(0.042)	(0.042)	(0.041)
SIZE		−0.014***	0.022***		−0.015***	0.021***		0.014	0.048***
		(0.004)	(0.004)		(0.004)	(0.005)		(0.010)	(0.011)
MB		0.011***	0.008***		0.012***	0.008***		0.006***	0.004***
		(0.0003)	(0.0003)		(0.0004)	(0.0004)		(0.001)	(0.001)
LEV		−0.043***	−0.004		−0.033***	0.002		−0.131***	−0.060**
		(0.009)	(0.009)		(0.010)	(0.010)		(0.026)	(0.026)
STOCKILLIQ			0.646***			0.735***			−0.345
			(0.145)			(0.161)			(0.388)
OPTIONILLIQ			−0.808***			−0.805***			−0.798***
			(0.011)			(0.012)			(0.030)
BOWCOST			−0.041			−0.055			0.373
			(0.147)			(0.165)			(0.350)
DELTA			0.082***			0.077***			0.091**
			(0.016)			(0.018)			(0.044)
Observations	158,339	158,339	158,339	133,782	133,782	133,782	23,365	23,365	23,365
Adjusted R^2	0.431	0.436	0.459	0.437	0.441	0.464	0.442	0.444	0.465

Table 8: Effects of Actual Share Repurchase on At-the-money Options to Stock Volume Ratio

This table presents results from panel regressions that examine how actual share repurchases affect ATMOS in the pre-repurchase quarter. ATMOS is the natural log of the ratio of at-the-money options trading volume to stock trading volume. REP is the total amount of actual share repurchase scaled by total assets. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. SIZE is the percentile rank of market cap among firms listed on NYSE. MB is the market-to-book ratio, and LEV is the firm leverage calculated as long-term debt scaled by total assets. STOCKILLIQ (OPTIONILLIQ) is the stock (options) illiquidity measured by the relative bid-ask spread. BOWCOST is the borrowing cost measured by the risk-free rate. DELTA measures the sensitivity of options price to the change of underlying stock price. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

	Panel A: Full Sample			Panel B: REPDUM = 0			Panel C: REPDUM = 1		
	ATMOS								
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
REP	0.170***	0.134***	0.115***	0.132***	0.019	0.030	0.204***	0.201***	0.168***
	(0.014)	(0.014)	(0.014)	(0.037)	(0.037)	(0.036)	(0.017)	(0.017)	(0.017)
SIZE		0.061***	0.052***		0.062***	0.052***		0.066***	0.057***
		(0.002)	(0.002)		(0.002)	(0.002)		(0.004)	(0.005)
MB		0.004***	0.003***		0.004***	0.003***		0.004***	0.002***
		(0.0001)	(0.0001)		(0.0002)	(0.0002)		(0.0004)	(0.0004)
LEV		−0.042***	−0.020***		−0.043***	−0.021***		−0.043***	−0.013
		(0.004)	(0.004)		(0.004)	(0.004)		(0.011)	(0.011)
STOCKILLIQ			−1.243***			−1.207***			−1.727***
			(0.059)			(0.065)			(0.158)
OPTIONILLIQ			−0.331***			−0.326***			−0.363***
			(0.004)			(0.005)			(0.012)
BOWCOST			−0.177***			−0.211***			0.149
			(0.060)			(0.067)			(0.143)
DELTA			−0.184***			−0.185***			−0.167***
			(0.007)			(0.007)			(0.018)
Observations	158,339	158,339	158,339	133,782	133,782	133,782	23,365	23,365	23,365
Adjusted R^2	0.492	0.499	0.525	0.483	0.490	0.516	0.596	0.602	0.625

Table 9: Abnormal Return and Operating Performance Sorted by Call Options to Stock Volume Ratio

This table reports BHAR (Panel A) and ROA (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3 sorted by quintiles of CALLOS in pre-repurchase quarters. BHAR is the buy-and-hold abnormal return calculated as the difference of stock return between repurchase quarter and matching non-repurchase quarter. ROA is the return on assets. CALLOS is the natural log of the ratio of call options trading volume to stock trading volume. For each quintile, I report mean CALLOS and mean BHAR or ROA. The difference between the highest (quintile 5) and the lowest (quintile 1) CALLOS groups is presented in the last column. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A

	1 (Low)	2	3	4	5 (High)	High - Low
CALLOS	0.001	0.005	0.013	0.028	0.084	0.083**
BHAR [Quarter 1]	-0.020	-0.015	-0.012	-0.009	-0.006	0.013**
BHAR [Quarter 2]	-0.017	-0.012	-0.012	-0.010	-0.007	0.010***
BHAR [Quarter 3]	-0.016	-0.014	-0.012	-0.010	-0.008	0.008**
BHAR [Quarter 4]	-0.017	-0.013	-0.012	-0.010	-0.007	0.010**
BHAR [Year 1]	-0.079	-0.062	-0.053	-0.043	-0.033	0.046*
BHAR [Year 2]	-0.072	-0.060	-0.052	-0.045	-0.035	0.037*
BHAR [Year 3]	-0.066	-0.054	-0.049	-0.044	-0.036	0.030*

Panel B

	1 (Low)	2	3	4	5 (High)	High - Low
CALLOS	0.001	0.005	0.013	0.028	0.084	0.083**
ROA [Quarter 1]	0.003	0.008	0.009	0.009	0.008	0.005**
ROA [Quarter 2]	0.001	0.007	0.008	0.009	0.008	0.007**
ROA [Quarter 3]	0.001	0.006	0.008	0.009	0.008	0.007**
ROA [Quarter 4]	0.001	0.006	0.008	0.009	0.008	0.008**
ROA [Year 1]	0.001	0.007	0.008	0.009	0.008	0.007*
ROA [Year 2]	0.001	0.006	0.008	0.009	0.006	0.007**
ROA [Year 3]	0.001	0.006	0.008	0.009	0.006	0.007**

Table 10: Abnormal Volatility and Operating Performance Volatility Sorted by At-the-money Options to Stock Volume Ratio

This table reports RETABV (Panel A) and ROAV (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3 sorted by quintiles of ATMOS in pre-repurchase quarters. RETABV is the abnormal volatility of stock return. ROAV is the standard deviation of ROA. ATMOS is the natural log of the ratio of at-the-money options trading volume to stock trading volume. For each quintile, I report mean ATMOS and mean RETABV or ROAV. The difference between the highest (quintile 5) and the lowest (quintile 1) ATMOS groups is presented in the last column. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A

	1 (Low)	2	3	4	5 (High)	High - Low
ATMOS	0.000	0.002	0.006	0.013	0.036	0.036**
RETABV [Quarter 1]	0.023	0.025	0.026	0.028	0.028	0.005**
RETABV [Quarter 2]	0.022	0.024	0.026	0.028	0.028	0.005**
RETABV [Quarter 3]	0.022	0.024	0.026	0.028	0.028	0.006*
RETABV [Quarter 4]	0.022	0.024	0.026	0.027	0.028	0.006*
RETABV [Year 1]	0.022	0.024	0.026	0.028	0.028	0.006*
RETABV [Year 1]	0.022	0.024	0.026	0.027	0.028	0.005**
RETABV [Year 3]	0.022	0.024	0.026	0.027	0.027	0.005**

Panel B

	1 (Low)	2	3	4	5 (High)	High - Low
ATMOS	0.000	0.002	0.006	0.013	0.036	0.036**
ROAV [Year 1]	0.005	0.007	0.007	0.007	0.006	0.001*
ROAV [Year 2]	0.003	0.007	0.007	0.006	0.005	0.002*
ROAV [Year 3]	0.003	0.007	0.007	0.006	0.005	0.002**

Table 11: Effects of Call Options to Stock Volume Ratio on Abnormal Return and Operating Performance

This table presents results from panel regressions that examine how CALLOS in pre-repurchase quarters affects BHAR (Panel A) and ROA (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3. BHAR is the buy-and-hold abnormal return calculated as the difference of stock return between repurchase quarter and matching non-repurchase quarter. ROA is the return on assets. CALLOS is the natural log of the ratio of call options trading volume to stock trading volume. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

Panel A

	REPDUM = 1						
	BHAR						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
CALLOS	0.769***	0.764***	0.176**	−0.339	1.091***	0.412**	0.660**
	(0.231)	(0.229)	(0.226)	(0.228)	(0.316)	(0.117)	(0.313)
Observations	16,040	16,040	16,040	16,040	16,040	16,040	16,040
Adjusted R^2	0.026	0.028	0.017	0.025	0.156	0.167	0.138

Panel B

	REPDUM = 1						
	ROA						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
CALLOS	0.186***	0.091*	0.155***	0.194***	0.156***	0.080**	0.050*
	(0.047)	(0.052)	(0.052)	(0.054)	(0.031)	(0.032)	(0.028)
Observations	16,040	16,040	16,040	16,040	16,040	16,040	16,040
Adjusted R^2	0.403	0.365	0.354	0.334	0.607	0.601	0.673

Table 12: Effects of At-the-money Options to Stock Volume Ratio on Abnormal Volatility and Operating Performance Volatility

This table presents results from panel regressions that examine how ATMOS in pre-repurchase quarters affects RETABV (Panel A) and ROAV (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3. RETABV is the abnormal volatility of stock return. ROAV is the standard deviation of ROA. ATMOS is the natural log of the ratio of at-the-money options trading volume to stock trading volume. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

Panel A

	REPDUM = 1						
	RETABV						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
ATMOS	0.058***	1.314*	1.674**	3.402***	1.583***	2.664***	2.857***
	(0.019)	(0.799)	(0.482)	(0.815)	(0.609)	(0.542)	(0.469)
Observations	16,843	16,843	16,843	16,843	16,843	16,843	16,843
Adjusted R^2	0.341	0.302	0.299	0.283	0.425	0.482	0.556

Panel B

	REPDUM = 1		
	ROAV		
	[Year 1]	[Year 2]	[Year 3]
ATMOS	3.005**	3.595***	3.951***
	(1.278)	(1.232)	(1.175)
Observations	16,843	16,843	16,843
Adjusted R^2	0.379	0.499	0.573

Table 13: Interaction Effects of Institutional Holdings and Call Options to Stock Volume Ratio

This table presents results from panel regressions that examine how the interaction of CALLOS and INSOWN in pre-repurchase quarters affects BHAR (Panel A) and ROA (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3. BHAR is the buy-and-hold abnormal return calculated as the difference of stock return between repurchase quarter and matching non-repurchase quarter. ROA is the return on assets. CALLOS is the natural log of the ratio of call options trading volume to stock trading volume. INSOWN is the proportion of stocks owned by institutional investors. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

Panel A

	REPDUM = 1						
	BHAR						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
CALLOS	0.515***	1.156*	0.566*	0.585	3.182**	1.710***	3.747***
	(0.023)	(0.514)	(0.401)	(0.907)	(1.266)	(0.270)	(1.252)
CALLOS × INSOWN	−0.792*	−1.879**	−1.448***	−0.740***	−3.779*	2.343	−5.327**
	(0.667)	(0.652)	(0.228)	(0.139)	(1.286)	(2.294)	(2.261)
Observations	13,548	13,548	13,548	13,548	13,548	13,548	13,548
Adjusted R^2	0.023	0.023	0.018	0.023	0.150	0.160	0.133

Panel B

	REPDUM = 1						
	ROA						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
CALLOS	0.297**	0.403**	0.237**	0.027*	0.241**	0.034***	0.250**
	(0.085)	(0.104)	(0.102)	(0.014)	(0.021)	(0.009)	(0.108)
CALLOS × INSOWN	−0.943***	−0.953***	−0.821**	0.449	−0.792***	0.191	−0.388**
	(0.334)	(0.368)	(0.365)	(0.386)	(0.219)	(0.215)	(0.195)
Observations	13,548	13,548	13,548	13,548	13,548	13,548	13,548
Adjusted R^2	0.389	0.351	0.354	0.320	0.593	0.615	0.674

Table 14: Interaction Effects of Institutional Holdings and At-the-money Options to Stock Volume Ratio

This table presents results from panel regressions that examine how the interaction of ATMOS and INSOWN in pre-repurchase quarters affects RETABV (Panel A) and ROAV (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3. RETABV is the abnormal volatility of stock return. ROAV is the standard deviation of ROA. ATMOS is the natural log of the ratio of at-the-money options trading volume to stock trading volume. INSOWN is the proportion of stocks owned by institutional investors. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

Panel A

	REPDUM = 1						
	RETABV						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ATMOS	0.504**	0.712***	0.417*	0.218	0.463**	0.330*	0.312**
	(0.251)	(0.260)	(0.251)	(0.262)	(0.196)	(0.172)	(0.150)
ATMOS × INSOWN	−1.074**	−0.870**	−0.336**	0.396	−0.471**	−0.013**	0.021
	(0.425)	(0.440)	(0.126)	(0.443)	(0.132)	(0.004)	(0.253)
Observations	13,548	13,548	13,548	13,548	13,548	13,548	13,548
Adjusted R^2	0.310	0.269	0.272	0.252	0.389	0.449	0.522

Panel B

	REPDUM = 1		
	ROAV		
	[Year 1]	[Year 2]	[Year 3]
ATMOS	0.401**	0.759**	0.177**
	(0.270)	(0.348)	(0.355)
ATMOS × INSOWN	−0.513**	−0.906**	0.386
	(0.156)	(0.389)	(0.601)
Observations	13,548	13,548	13,548
Adjusted R^2	0.355	0.446	0.520

Table 15: Difference-in-difference Analysis of Call Options to Stock Volume Ratio Using 2003 Modification to SEC Rule 10b-18

This table presents results from panel regressions that examine how the regulatory change of repurchase disclosure affects the impact of pre-repurchase CALLOS on BHAR (Panel A) and ROA (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3. BHAR is the buy-and-hold abnormal return calculated as the difference of stock return between repurchase quarter and matching non-repurchase quarter. ROA is the return on assets. CALLOS is the natural log of the ratio of call options trading volume to stock trading volume. HCALLOS is a dummy variable that equals 1 if a firm has above-median CALLOS in a given quarter and equals 0 otherwise. Following Bonaim? (2015), I define HDISC as a dummy variable that equals 1 if the observation is from Year 2004 Quarter 1 to Year 2017 Quarter 4 because the modification to SEC Rule 10b-18 was enacted on March 15, 2004. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

Panel A

	REPDUM = 1						
	BHAR						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
HCALLOS	0.162**	0.339***	0.213**	0.219**	1.152***	2.231***	1.960***
	(0.058)	(0.022)	(0.098)	(0.053)	(0.336)	(0.340)	(0.332)
HCALLOS × HDISC	−0.326**	−0.565**	−0.376*	0.122	−1.382***	−2.666***	−2.500***
	(0.237)	(0.231)	(0.227)	(0.232)	(0.350)	(0.356)	(0.348)
Observations	17,890	17,782	17,672	17,543	17,672	17,130	16,756
Adjusted R^2	0.00002	0.0003	0.0001	−0.00005	0.001	0.003	0.003

Panel B

	REPDUM = 1						
	ROA						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
HCALLOS	0.161***	0.198***	0.193***	0.238***	0.198***	0.167***	0.187***
	(0.055)	(0.059)	(0.058)	(0.060)	(0.044)	(0.045)	(0.045)
HCALLOS × HDISC	−0.557***	−0.503***	−0.543***	−0.563***	−0.542***	−0.468***	−0.453***
	(0.058)	(0.062)	(0.061)	(0.062)	(0.046)	(0.047)	(0.047)
Observations	17,934	17,934	17,934	17,934	17,934	17,934	17,934
Adjusted R^2	0.009	0.005	0.007	0.006	0.012	0.008	0.007

Table 16: Difference-in-difference Analysis of At-the-money Options to Stock Volume Ratio Using 2003 Modification to SEC Rule 10b-18

This table presents results from panel regressions that examine how the regulatory change of repurchase disclosure affects the impact of pre-repurchase ATMOS on RETABV (Panel A) and ROAV (Panel B) in post-repurchase windows ranging from Quarter 1 to Year 3. RETABV is the abnormal volatility of stock return. ROAV is the standard deviation of ROA. ATMOS is the natural log of the ratio of at-the-money options trading volume to stock trading volume. HATMOS is a dummy variable that equals 1 if a firm has above-median ATMOS in a given quarter and equals 0 otherwise. Following Bonaim? (2015), I define HDISC as a dummy variable that equals 1 if the observation is from Year 2004 Quarter 1 to Year 2017 Quarter 4 because the modification to SEC Rule 10b-18 was enacted on March 15, 2004. REPDUM is a dummy variable that equals 1 if a firm buys back more than 1% of its total shares in a given quarter and equals 0 otherwise. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors (in parentheses) are robust to firm and quarter fixed and clustering effects.

Panel A

	REPDUM = 1						
	RETABV						
	[Quarter 1]	[Quarter 2]	[Quarter 3]	[Quarter 4]	[Year 1]	[Year 2]	[Year 3]
HATMOS	0.811***	0.739***	0.614***	0.589***	0.686***	0.546***	0.469***
	(0.031)	(0.032)	(0.031)	(0.033)	(0.027)	(0.024)	(0.022)
HATMOS × HDISC	−0.973***	−0.870***	−0.758***	−0.760***	−0.840***	−0.706***	−0.613***
	(0.031)	(0.033)	(0.032)	(0.034)	(0.027)	(0.025)	(0.023)
Observations	17,865	17,759	17,655	17,521	17,672	17,130	16,756
Adjusted R^2	0.052	0.039	0.031	0.028	0.052	0.044	0.041

Panel B

	REPDUM = 1		
	ROAV		
	[Year 1]	[Year 2]	[Year 3]
HATMOS	0.132***	0.095**	0.111***
	(0.033)	(0.044)	(0.043)
HATMOS × HDISC	−0.116***	−0.073*	−0.064
	(0.033)	(0.044)	(0.043)
Observations	17,934	17,934	17,934
Adjusted R^2	0.401	0.488	0.601

Table 17: Descriptive Statistics

This table presents the descriptive statistics of the main variables of this paper. Negative_Skewness is the negative skewness of firm-specific daily returns over the fiscal quarter. Extreme_ND is the number of days with negative extreme firm-specific daily returns over the fiscal quarter. A firm-specific daily return 3.2 standard deviations below the mean firm-specific daily return over the fiscal quarter is considered negative extreme. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. Stock_Turnover is the average daily stock turnover over the fiscal quarter. Institution_Ownership is the proportion of stocks of the firm owned by institutional investors. Analyst is the number of analysts following a stock. Size is the log of the market value of equity. Leverage is the total long-term debt divided by total assets. MB is the market value of equity divided by total assets. Earnings_VOL is the the standard deviation of earnings before extraordinary items (scaled by total assets) over the past 20 quarters. Cash_VOL is the standard deviation of operating cash flows (scaled by total assets) over the past 20 quarters. Sales_VOL is the standard deviation of sales revenue (scaled by total assets) over the past 20 quarters. Beta is the market beta for the firm. RET is the quarterly stock return over the fiscal quarter. Total_VOL is the standard deviation of daily stock returns over the fiscal quarter. Idiosyncratic_VOL is the standard deviation of firm-specific daily returns over the fiscal quarter. All variables are winsorized at the 1% and 99% levels.

	Mean	Std.Dev	Min	Q1	Median	Q3	Max	Skewness
Analyst	10.846	7.259	1.000	5.000	9.000	15.000	51.000	1.037
Beta	1.061	0.474	-21.016	0.783	1.031	1.309	8.127	-0.134
Cash_VOL	0.018	0.071	0.000	0.006	0.011	0.020	5.965	70.646
Earnings_VOL	0.024	0.123	0.000	0.006	0.011	0.024	8.415	51.052
EPS_REP	0.005	0.072	0.000	0.000	0.000	0.000	1.000	13.796
Extreme_ND	0.273	0.470	0.000	0.000	0.000	1.000	3.000	1.344
Idiosyncratic_VOL	0.020	0.012	0.001	0.012	0.017	0.026	0.241	1.871
Institution_Ownership	0.706	0.231	0.001	0.607	0.764	0.875	0.992	-1.330
IV_Skew	0.044	0.035	-0.068	0.025	0.038	0.056	0.261	1.643
Leverage	0.182	0.170	0.000	0.019	0.155	0.292	1.495	0.883
MB	3.596	3.604	0.441	1.578	2.492	4.146	34.417	3.460
Negative_Skewness	-0.190	1.422	-7.442	-0.733	-0.168	0.355	6.935	-0.051
REP	0.006	0.013	0.000	0.000	0.000	0.005	0.092	3.171
RET	0.031	0.204	-0.564	-0.087	0.026	0.139	0.855	0.341
Sales_VOL	0.049	0.063	0.000	0.017	0.034	0.060	2.475	9.226
Size	7.852	1.654	2.708	6.623	7.711	8.962	13.886	0.389
Stock_Turnover	9.901	7.024	1.502	5.199	7.917	12.299	50.789	1.987
Total_VOL	0.025	0.014	0.001	0.015	0.022	0.031	0.201	1.799

Table 18: Effects of EPS-motivated Share Repurchase on Stock Price Crash Risk

This table presents results from panel regressions that examine how EPS-motivated share repurchase affects stock price crash risk. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Crash risk is measured by Negative_Skewness and Extreme_ND. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. Negative_Skewness is the negative skewness of firm-specific daily returns over the fiscal quarter. Extreme_ND is the number of days with negative extreme firm-specific daily returns over the fiscal quarter. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:							
	Negative_Skewness				Extreme_ND			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EPS_REP × REP	−0.240	−0.523*	−0.563*	−0.288	0.018	−0.054	−0.035	−0.141
	(0.282)	(0.283)	(0.304)	(0.280)	(0.091)	(0.092)	(0.099)	(0.093)
EPS_REP	−0.062	−0.057	−0.048	0.023	0.007	0.009	−0.005	−0.002
	(0.055)	(0.055)	(0.059)	(0.055)	(0.018)	(0.018)	(0.019)	(0.018)
REP	9.761***	10.287***	10.703***	7.198***	2.577***	2.708***	2.800***	2.009***
	(0.326)	(0.328)	(0.342)	(0.316)	(0.106)	(0.107)	(0.111)	(0.105)
Size		−0.226***	−0.230***	−0.020**		−0.064***	−0.066***	0.033***
		(0.008)	(0.009)	(0.009)		(0.003)	(0.003)	(0.003)
Leverage		−0.075	−0.051	0.066		−0.006	−0.001	0.014
		(0.046)	(0.049)	(0.045)		(0.015)	(0.016)	(0.015)
MB		0.021	0.023	0.017		0.008	0.008	0.005
		(0.017)	(0.017)	(0.016)		(0.006)	(0.006)	(0.005)
Earnings_VOL			−0.264**	0.008			−0.086**	−0.003
			(0.117)	(0.108)			(0.038)	(0.036)
Cash_VOL			0.338*	−0.028			0.161***	0.024
			(0.183)	(0.169)			(0.060)	(0.056)
Sales_VOL			0.367***	0.511***			0.104***	0.026
			(0.116)	(0.107)			(0.038)	(0.036)
Beta				−0.002				−0.005
				(0.010)				(0.003)
RET				−2.723***				−0.668***
				(0.018)				(0.006)
Total_VOL				−12.675***				−15.000***
				(1.047)				(0.350)
Idiosyncratic_VOL				7.735***				27.151***
				(1.250)				(0.417)
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	152,070	150,746	134,238	134,238	152,104	150,780	134,260	134,238
Adjusted R^2	0.048	0.053	0.052	0.198	0.060	0.064	0.063	0.167

Table 19: Effects of EPS-motivated Share Repurchase on Expected Stock Price Crash Risk

This table presents results from panel regressions that examine how EPS-motivated share repurchase affects expected stock price crash risk. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Expected stock price crash risk is measured by IV_Skew. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:			
	IV_Skew			
	(1)	(2)	(3)	(4)
EPS_REP × REP	13.611***	12.819***	12.644***	11.071***
	(0.554)	(0.555)	(0.578)	(0.564)
EPS_REP	0.200*	0.196*	0.198*	0.159
	(0.107)	(0.107)	(0.113)	(0.110)
REP	−7.959***	−6.907***	−5.966***	−4.344***
	(0.640)	(0.644)	(0.650)	(0.636)
Size		−0.339***	−0.362***	−0.258***
		(0.016)	(0.017)	(0.017)
Leverage		1.479***	1.501***	1.317***
		(0.090)	(0.093)	(0.090)
MB		0.044	0.042	0.040
		(0.034)	(0.033)	(0.032)
Earnings_VOL			−0.597***	−0.481**
			(0.223)	(0.217)
Cash_VOL			2.621***	2.277***
			(0.349)	(0.340)
Sales_VOL			1.954***	1.062***
			(0.221)	(0.216)
Beta				−0.202***
				(0.020)
RET				0.542***
				(0.036)
Total_VOL				137.059***
				(2.109)
Idiosyncratic_VOL				−98.024***
				(2.517)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes
Observations	152,104	150,780	134,260	134,238
Adjusted R^2	0.342	0.347	0.345	0.378

Table 20: Effects of EPS-motivated Share Repurchase on Future Expected Stock Price Crash Risk

This table presents results from panel regressions that examine how EPS-motivated share repurchase affects future expected stock price crash risk. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Future expected crash risk is measured by IV_Skew in 1-4 quarters after the current fiscal quarter. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:			
	IV_Skew[quarter 1]	IV_Skew[quarter 2]	IV_Skew[quarter 3]	IV_Skew[quarter 4]
	(1)	(2)	(3)	(4)
EPS_REP × REP	7.901***	5.830***	3.110***	2.523***
	(0.710)	(0.782)	(0.813)	(0.826)
EPS_REP	−0.151	−0.158	−0.204	−0.394**
	(0.140)	(0.154)	(0.159)	(0.161)
REP	−4.318***	−4.223***	−6.264***	−6.018***
	(0.800)	(0.878)	(0.908)	(0.921)
Size	−0.272***	−0.271***	−0.256***	−0.215***
	(0.022)	(0.024)	(0.025)	(0.025)
Leverage	1.445***	1.430***	1.280***	1.245***
	(0.114)	(0.125)	(0.130)	(0.133)
MB	−0.025	−0.020	−0.014	0.124
	(0.040)	(0.044)	(0.048)	(0.221)
Earnings_VOL	−0.269	−0.416	−2.591***	−3.444***
	(0.277)	(0.310)	(0.351)	(0.355)
Cash_VOL	2.267***	2.755***	6.161***	6.788***
	(0.431)	(0.479)	(0.530)	(0.536)
Sales_VOL	0.800***	0.554*	−0.005	−0.144
	(0.272)	(0.299)	(0.310)	(0.316)
Beta	−0.150***	−0.075***	−0.017	0.028
	(0.025)	(0.027)	(0.028)	(0.028)
RET	0.248***	0.053	−0.053	−0.064
	(0.045)	(0.050)	(0.052)	(0.053)
Total_VOL	111.454***	83.077***	54.128***	35.195***
	(2.653)	(2.913)	(3.007)	(3.045)
Idiosyncratic_VOL	−75.548***	−52.105***	−21.501***	−4.194
	(3.173)	(3.498)	(3.622)	(3.677)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes
Observations	132,488	130,536	128,346	126,030
Adjusted R^2	0.286	0.274	0.276	0.273

Table 21: Effects of Stock Liquidity on Expected Stock Price Crash Risk Induced by EPS-motivated Share Repurchase

This table presents results from panel regressions that examine how stock liquidity affects expected crash risk induced by EPS-motivated share repurchase. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Expected crash risk is measured by IV_Skew. Stock liquidity is measured by Stock_Turnover. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. Stock_Turnover is the average daily stock turnover over the fiscal quarter. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:			
	IV_Skew			
	(1)	(2)	(3)	(4)
EPS_REP × REP × Stock_Turnover	0.393***	0.351***	0.481***	0.423***
	(0.060)	(0.060)	(0.064)	(0.063)
EPS_REP × REP	8.365***	8.050***	6.714***	6.539***
	(0.838)	(0.838)	(0.863)	(0.847)
Stock_Turnover	−2.181***	−1.944***	−2.682***	−2.389***
	(0.342)	(0.342)	(0.367)	(0.360)
EPS_REP	0.127	0.123	0.116	0.126
	(0.107)	(0.107)	(0.112)	(0.110)
REP	−7.742***	−6.710***	−5.961***	−4.412***
	(0.636)	(0.640)	(0.646)	(0.635)
Size		−0.356***	−0.363***	−0.292***
		(0.016)	(0.017)	(0.017)
Leverage		1.258***	1.276***	1.232***
		(0.089)	(0.092)	(0.090)
MB		0.042	0.040	0.040
		(0.034)	(0.033)	(0.032)
Earnings_VOL			−0.576***	−0.492**
			(0.221)	(0.217)
Cash_VOL			2.329***	2.194***
			(0.346)	(0.340)
Sales_VOL			1.374***	0.920***
			(0.220)	(0.215)
Beta				−0.198***
				(0.020)
RET				0.566***
				(0.036)
Total_VOL				133.725***
				(2.115)
Idiosyncratic_VOL				−103.886***
				(2.539)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes
Observations	152,104	150,780	134,260	134,238
Adjusted R^2	0.350	0.355	0.355	0.379

Table 22: Effects of Stock Liquidity on Future Expected Stock Price Crash Risk Induced by EPS-motivated Share Repurchase

This table presents results from panel regressions that examine how stock liquidity affects future expected crash risk induced by EPS-motivated share repurchase. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Future expected crash risk is measured by IV_Skew in 1-4 quarters after the current fiscal quarter. Stock liquidity is measured by Stock_Turnover. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. Stock_Turnover is the average daily stock turnover over the fiscal quarter. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:			
	IV_Skew[quarter 1]	IV_Skew[quarter 2]	IV_Skew[quarter 3]	IV_Skew[quarter 4]
	(1)	(2)	(3)	(4)
EPS_REP × REP × Stock_Turnover	0.632***	0.471***	0.706***	0.419***
	(0.075)	(0.083)	(0.091)	(0.092)
EPS_REP × REP	2.421**	1.317	−4.091***	−2.174*
	(1.054)	(1.162)	(1.222)	(1.240)
Stock_Turnover	−3.549***	−2.629***	−3.972***	−2.352***
	(0.430)	(0.474)	(0.518)	(0.526)
EPS_REP	−0.078	0.059	−0.263*	−0.439***
	(0.135)	(0.149)	(0.159)	(0.161)
REP	−7.380***	−5.535***	−6.812***	−6.143***
	(0.800)	(0.884)	(0.906)	(0.920)
Size		−0.379***	−0.380***	−0.269***
		(0.022)	(0.024)	(0.025)
Leverage		1.295***	1.151***	1.117***
		(0.124)	(0.130)	(0.133)
MB		−0.020	−0.013	0.139
		(0.047)	(0.048)	(0.221)
Earnings_VOL			−2.667***	−3.487***
			(0.351)	(0.355)
Cash_VOL			6.114***	6.699***
			(0.530)	(0.536)
Sales_VOL			0.002	−0.362
			(0.310)	(0.316)
Beta				0.032
				(0.028)
RET				−0.026
				(0.053)
Total_VOL				29.888***
				(3.056)
Idiosyncratic_VOL				−13.299***
				(3.709)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes
Observations	150,053	146,451	128,368	126,030
Adjusted R^2	0.271	0.275	0.275	0.275

Table 23: Effects of Institutional Ownership on Expected Stock Price Crash Risk Induced by EPS-motivated Share Repurchase

This table presents results from panel regressions that examine how institutional ownership affects expected crash risk induced by EPS-motivated share repurchase. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Expected crash risk is measured by IV_Skew. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. Institution_Ownership is the proportion of stocks of the firm owned by institutional investors. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:			
	IV_Skew			
	(1)	(2)	(3)	(4)
EPS_REP × REP × Institution_Ownership	-1.991*	-1.400*	-2.882**	-0.747*
	(2.219)	(2.224)	(2.369)	(2.310)
EPS_REP × REP	12.299***	11.925***	10.793***	10.603***
	(1.511)	(1.516)	(1.632)	(1.591)
Institution_Ownership	−11.837	−8.096	−16.345	−3.892
	(12.691)	(12.720)	(13.553)	(13.213)
EPS_REP	0.201*	0.196*	0.199*	0.160
	(0.107)	(0.107)	(0.113)	(0.110)
REP	−8.009***	−6.923***	−5.934***	−4.257***
	(0.641)	(0.645)	(0.651)	(0.636)
Size		−0.336***	−0.366***	−0.269***
		(0.016)	(0.017)	(0.017)
Leverage		1.479***	1.501***	1.318***
		(0.090)	(0.093)	(0.090)
MB		0.044	0.041	0.038
		(0.034)	(0.033)	(0.032)
Earnings_VOL			−0.588***	−0.465**
			(0.223)	(0.217)
Cash_VOL			2.608***	2.255***
			(0.349)	(0.340)
Sales_VOL			1.957***	1.069***
			(0.221)	(0.216)
Beta				−0.202***
				(0.020)
RET				0.547***
				(0.036)
Total_VOL				136.972***
				(2.109)
Idiosyncratic_VOL				−97.719***
				(2.518)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes
Observations	152,104	150,780	134,260	134,238
Adjusted R^2	0.342	0.347	0.345	0.378

Table 24: Effects of Institutional Ownership on Future Expected Stock Price Crash Risk Induced by EPS-motivated Share Repurchase

This table presents results from panel regressions that examine how institutional ownership affects future expected crash risk induced by EPS-motivated share repurchase. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Future expected crash risk is measured by IV_Skew in 1-4 quarters after the current fiscal quarter. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. Institution_Ownership is the proportion of stocks of the firm owned by institutional investors. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:			
	IV_Skew[quarter 1]	IV_Skew[quarter 2]	IV_Skew[quarter 3]	IV_Skew[quarter 4]
	(1)	(2)	(3)	(4)
EPS_REP × REP × Institution_Ownership	1.162	1.377	4.463	3.321
	(2.790)	(3.086)	(3.345)	(3.390)
EPS_REP × REP	9.473***	6.504***	1.280	0.399
	(1.901)	(2.105)	(2.308)	(2.340)
Institution_Ownership	−6.924	−7.750	−24.998	−18.249
	(15.960)	(17.651)	(19.136)	(19.391)
EPS_REP	0.005	0.134	−0.172	−0.393**
	(0.136)	(0.150)	(0.160)	(0.161)
REP	−7.642***	−5.694***	−6.688***	−5.832***
	(0.804)	(0.888)	(0.909)	(0.922)
Size		−0.369***	−0.397***	−0.235***
		(0.023)	(0.024)	(0.026)
Leverage		1.516***	1.375***	1.248***
		(0.124)	(0.130)	(0.133)
MB		−0.019	−0.017	0.119
		(0.047)	(0.048)	(0.221)
Earnings_VOL			−2.628***	−3.412***
			(0.352)	(0.355)
Cash_VOL			6.319***	6.744***
			(0.532)	(0.536)
Sales_VOL			0.589*	−0.130
			(0.310)	(0.316)
Beta				0.029
				(0.028)
RET				−0.054
				(0.053)
Total_VOL				35.052***
				(3.045)
Idiosyncratic_VOL				−3.594
				(3.678)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes
Observations	150,053	146,451	128,368	126,030
Adjusted R^2	0.265	0.270	0.270	0.273

Table 25: Effects of Analyst Coverage on Expected Stock Price Crash Risk Induced by EPS-motivated Share Repurchase

This table presents results from panel regressions that examine how analyst coverage affects expected crash risk induced by EPS-motivated share repurchase. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Expected crash risk is measured by IV_Skew. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. Analyst is number of analysts following a stock. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:			
	IV_Skew			
	(1)	(2)	(3)	(4)
EPS_REP × REP × Analyst	-1.064***	-1.028***	-0.904***	-0.762***
	(0.092)	(0.092)	(0.098)	(0.095)
EPS_REP × REP	5.448***	5.038***	5.736***	5.183***
	(0.901)	(0.904)	(0.939)	(0.915)
Analyst	−6.101***	−5.881***	−5.175***	−4.361***
	(0.523)	(0.528)	(0.560)	(0.546)
EPS_REP	0.197*	0.187*	0.188*	0.156
	(0.107)	(0.107)	(0.113)	(0.110)
REP	−7.434***	−6.698***	−5.812***	−4.224***
	(0.640)	(0.643)	(0.648)	(0.633)
Size		−0.319***	−0.337***	−0.232***
		(0.017)	(0.018)	(0.018)
Leverage		1.456***	1.491***	1.302***
		(0.090)	(0.093)	(0.090)
MB		0.045	0.043	0.041
		(0.034)	(0.033)	(0.032)
Earnings_VOL			−0.241	−0.180
			(0.246)	(0.239)
Cash_VOL			3.116***	2.616***
			(0.401)	(0.390)
Sales_VOL			1.705***	0.852***
			(0.224)	(0.218)
Beta				−0.201***
				(0.020)
RET				0.538***
				(0.036)
Total_VOL				137.674***
				(2.102)
Idiosyncratic_VOL				−98.718***
				(2.512)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes
Observations	151,113	149,793	133,333	133,311
Adjusted R^2	0.343	0.348	0.346	0.379

Table 26: Effects of Analyst Coverage on Future Expected Stock Price Crash Risk Induced by EPS-motivated Share Repurchase

This table presents results from panel regressions that examine how analyst coverage affects future expected crash risk induced by EPS-motivated share repurchase. EPS-motivated share repurchase is measured by the interaction term of ESP_REP and REP. Future expected crash risk is measured by IV_Skew in 1-4 quarters after the current fiscal quarter. EPS_REP is a dummy variable that equals 1 if the firm would have an EPS lower than the previous quarter without the share repurchase and 0 otherwise. REP is the amount of quarterly actual share repurchase scaled by total assets. IV_Skew is the average daily implied volatility skew over the fiscal quarter, where the daily implied volatility skew is the difference between the implied volatility of OTM put options and that of ATM call options. Analyst is the number of analysts following a stock. Please see Table 1 for the definition of the control variables. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable:			
	IV_Skew[quarter 1]	IV_Skew[quarter 2]	IV_Skew[quarter 3]	IV_Skew[quarter 4]
	(1)	(2)	(3)	(4)
EPS_REP × REP × Analyst	-1.256***	-1.219***	-0.951***	-0.658***
	(0.114)	(0.127)	(0.137)	(0.138)
EPS_REP × REP	0.214	2.425*	3.035**	2.665**
	(1.131)	(1.250)	(1.327)	(1.350)
Analyst	−7.196***	−6.971***	−5.439***	−3.763***
	(0.655)	(0.724)	(0.781)	(0.791)
EPS_REP	0.026	0.146	−0.209	−0.410**
	(0.135)	(0.149)	(0.159)	(0.161)
REP	−7.157***	−5.653***	−6.644***	−5.825***
	(0.801)	(0.884)	(0.903)	(0.919)
Size		−0.358***	−0.372***	−0.210***
		(0.023)	(0.025)	(0.027)
Leverage		1.477***	1.336***	1.242***
		(0.124)	(0.130)	(0.133)
MB		−0.017	−0.010	0.138
		(0.046)	(0.048)	(0.220)
Earnings_VOL			−2.032***	−3.193***
			(0.396)	(0.401)
Cash_VOL			5.111***	6.129***
			(0.607)	(0.615)
Sales_VOL			0.601*	−0.160
			(0.313)	(0.319)
Beta				0.024
				(0.029)
RET				−0.046
				(0.053)
Total_VOL				34.951***
				(3.037)
Idiosyncratic_VOL				−4.142
				(3.672)
Firm Fixed Effect	Yes	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes	Yes
Observations	149,125	145,590	127,621	125,332
Adjusted R^2	0.265	0.271	0.270	0.273

APPENDICES

Methodogy of Estimating Abnormal Volatility

Denoting the price of the security on quarter t as P_t and that of the market index as M_t, the market model in the GARCH(1,1) form can be written as:

$$ln\frac{P_{t+1}}{P_t} = \alpha + \beta * ln\frac{M_{t+1}}{M_t} + \eta_{t+1}, \eta_{t+1} \sim N(0, h_{t+1}), \tag{13}$$

$$h_{t+1} = a_0 + b_1 * h_t + a_1 * \eta_t^2. \tag{14}$$

This model is based on a continuous-time diffusion with mean-reverting volatility. The vectors of estimated errors η_t and their variances h_t are used in the abnormal volatility estimation, as discussed in the following paragraphs.

Two types of factors determine the level of unsystematic volatility at quarter t of the event window: security specific (time drift of instantaneous returns, correlation with the market, long-run volatility mean, etc.) and event specific. Security-specific factors are independent of the event and are captured by the model for the security price process. Because h_{t+1} in equation (14) depends only on the parameters governing the price process, it ignores the effect of the event.

We use the parameter $\lambda > 0$ to measure the effect of the given event on the unsystematic volatility of a security's returns. The parameter λ measures the multiple by which the unsystematic volatility increases from its no-event level due to the event. For example, if $\lambda = 1$, the event has no effect, whereas if $\lambda = 2$, the unsystematic volatility is doubled. Volatility decreases if $\lambda < 1$.

The estimate of λ_t for quarter t can be obtained by computing the cross-sectional variance of the standardized GARCH(1,1) residuals in equation (13). If the event has no effect on the securities's abnormal volatilities on quarter t, the cross-sectional variance of the standardized residuals should be equal to 1. The use of cross-sectional data is justified because the same type of event is af- fecting all securities in the sample. Additionally, the event effect on a security's volatility would be hard to distinguish from noise if only that security's data were used. Just as in traditional event study of returns the cross-section is needed to assess the average abnormal return, it is needed here to assess abnormal volatility.

For the N security sample

$$\hat{\lambda}_t = \frac{1}{N-1}\sum_{i=1}^{N}\frac{(\hat{\eta}_{i,t} - 1/N\sum_{j=1}^{N}\hat{\eta}_{j,t})^2}{(N-2)/N * \hat{h}_{i,t} + 1/N^2\sum_{j=1}^{N}\hat{h}_{j,t}} \tag{15}$$

The estimator of the cumulative abnormal volatility between event quarters k and m is the sum of the individual estimators:

$$C\hat{\lambda_{k,m}} = \sum_{t=k}^{m}(\hat{\lambda}_t - 1) \qquad (16)$$

2003 Modification to SEC Rule 10b-18

The SEC recently amended the stock repurchase safe harbor rule under Rule 10b-18 of the Securities Exchange Act of 1934, which provides an issuer with a safe harbor from liability for repurchases of its common stock if the issuer complies with the rule's manner, timing, price and volume conditions. The amendments to Rule 10b-18 simplify and update the safe harbor provisions to reflect market changes that have developed since Rule 10b-18's adoption in 1982, and require more rapid and regular disclosure of issuer repurchases.

Amendments to Rule 10b-18's "Safe Harbor"

Amended Rule 10b-18 continues to provide an issuer with a safe harbor from liability for manipulation of its stock price (under Section 9(a)(2), Section 10(b) and Rule 10b-5 of the Exchange Act) when repurchasing its shares in the open market. To qualify for the safe harbor for any given day, an issuer must satisfy each of the manner, timing, price and volume conditions of the rule. If an issuer fails to meet any one of the four conditions, the issuer's purchases are disqualified from the safe harbor for that day. Amended Rule 10b-18 expands eligibility for the safe harbor and alters the timing, price and volume conditions mainly to allow issuers whose securities are less susceptible to manipulation to stay in the market longer and to repurchase a greater number of shares during periods of severe market decline.

Definition of Eligible Securities Expanded

The amendment expands the definition of a Rule 10b-18 purchase to include any bid or limit order that would effect such a purchase, continues to apply to purchases by or for an issuer or any affiliated purchaser of the issuer, and codifies the position that the safe harbor is available for repurchases of all common equity securities including units of beneficial interests in a trust or limited partnership or depository shares. The amended rule continues to be unavailable for repurchases involving securities that are not common equity securities, such as preferred stock, warrants, rights, convertible debt securities, options or security futures products, and repurchases effected in markets outside of the United States.

Price Condition Made Uniform

Prior to these amendments, Rule 10b-18's price limitations varied depending on the market for the security. The amended rule applies a uniform price condition regardless of where the securities are traded. Under amended Rule 10b-18, issuers may repurchase their securities at a price that does not exceed the highest independent bid or the last independent transaction price, whichever is higher, reported in the consolidated system.

Volume Limitations Amended to Include Block Repurchases

Prior to these amendments, Rule 10b-18 limited an issuer' s daily repurchases to a maximum of 25% of the average daily trading volume of its shares. Because block purchases were not subject to this volume limitation, and shares repurchased in block trades were not included in calculating the average daily trading volume, issuers could make unlimited block repurchases. Under amended Rule10b-18, issuers must include block repurchases in their calculation of the 25% average daily trading volume limitation, and can include these block repurchases in calculating the average daily trading volume for the security, which increases the amount of stock that some issuers may repurchase within the safe harbor. Amended Rule 10b-18 also allows issuers to repurchase one block per week, in lieu of complying with the 25% average daily trading volume limitation, provided that the issuer does not make any other Rule 10b-18 purchases on that day. However, the issuer may not use the volume increase from such a block repurchase to increase its 25% average daily trading volume limitation.

Issuers Must Disclose Repurchases in Periodic Reports

An issuer must disclose in its periodic reports all repurchases of equity securities, regardless of whether the transactions are within the Rule 10b-18 safe harbor. Issuers are required to disclose, among other things, the total number of shares repurchased, the average price paid per share, the number of shares repurchased as part of a publicly announced plan or program, and the maximum number (or approximate dollar value) of shares that may yet be purchased under the plans or programs. Both open market and private transactions must be disclosed in a new table required in Item 2(e) of Forms 10-Q and 10-QSB, Item 5(c) of Forms 10-K and 10-KSB, and in Form 20-F pursuant to new Item 703 of Regulations S-K and S-B. The table includes required disclosure of all issuer repurchases of equity securities during its last fiscal quarter. In addition, an issuer must disclose in footnotes to the table the principal terms of publicly announced repurchase plans or programs.

Effective Date

Amended Rule 10b-18 became effective on December 17, 2003. The new repurchase disclosure will be required in reports on Forms 10-Q, 10-QSB, 10-K and 10-KSB filed for periods ending on or after March 15, 2004 (and in reports on Form 20-F for fiscal years ending on or after December 15, 2004).

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