On the relation between Actual Share Repurchases and Investor Attention

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Abstract

This thesis examines the relation between share repurchases and investor attention by using different measures of share repurchase intensity and investor attention for U.S. firms. I find evidence that the relation between repurchase activity and investor attention differs between individual and institutional investor attention. While the relation between individual attention and share repurchases tends to be negative, results on institutional attention show a positive relation. For both measures of attention, institutional attention in particular, the results show that firms can improve price efficiency, reduce idiosyncratic risk and increase upward price pressure by performing share repurchases during times of low attention. As institutional attention significantly changes short-selling of a stock, share repurchases may be used to offset potential downward pressure on the stock price. I do not find evidence that undervaluation drives the positive relation between institutional attention and share repurchases. Consequently, there may exist other factors related to institutional behavior explaining the positive relation between institutional attention and repurchase activity.

Keywords: Share repurchases, investor attention, price efficiency, idiosyncratic risk, institutional trading

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Table of Contents

List of Figures

List of Tables

Appendices

1. Introduction

The dominance of share repurchases in corporate payout policies is growing. Share repurchases provide more flexibility compared to dividend payments. In addition, the possibility to adjust share repurchases to increase earnings per share and timing the market is preferred by most managers. This growing role of share repurchases is supported by evidence from Busch and Obernberger (2016) that share repurchases accounted for approximately 58% of total corporate payouts between 2004 and 2010. In line with this growing impact, the academic literature on share repurchases is increasing as well.

As frequent information on actual share repurchases, especially in U.S., is only available since several years, most of the research is focused on the announcement effects of share repurchases. A recent paper by Busch and Obernberger (2016), focused on actual repurchases, documents price support at fundamental values as a potential motivation behind share repurchases, this price support induces a higher information content of stock prices. These findings are further supported by the paper of Liu and Swanson (2016), which states that price support using share repurchases is most pronounced in months with low stock returns proxying for undervaluation. In this context, literature on the role of investor attention is growing. Findings from Da, Engelberg and Gao (2011) support the consensus that this undervaluation, or mispricing, is potentially due to a lack of investor attention. They find evidence that an increase in investor attention increases the incorporation of information in prices.

The objectives of this thesis are twofold. First, my aim is to address investor attention as a motive behind share repurchases. Existing literature provides evidence for share repurchases being more pronounced during times of relatively low investor attention. Firms may use share repurchases as a tool to support prices when investor attention turns out to be insufficient. Second, I compare and distinguish individual investor attention and institutional investor attention by using two different proxies for investor attention.

I formulate three hypotheses on the impact of share repurchases on investor attention. First, I hypothesize that share repurchases increase when investor attention is relatively low. This means that firms will increase their share repurchases when the level of attention for the firms' stock is relatively low. Hou and Moskowitz (2005) find that delay and investor attention / recognition are negatively related. In addition, Busch and Obernberger (2016) find that share repurchases reduce delay of in the incorporation of information in stock

prices. So, based on the combined results of both studies, it is reasonable to think that firms with relatively low investor attention will increase their share repurchases.

Second, I hypothesize that the relation between share repurchases and investor attention is not uniform for individual and institutional investors. Informational differences (Barber and Odean, 2005) and different investor preferences (Grinstein and Michaely, 2005) may cause the relation to differ between both groups of investors.

Finally, I hypothesize that the relation between share repurchases and investor attention is positive for institutional investors. The growing impact of institutional power (Ryan and Schneider, 2003), simultaneous trading on undervalued stocks and institutional short-selling (Liu and Swanson, 2016) predict that share repurchases increase with institutional attention.

To analyze these hypotheses, I collect quarterly share repurchase data from the 1st of January 2007 until the 31st of December 2017 from Compustat. In addition, I collect individual attention data from Google Trends and institutional attention data from Bloomberg. The final sample consists of 85.364 firm-quarters from 3.368 firms. As the Bloomberg attention measure is only available from 2010 onwards, this sample consists of 58.028 firm-quarters divided over 2.775 firms.

I construct two groups for measuring investor attention, one for individual investor attention and one for institutional investor attention. I follow Da, Engelberg and Gao (2011) to construct my measure for individual investor attention. Using Google Trends, I calculate the monthly Google search volume (GSVI) for each firm. These monthly data are then transformed into quarterly data points. For data on abnormal institutional investor attention I follow the paper of Ben-Rephael, Da and Israelsen (2017) and obtain the daily average readership from Bloomberg. These daily readership data are averaged into quarterly observations. As, according to Ben-Rephael, Da and Israelsen (2017), the Google attention data and Bloomberg attention data explain less than 2% of each other's variation, these proxies allow for a comparison between both.

The construction of the three quarterly repurchase measures is based on the paper of Banyi, Dyl and Kahle (2005). The first measure is created by taking the purchase of common and preferred stock from Compustat and correcting this measure for changes in preferred stock. The second measure is derived from CRSP and is defined as the change in quarterly shares outstanding. Both measures prove to be the most accurate in the before mentioned

paper. The final measure uses the relatively new line of purchased common stock from Compustat. Following the paper of Busch and Obernberger (2016), all measures are scaled by quarterly shares outstanding. To relate both share repurchases and investor attention to the existing literature on price efficiency and price support, I follow the methodology of Hou and Moskowitz (2005) and create variables on the incorporation of information into stock prices.

I find that there exists no uniform relation between share repurchases and investor attention. The results show a significant, negative relation between individual attention and share repurchases. In contrast, the results on institutional attention show that share repurchase activity increases significantly with attention. Regarding differences between up and down-markets, I observe no differences between these conditions for both attention measures. Looking at the economic significance of these results, the effects are quite limited. The relation between individual investor attention and share repurchases is in line with existing literature on price support. Low investor attention indicates that investors stay away from a firm's stock. This investor neglect may cause stock prices to move away from their fundamental values (Hou and Moskowitz, 2005). Firms can partly offset this effect of investor neglect by increasing their share repurchases. These results are further supported by the results on price efficiency and idiosyncratic risk. Using an interaction variable of share repurchases and investor attention, I find that firms are able to increase price efficiency and reduce idiosyncratic risk during times of low attention. This effect is not observed during times of high attention. The results on institutional attention show a similar effect on price efficiency and idiosyncratic risk during times of low attention. This evidence shows that the positive relation between share repurchases and institutional attention is not driven by price efficiency. For this reason, I study several other factors that may support this positive relation between both. One of these factors may be the increase in institutional investor power, documented by Ryan and Schneider (2003). As institutional investors gain more power, the potential impact of these institutions on a firm's corporate governance (e.g. payout policy) may increase. Another example of such an effect related to institutional behavior is that firms increase share repurchases to meet on institutional return requirements and thereby substantially increase trading on their stock. This last example is supported by results from this analysis that institutional attention causes trading, whereas individual attention does not. Furthermore, the results in this analysis show that investor attention is positively related to the change in short interest of a stock. In particular, when institutional attention rises, so does

the change in short sales. In this context, an increase in share repurchases may be motived to offset downward pressure on the stock price. However, the effect of institutional attention on share repurchases is robust to including this factor in the analysis.

As trading on undervalued stocks is another potential factor that drives the positive relation between institutional attention and share repurchases, I examine the returns of portfolios on share repurchases and institutional attention. I do not find evidence that institutional trading on, and repurchasing of undervalued stocks appear simultaneously. What other factors are involved in this positive relation between both remains open for further research.

To identify the robustness of these results, I include several robustness checks in my analysis. As there exist a potential reversed effect from share repurchases on investor attention, I perform additional analysis using lagged investor attention. For most of the observations, the results remain qualitatively the same. As investor attention from Google is available for a larger sample period, I test whether this relation also holds in the 2010 – 2017 sample, which is the case. Furthermore, I show that results are not driven by unobserved liquidity factors. Finally, I show that results are robust to excluding firm-quarters with a value of zero for individual investor attention.

My study is closely related to the literature on the role of investor attention in corporate decision making. It will contribute to the existing literature in several ways. First, to the best of my knowledge, Bloomberg's investor attention measures have not yet been used to study actual share repurchases before. This measure provides a better understanding of the impact of institutional investor attention. Second, while Google's SVI has been used to study corporate events and even share repurchases before, most of these studies focus on announcement effects and post-announcement drifts. By studying actual repurchases, a potential causal relation between share repurchases and individual investor attention is addressed more accurate. Finally, my study is the first to study two measures of institutional investor attention and individual investor attention simultaneously. In the end, my aim is to contribute to the literature around share repurchases and obtain insights about the role of investor attention.

The remainder of this thesis is organized as follows. Chapter 2 describes the existing literature on both share repurchases and the role of investor attention in corporate events. Chapter 3 discusses the formation of hypotheses. Chapter 4 describes the formation of the

sample and elaborates further on the methodology used in this analysis. Chapter 5 discusses the empirical results from the analysis and relates these results to the existing literature. Chapter 6 concludes. Chapter 7 presents limitations of the analysis and provides recommendations for further research.

2. Theoretical framework

Share repurchases have become a popular alternative to dividend payment to distribute earnings to shareholders. Important reasons for this increased popularity are change in legislation and the relative flexibility of share repurchases in comparison to dividends. Furthermore, dividends create the obligation to distribute the earnings immediately whereas share repurchases do not create such an obligation. As of 2005, share repurchases first exceeded dividends as the dominant tool to redistribute cash to shareholders. Literature on share repurchases, especially actual share repurchases, is still relatively scarce. To provide a deeper understanding of why firms choose share repurchases, I first touch upon some basics of share repurchases and outline the underlying motivations. Thereafter, I discuss the literature on share repurchase characteristics and U.S. regulation. Finally, I discuss the potential role of investor attention.

2.1 Basics of share repurchases

As mentioned before, firms can choose between dividends or repurchasing shares to distribute earnings to shareholders. When using repurchases, there are four ways in which this is usually carried out: open-market repurchases, tender offers, Dutch auctions and privately negotiated repurchases.

The most commonly used method for a repurchase is an open-market repurchase program. According to Grullon and Ikenberry (2000) around 90% of all repurchases is performed in the open market. When using the open-market method, a firm announces that it intends to buy back a predetermined number of shares or (Dollar) volume within a certain time period. Important to realize is that this does not create the obligation to follow-up on this announcement. Instead, a firm may decide to extend or terminate the program.

A tender offer is a proposal by the firm to purchase shares from shareholders in the firm. One of the key advantages of a tender offer is the fixed price. A tender offer consists of an offer price, the number of shares to be purchased and the expiration date of the offer. When the tender offer is announced, shareholders decide if they find the offer sufficient and if they want to tender (part of) their shares. When the number of tendered shares is below the desired number by the firm, the firm may choose to cancel the offer. In contrast, when

the tender offer is oversubscribed, the firm purchases shares proportionally to the initial tendering shares per shareholder.

The Dutch auction was introduced in 1981 and is an alternative form of tender offer. This method specifies a price range within which shares are purchased. Shareholders are allowed to tender their shares at any price within this price range. At the end of the auction period, the firm purchases at the lowest price that allows the firm to buy the desired number of shares. The firm pays this price to all shareholders that tendered at or below this price. Again, if too few shares are tendered, the firm has the opportunity to cancel the offer. If the auction is oversubscribed, the firm repurchases the number of shares it desires at or below the purchase price from shareholders that tendered on a value in the range below this purchase price.

Finally, a privately negotiated repurchase is a less common method to perform the share repurchase. In this privately negotiated deal, a firm often buys from a single major shareholder. Motivations behind privately negotiated repurchases include purchasing back shares from a hostile bidder (targeted repurchase) and purchasing (large numbers of) shares privately due to illiquid stock market conditions.

As most share repurchases are performed in the open-market, this thesis will primarily study open-market share repurchases. As open-market share repurchases account for approximately 90% of all repurchases, limiting the scope to only open-market repurchases will still yield representative results. Furthermore, open-market repurchases allow for a more extensive stock price analysis following the announcement.

2.2 Motivations behind share repurchases

Existing literature on share repurchase provides a long list of motivations behind the repurchase. Examples include takeover defenses, substitution of dividends and capital structure adjustment. To get a better understanding of stock price development it is worth looking deeper into repurchase motivation. The following section will outline these motivations to perform a share repurchase.

2.2.1 Dividend substitution

Grullon and Michaely (2002) state that firms use funds for share repurchases that would otherwise be used for the payment of dividends. Firms' management can create shareholder

value when they take the tax differential in mind. According to Grullon and Michaely, the tax differential between capital gains and dividend payments creates a preference for share repurchases over dividends by investors. In addition, investors are able to postpone their tax payments on capital gains as capital gains are taxed when the shares are sold. While the paper of Grullon and Michaely provides strong evidence in favor of the substitution hypothesis, it is important to realize that there is a large counterpart of papers that do not find evidence for the substitution hypothesis (e.g. Dittmar (2000), and Allen, Bernardo and Welch (2000)).

2.2.2 Optimal capital structure

According to Dittmar (2000) firms may use share repurchases to reach their optimal leverage ratio. Share repurchases redistribute a firms' capital back to shareholders, thereby reducing its equity and increasing the leverage ratio. If an optimal leverage ratio exists, firms that are below their optimal leverage ratio are more likely to perform share repurchases. This reflects the potential role of a firms' capital structure on the decision to repurchase.

2.2.3 Signaling

According to Vermaelen (1981), the most important motivation behind share repurchases is signaling. The signaling theory is based on asymmetric information between a firm's managers and the market. A share repurchase announcement is considered a valuable signal for the less informed market. It can be used by managers to signal their positive prospects about a firm's opportunities. If the market is efficient, prices should react immediately. As a result, the new equilibrium price should reflect the full true value of the newly received information. In addition, no additional wealth transfer should occur (Ikenberry , Lakonishok and Vermaelen ,1995). The most mentioned reason to perform share repurchases by managers, undervaluation, is consistent with this signaling theory. Yet, if prices adjust immediately, the motivation to perform the repurchase is taken away. Surprisingly however, most of the times managers do not cancel the repurchase, suggesting that the market reaction is insufficient and will not process all information immediately. Literature around corporate events has documented similar market reactions around IPOs (Ritter, 1991) and seasoned equity offerings (Loughran and Ritter, 1995).

2.2.4 Distribution of excess capital

When a firm has excess cash after all investment opportunities have been exhausted, it may choose to retain this cash or choose to redistribute it to their shareholders. Because the incentives of shareholders and management are often not perfectly aligned, retaining cash may induce managers to use this cash in their own interests. This is referred to as an agency conflict, Jensen (1986). Share repurchases are potentially an effective tool to reduce these agency conflicts by redistributing excess cash to shareholders. Like repurchasing, dividends are another tool to distribute this excess cash. However, as mentioned earlier, repurchases have the advantage of not creating a commitment and signal that the distribution of cash is non-regular. Therefore, firms may prefer repurchases over dividends to distribute excess funds.

2.2.5 Takeover deterrence

Dittmar (2000) documents share repurchases as a potential tool to prevent corporate takeover by increasing the minimum price that has to be paid by the acquiror. Using the upward sloping supply curve and investor heterogeneity, buying back own shares will increase the takeover costs for the acquiror. For this reason, firms that experience high takeover risk are more likely to perform a repurchase.

2.2.6 Dilution of earnings per share

While the use of dividends to distribute excess capital may dilute earnings per share (EPS), share repurchases offer a way to distribute funds without diluting EPS. Therefore, companies may induce a share repurchase to redistribute capital to shareholders. Bens, Nagar, Skinner and Wong (2003) investigate whether repurchase decisions are affected by earnings per share dilution. They find that share repurchases increase with the dilutive effect of stock options. While managers are often granted stock options, performing share repurchases is also in their own best interest. So, firms rewarding their management with stock options may have a larger incentive to perform a share repurchase.

2.2.7 Undervaluation

A firm's undervaluation is often referred to as an of the most important reasons to induce a share repurchase. As stated by Ikenberry, Lakonishok and Vermaelen (1995), the

undervaluation hypothesis is based on asymmetric information between managers and investors. This asymmetric information may cause the firm to be misvalued. If managers believe that the firm is undervalued, they will often buy back shares to signal this undervaluation to investors. As the market receives this action as a signal of undervaluation, the positive price reaction following the announcement should correct for any undervaluation. However, as documented the paper of Ikenberry, Lakonishok and Vermaelen (1995), the price reaction following the repurchase announcement is often not sufficient. The paper documents a 4-year positive abnormal return following share repurchase announcements, thereby providing evidence of an insufficient market reaction. Firms have to think strongly about their market position before inducing a share repurchase in order to reach the desired positive price effect.

2.2.8 Market timing

More recent research on share repurchases by Dittmar and Field (2015) documents the ability of managers to time the market. They find that firms pay a significant lower price than the average market price when repurchasing. Furthermore, this effect is stronger for firms that repurchase less frequently and when repurchases are aligned with insider trading. An important reason for a firm buying back its own shares in this context may be related to the paper of Peyer and Vermaelen (2008). They document that firms buy back shares because they believe that the market has overreacted to negative news. Dittmar and Field find support for this finding, by documenting evidence of firms timing repurchases after a stock price downturn. They document similar timing ability of firms following aggregate market downturns.

2.2.9 Analysts' earnings per share forecasts

While most of the previously mentioned motivations are supported by a broad range of academic papers, the use of share repurchases for earnings management receives less coverage. The paper of Hribar, Jenkins and Johnson (2006) examines the relation between share repurchases and analysts' earnings per share forecasts. The authors document a significant larger number of share repurchases among firms that would have missed analysts' earnings per share (EPS) forecasts if they did not perform the repurchase. While the repurchase related part of an EPS surprise is discounted by investors, as investors recognize

this benchmark beating behavior, it mitigates some of the negative price shock that would have been appeared otherwise. These findings indicate that acting based on analysts' forecasts may influence a firm's repurchase decision.

2.2.10 Price support

Short selling has recently been used by Liu and Swanson (2016) to investigate whether firms provide price support using share repurchases when their equity is overvalued. Previous empirical research has shown that short sellers are often highly skilled in identifying overvalued equity. One reason for this high skill level is that 74% of all short sales is performed by institutional investors and hedge funds. In contrast, individual investors account for only 2% of the short sales performed (Boehmer, Jones and Zhang, 2008). Liu and Swanson interpret an increase in short interest, combined with an increase in share repurchases, as firms providing price support to their equity. Supported by a continuously found positive relation between change in short interest and change in share repurchases, the results in the paper confirm that price support is an important potential motivation behind share repurchases. The most important difference between the use of short interest and other measures to study this relation, is that short interest provides a direct measure at the time of decision making. Previous studies have only studied the topic indirectly or using ex-post measures such as subsequent returns.

2.3 Characteristics of share repurchases

This section discusses the existing literature on share repurchases. Abnormal returns following share repurchases have been an important research topic, and results show different developments of these returns in the cross-section and over time. Furthermore, existing literature documents interesting results concerning repurchase characteristics (e.g. size and frequency).

2.3.1 Abnormal returns following share repurchases

One of the first papers to conclude about both open-market repurchases as tender offers is Vermaelen (1981). The paper documents a permanent price increase of firms repurchasing their own shares. This effect is mainly attributed to the information (signaling) hypothesis, stating that firms repurchase shares when they are positive about future growth

opportunities. Important to note in this context is that the results of Vermaelen (1981) are less conclusive for open-market share repurchases. This may be caused by the minor role of open-market repurchases at the time, compared to dividends and tender offers.

Lakonishok and Vermaelen (1990) build upon the paper of Vermaelen (1981) and study almost all tender offers performed between 1962 and 1986. The authors find that repurchasing firms experience significant abnormal returns following the repurchase. A simple trading strategy around tender offers yields abnormal returns around 9 percent within the time period of a week. These abnormal returns are mainly present for small firms in the sample, explained by less analyst coverage and thus higher potential undervaluation. Small firms earn negative returns prior to the repurchase and positive abnormal returns afterwards. In contrast, large firms earn positive abnormal returns before the announcement and no significant returns afterwards. This implicates motivational differences between small and large firms regarding repurchases. Like in the paper of Vermaelen (1981) results indicate that firm size is an important factor to include in share repurchase analysis.

Looking at abnormal returns in the long-run, Ikenberry, Lakonishok and Vermaelen (1995) hypothesize that share repurchase announcements are treated with care by the market, causing prices to adjust slowly. Where previously mentioned studies concluded mostly about tender offers, this paper focusses on open-market share repurchases. In contrast to the efficient market theory, they find that information around repurchase announcement is almost entirely ignored by the market. This is supported by a 12.1% abnormal return of a buy-and-hold return portfolio over the next four years of the repurchase announcement. In particular high book-to-market (value) firms seem to explore high abnormal performance following the repurchase announcement, thereby introducing book-to-market as another important control variable. In contrast to low book-to-market firms, which do not experience abnormal returns following a repurchase announcement, high book-to-market firms beat their peers by 45.3% in the four years after the announcement.

An interesting question is whether these abnormal returns are still present in more recent studies. Using more recent data, Peyer and Vermaelen (2008) still find evidence of the post-announcement drift following share repurchase announcements. Their results are in contrast to the paper of Schwert (2003), which documents that the share repurchase anomalies disappeared. Due to criticism on the buy-and-hold method in previous papers by Fama (1998) and Mitchell and Stafford (2000), the authors choose different methods to

perform their study. Using the returns across time and security (IRATS) method and the Fama-French (1993) calendar-time approach they find that long-term abnormal returns following share repurchase announcements are still present. These results hold for open-market repurchases, as well as for tender offers. By putting a large emphasis on size, book-to-market and prior returns as key determinants of abnormal returns they highlight the need to control for these factors in further research. Focusing on the earlier mentioned undervaluation hypothesis, they develop the Undervaluation index, comprising of the three before mentioned factors extended with motivation to study the relation between undervaluation and abnormal post-announcement returns. Results show that higher undervaluation results in higher abnormal returns following the announcement.

These papers on the relation between abnormal returns and share repurchases provide some important information regarding motivations behind share repurchases and the role of firm characteristics. However, as many firms announce a share repurchase but never actually repurchase their stock (Stephen and Weisbach, 1998), analyzing actual share repurchases instead of repurchase announcements may result in different conclusions.

2.3.2 Timing and frequency

For a long time, research on share repurchases was focused on announcements, caused by the lack of legislation on reporting repurchases. Caused by a change in legislation, data on actual share repurchases is now more accessible. A recent paper on actual share repurchases by Dittmar and Field (2015), which I mentioned earlier, examines the timing and frequency of actual share repurchases. Evidence showing that firms repurchase at significantly lower prices than the average market price, implicates that managers are able to time the market. This effect is stronger following a market downturn and when insider trade activity is higher. The results of Dittmar and Field are supported by evidence from McNally, Smith and Barnes (2006) on share repurchases in the Canadian stock market. Consistent with share repurchases providing price support, authors find that repurchasing firms are able to time the market. Abnormal losses before the repurchase are followed by abnormal gains afterwards.

In addition to their findings on market timing, Dittmar and Field find that there exists a difference between frequent and infrequent buyers. As earlier documented by Jagannathan and Stephens (2003), frequent buyers turn out to be more profitable, larger and pay out more dividend. In addition, frequent repurchasers repurchase a significantly higher amount of their

market value each year (4.8% compared to 1.2%). These, and different firm characteristics implicate potential motivational differences between frequent and infrequent repurchasers. These implications are supported by evidence that timing ability decreases with frequency, suggesting that frequent repurchasers act on other motivations than undervaluation.

2.4 Regulation on share repurchases

This section discusses the regulation regarding share repurchases in the United States[1]. Key takeaway is the fact that regulation around share repurchases is rather limited. A share repurchase problem does not require the approval of shareholders, only the approval of the board is sufficient. While restrictions are limited, if not absent at all, the Securities and Exchange Commission (SEC) provides some 'safe harbor rules' in Rule 10B-18. These rules are aimed on manner of purchase, timing, price and volume. While Rule 10B-18 protects firms from being deemed in violation of anti-fraud provisions, firms that do not apply to the underlying rules may be charged for market (or stock price) manipulation. These rules state that (I) firms cannot purchase more than 25% of the average daily market volume, (II) purchasing firms have to purchase from a single broker during a single day, (III) firms with average daily trading volumes above $1 million can trade until the last 10 minutes of trading, firms below this average daily trading volume are not allowed to trade within the last 30 minutes, and finally, (IV) the price may not exceed the highest independent bid or last quoted price.

The SEC amended the rule in 2003, requiring firms to disclose more information on their share repurchases. In each quarterly 10-Q form and annual 10-K form, firms must provide monthly statistics on repurchases. Firms have to include (I) total number of shares purchased, (II) average price per share, (III) the total number of purchased shares through publicly announced programs, and (IV) the maximum number of shares it can repurchase using these public programs.

[1] The disclosed regulation regarding share repurchases in the United States is obtained directly from the website of the Securities and Exchange Commission (SEC).

2.5 The role of investor attention

As stated by Kahneman (1973), investor attention is a scarce cognitive resource forcing investors to choose from different sources of information. Due to the availability of many alternatives, stocks that attract attention are more likely to be considered. This is supported by evidence from Odean (1999), who finds that investors may limit their attention to stocks that have recently captured their attention. Studying previous literature on investor attention gives a clear view on the relation with corporate behavior and provides different proxies for investor attention.

2.5.1 Investor attention and corporate events

Investor attention towards information affects the price reaction, and limited attention may cause underreaction to public news. Recent studies have studied investor attention to explain market anomalies and stock price efficiency. As previous literature proposes that market underreactions are caused by limited investor attention, Hirshleifer, Lim and Teoh (2009) directly address this relation by measuring investor distraction in the context of corporate news. Showing evidence of high-news days receiving lower abnormal announcement returns following corporate news events and higher post-announcement return drift, the authors argue that abundant news decreases the market's reaction to relevant news. Their study distinguishes itself from related literature in measuring investor distraction instead of investor attention. This 'investor distraction hypothesis' is based on investor attention being limited, thereby forcing investors to choose between different news signals. The most relevant take away from the paper of Hirshleifer, Lim and Teoh (2009, is the fact that the total amount of news events on a day may influence the investor attention towards a single event.

In addition, using prior turnover as a proxy for investor attention, Loh (2010) studies stock recommendations. The study shows that all stocks increase their turnover (investor attention) in the three-day event window, compared to the average turnover in the prior three months. Furthermore, it shows that low-attention stocks react less to these stock recommendations in the three-day event window, compared to high-attention stocks. This causes the low-attention stocks to experience a significantly higher stock price drift following these recommendations. In the next three months this pattern reverses, which is consistent with delayed reaction to recommendations potentially caused by inattention.

Ben-Rephael, Da and Israelsen (2017) examine the relation between institutional investor attention and underreaction to news. Whereas the research of Hirshleifer, Lim and Teoh (2009) and Loh (2010) focuses primarily on individual investors, Ben Rephael, Da and Israelsen (2017) study both institutional and individual investors. They introduce abnormal institutional investor attention (AIA) as a new measure to study the relation between investor attention and information incorporation around corporate events. This measure creates the opportunity to distinguish institutional investor attention from individual investor attention. According to Ben Rephael, Da and Israelsen (2017) the institutional attention measure, AIA, and the Google Search proxy for retail attention explain less than 2% of each other's variation. This makes both measures suitable for a comparison between both in studying share repurchases. Results from studying earnings announcements and stock recommendations yield a significant influence of institutional investor attention on post-announcement drift. Stocks that receive abnormal institutional attention experience larger returns, and limited price drift following the events in comparison to stocks with limited attention.

2.5.2 Investor attention and Market conditions

Findings from Karlsson, Loewenstein and Seppi (2005) on Scandinavian datasets indicate that investors are more likely to pay attention to their portfolio in up markets than in down markets. The authors develop a model on selective attention and apply this to investors decision making. Their findings are in line with their expectations that investors first check on the overall market state, before they decide to check their own portfolio. If the aggregate market performs good, investors check on their own portfolio. But when the aggregate market fails to achieve the desired performance, investors tend to neglect their own portfolio results. They do so, to protect themselves from the collection of further 'bad news'. They refer to this as the 'ostrich effect'. This suggests that investor attention increases in rising markets and decreases in down markets. The potentially larger absence of investor attention in down markets may cause larger deviations from fundamental values.

In addition to this paper, Hou, Peng and Xiong (2009) document different investor reactions between up and down-markets for both cross-section and time-series analysis. Studying investor attention using trading volume as a proxy, the authors find significant results for their market state analysis. Investor reactions to earnings announcements are lower in down markets compared to up markets. In particular, they find a dual effect of investor

attention around earnings announcements. Higher investor attention results in a lower initial underreaction to the announcement but is positively related to price continuation in case of an initial overreaction. Although their market state dummy does not find significant return differences, they find significant higher returns when performing trade strategies after up-market periods.

2.5.3 Institutional investors versus Individual investors

The study of Barber and Odean (2007) shows that attention is not as scarce for institutional investors as it is for individual investors. Institutions have more information on which they base their attention and are better able to manage the range of available options. In particular, institutional investors are better able to obtain access to advanced computer databases. This allows them to limit the range of options based on firm characteristics. As a result, institutional investors are less likely to be influenced by attention generating firms. It is important to note that this difference is based on differences in buying behavior. When selling stocks, individual investors often limit their search to the stocks they own, thereby excluding the scarcity of their attention. So, focusing solely on buying decisions, individual investors are net buyers of attention-grabbing stocks. This attention-based trading has not only implications for individual investors, but it also influences stock returns. The authors do not find such attention-based buying behavior for institutional investors.

3. Hypotheses

I formulate three hypotheses on the relation between share repurchases and investor attention, all hypotheses are based on documented findings in the academic literature.

Literature on the relation between investor attention and price efficiency is rising. Findings from the academic literature implicate that higher levels of investor attention may reduce the delay with which information is incorporated in prices. Studying the effect of market frictions on price response to information, Hou and Moskowitz (2005) find that the most delayed firms experience large returns premiums. In addition, the authors state that most of this effect can be explained by (the lack of) investor recognition. These findings highlight a potential negative relationship between delay and investor attention / recognition. In the context of a potential negative relation between information incorporation in prices and investor attention, Busch and Obernberger (2016) find that share repurchases reduce

delay of in the incorporation of information in stock prices. These results oppose earlier literature that states that firms may use share repurchases to improve their stock's performance, and therefore this should not increase informational efficiency (Bonaimé and Ryngaert, 2013). However, when share repurchases induces an increase in investor attention, this higher level of investor attention may cause prices to become more efficient due to an increase in overall attention for the stock. This is supported by the earlier mentioned findings of Hou and Moskowitz (2005). Based on the combined results of both studies, it is reasonable to think that firms with relatively low investor attention will increase their share repurchases. As investor attention increases, because of the increase in share repurchases, this may lead to less delay and higher price efficiency. I formulate the following hypothesis to test this prediction:

Hypothesis 1: *Firms increase share repurchases when the level of investor attention is relatively low.*

It is important to distinguish individual investors from institutional investors. The study of Barber and Odean (2005) shows that attention is not as scarce for institutional investors as it is for individual investors. Having access to more information on which they base their attention, institutional investors are better able to manage the range of available options. As a result, institutional investors are less likely to be influenced by attention generating firms. In this context, institutional investors may also have more accurate information on whether or not firms repurchase shares in a particular period. As the undervaluation hypothesis predicts that firms repurchase their stock when they believe that their stock is undervalued, this may motivate institutional investors to align their investments with share repurchases. Furthermore, evidence from Grinstein and Michaely (2005) shows that institutions prefer firms that repurchase stock and that they prefer frequent repurchasers over infrequent repurchasers. In addition, the paper of Jain (2007) documents that individual investors prefer high-dividend paying firms, whereas institutional investors tend to prefer repurchasing firms. Both of the abovementioned factors suggest that the relation between investor attention and share repurchases may not be uniform for individual and institutional investor attention. I therefore formulate the following hypothesis:

Hypothesis 2: *The relation between share repurchases and investor attention is different for individual and institutional attention.*

My third hypothesis is focused solely on the relation between share repurchases and institutional investor attention. The previous hypothesis suggests that the relation between share repurchases and investor attention is not uniform for both groups of investors. In fact, there exist several factors that may cause a positive relation between institutional investor attention and share repurchases. These factors are related to institutional trading, institutional power and undervaluation. The paper of Ryan and Schneider (2003) documents evidence of the growing impact of institutional power. As the power of institutions to influence corporate decisions is growing, this may also affect share repurchase decisions. Combining this with the results of Grinstein and Michaely (2005), the combined prediction is that share repurchases are positively related to institutional attention. Furthermore, combining the undervaluation and market-timing hypothesis predicts that firms buy back their own stock when they believe it is undervalued. As these value stocks yield relatively high returns, institutions may be focused on identifying and trading on these stocks. If both factors appear at the same time, this will induce a positive relation between institutional attention and share repurchases. Finally, institutions are relatively often short-sellers, compared to individual investors. For this reason, institutional attention may induce higher short-selling of a firm's stock. As this short selling creates downward pressure on a firm's stock, firms may step in to support their stock price (Liu and Swanson, 2016). Based on the combined predictions of all three factors, I construct the following hypothesis:

Hypothesis 3*: The relation between share repurchases and institutional investor attention is positive.*

4. Data and Methodology

4.1 Sample selection

The analysis in this paper focuses on share repurchases performed by firms in the United States. The construction of the dataset is made on a number of restrictions. As a starting point, I obtain all ordinary shares (share code 10 or 11) from CRSP from the 1st of January 2007 until the 31st of December 2017. Firms are required to be traded on the NYSE, AMEX or NASDAQ (exchange codes 1, 2 and 3). I exclude financial and utility firms from the sample (SIC-codes 4900-4999 and 6000-6999) and drop firms with stock prices below $5 in a particular quarter. This results in an initial sample of 5.531 firms from CRSP. I combine this sample with quarterly firm characteristics and repurchase data from Compustat, which results in a sample of 4.804 firms. Thereafter, firms are required to have available data for Compustat Annual, I/B/E/S, Thomson Reuters Insider / Institutional and Compustat Short Interest databases. Combining the dataset with all databases results in a sample of 4.569 firms and 99.630 firm-quarters. Next, I drop firms without available investor attention data on Google Trends and Bloomberg data. This results in a final sample of 3.368 firms and 85.364 firm-quarters for the individual investor analysis using Google trend data. The final sample for the analysis of institutional investors using Bloomberg consists of 2.775 firms and 58.028 firm-quarters.[2]

4.2 Measuring share repurchases

For my analysis on share repurchases I construct several measures of actual quarterly share repurchases. Using the paper of Banyi, Dyl and Kahle (2005) as a starting point, I construct the number of shares repurchased using both Compustat and CRSP data. The leading measure of share repurchases is Compustat line 'purchase of common and preferred stock'. As the average purchasing price for these shares is not known, I follow Stephens and Weisbach (1998) and assume that shares were repurchased at the average monthly closing price during the quarter. This average monthly closing price is obtained from CRSP. Furthermore, the Compustat line represents aggregate numbers of all security retirements and repurchases during the quarter. As a result, share repurchases may be overstated when using this

[2] The difference in sample size between the Google Trend and Bloomberg sample is mostly due to the fact that Bloomberg attention data is only available from the second quarter of 2010 onwards. In addition, not all firms from the Google trend data sample appear with available data in the Bloomberg database.

measure. To correct for this, I follow Kahle (2002) and adjust purchase of common and preferred stock by any decreases in preferred stock during the quarter. The resulting number of repurchased shares is than scaled on shares outstanding. This measure of repurchase intensity will be referred to as Compustat II.

For robustness purposes I construct more than one measure of share repurchases for my analysis. The Compustat line 'total shares repurchased' only reports the number of common shares repurchased. As changes in other securities are not included in this line, it may provide a more precise view on actual share repurchases of common stock. While this line appears to have a large amount of missing data points, I assume that these missing data points represent a zero share repurchase for the particular quarter.[3] Like in the previous repurchase measure, the number of shares repurchased is scaled by shares outstanding. This measure of repurchase intensity is named Compustat I in the analysis.

Finally, again referring to the paper of Banyi, Dyl and Kahle (2005), I construct a CRSP based repurchase measure using the decrease in quarterly shares outstanding.[4] Following their paper, I adjust for stock splits a stock dividend. In addition, I do not aggregate monthly decreases in shares outstanding with increases in other months during the quarter. Monthly increases in shares outstanding are set to zero, as including these increases in my analysis may bias share repurchases downwards. It is important to realize that this measure may understate the number of shares repurchased during a quarter, as the exercise of stock options may bias this measure downwards. The scaling method equals the one used for the previous two measures. I use the term CRSP to refer to this measure in the analysis.

4.3 Individual investor attention

For a long time, individual investor attention has been measured by using news articles. The amount of news articles on a firm has proven to be an indication of investor attention towards a particular firm. Investor attention can be broken down in two parts: individual investor attention and institutional investor attention. While institutional investors often use sophisticated financial databases to collect information about a stock, individual investors are

[3] I performed analysis using 'total shares repurchased' including missing values, as well as setting missing values to zero. Setting missing values to zero yields similar results.

[4] Using this CRSP based measure allows for an analysis on a monthly basis, which may prove to be valuable for robustness purposes.

more likely to use news articles or search engines such as Google. Proposed by Dao, Engelberg and Gao (2011), the use of Google search frequencies is a relatively novel approach to measure individual (or retail) investor attention. In their paper, the authors state that an increase in Google search volume in a certain week will result in higher prices in the following two weeks. This effect is stronger for stocks with a high share of individual investors.

I use the Google Search Volume Index (GSVI) as a proxy for individual investor attention. The GVSI is provided by Google via Google Trends. The monthly Search volume Index for a particular term is the number of searches during a month scaled by the time-series average of that term. In a formula:

$$GSVI = \frac{number\ of\ search\ queries_{i,t}}{maximum\ number\ of\ search\ queries_t} \quad (1)$$

$number\ of\ search\ queries_{i,t}$ is the number of queries for firm *i* during month *t.* This firm-specific number of queries is divided by the highest number of queries for a particular month in the relevant data range, $maximum\ number\ of\ search\ queries_t$.

I manually download the monthly GSVI data from January 2007 until December 2017 for every stock ticker in my sample by searching for every ticker symbol and adding the term 'stock' behind the ticker symbol. I then correct for ambiguous terms such as 'A stock' or 'FCF stock'. Finally, I require the search for a firm's ticker to actually bring up information about the stock price or an information box about the firm. This results in a list of relative search volume with values between 0 and 100. I then transform these monthly data points to quarterly data points by taking the mean of the monthly data for each quarter.[5]

4.4 Institutional investor attention

Ben-Raphael, Da and Israelsen (2017) provide a new and novel measure to measure institutional investor attention. While this measure shows some relation with the GSVI measure for individual investor attention, both measures explain only 2% of each other's variation. The Abnormal Investor Attention measure from Ben-Raphael, Da and Israelsen is derived from the Bloomberg terminal. As almost 80% of the users of the Bloomberg terminal

[5] In addition, I performed my analysis using the maximum monthly GSVI for each quarter. The conclusions remain unchanged when using the maximum GSVI instead of mean GSVI.

works in the financial services, and terminal leases are expensive (ranging from $20.000 to $25.000), it is unlikely that terminals such as Bloomberg are used by individual (retail) investors.

Bloomberg provides a direct (daily) measure of institutional investor attention by recording the number of times an article on a particular stock is read, and the number of times that users searched for news for a stock. These numbers are than compared to the search behavior in the previous 30 days. Based on these data, Bloomberg provides transformed data on average and maximum daily readership ranging from zero 0 to 4. If a particular day's rolling average is in the bottom 80% of the past 30 days, Bloomberg provides a score of 0 for this day. In a similar way, scores of 1, 2, 3 and 4 are assigned for values between 80% and 90%, 90% and 94%, 94% and 96% and 96% or higher.

I collect the institutional investor attention data from Bloomberg using the manual provided by Ben-Rephael, Da and Israelsen (2017). Daily data on institutional attention is obtained from the Bloomberg terminal for each stock ticker. Thereafter, I construct a quarterly measure for institutional investor attention from April 2010 until December 2017.[6] I construct the institutional attention measure using the quarterly mean of the Bloomberg daily readership measure. This results in values ranging from 0 to 4 for each quarter.

4.5 Price efficiency, share repurchases and investor attention

To analyze whether firms increase share repurchases to provide price support / improve price efficiency during times of low attention, I measure the effect of share repurchases on price efficiency during times of low, respectively high, investor attention. This analysis allows to separately measure the effect from share repurchases on price efficiency from other motives of share repurchases. To construct the price efficiency measures, I follow Hou and Moskowitz (2005) and construct a delay measure based on daily stock returns which identifies to what extent available information is incorporated into stock prices.

Following Hou and Moskowitz, the first, base model, is computed by regressing the daily returns on the value-weighted (S&P 500) market returns. The second, extended model is computed by regressing the daily returns on the five-day value-weighted market returns.

[6] As Bloomberg institutional attention data is available from 2010 onwards, my analysis on institutional attention ranges from 2010 onwards. As shown in the descriptive statistics later on, this will still result in a sufficient sample.

This method of computing price delay is derived from the paper of Busch and Obernberger (2016).

Thereafter, price delay measures are calculation in line with the analysis of Hou and Moskowitz (2005). The first price delay measure is one minus the ratio of the base model R-squared and the extended model R-squared. This is based on reasoning that higher variation in the base model leads to higher price efficiency, or that lower variation in the extended model leads to higher price efficiency. The formula for calculating this first Delay measure is:

$$Delay = 1 - \frac{R^2_{base}}{R^2_{extended}} \tag{2}$$

The second price delay measure, again following Hou and Moskowitz (2005), is based on regressions coefficients of both models. This measure uses the lagged weighted sum of absolute β of the extended model and divides these by the sum of all β. All of these β coefficients are scaled by the component's standard error. The β at day t should be significantly different from zero to incorporate information into prices, however the β of the previous trading days should not differ from zero. In this context, higher β means lower price efficiency. So, the highest price efficiency is achieved when this delay measure is low. This coefficient-based delay measure is calculated as follows:

$$Coefficient\text{-}based\ delay = \frac{\sum_{n=1}^{5} n \times \frac{abs(\beta_i^n)}{se(\beta_i^n)}}{\frac{abs(\beta_i^0)}{se(\beta_i^0)} + \sum_{n=1}^{5} \frac{abs(\beta_i^n)}{se(\beta_i^n)}} \tag{3}$$

Finally, I measure the effect of share repurchases on idiosyncratic risk during times of low or high attention. To do so, I estimate the R-squared and Market correlation for each firm quarter. The amount of idiosyncratic risk is measured by using the base model R-squared and the correlation between a firm's stock return and the market return (Bris, Goetzman and Zu, 2007).

After calculating all delay and risk measures, these measures will be regressed on an interaction term of share repurchases and attention including control variables.

4.6 Research design and variable definition

My baseline regression analyzes a measure of the number of shares repurchased on a measure of investor attention and a set of control variables:

$$Repurchase_{i,t} = \alpha + \delta Repurchase_{i,t-1} + \beta Attention_{i,t} + \sum_{l=1}^{l=K} Controls_{i,l,t} + \mu_i + \eta_t + u_{i,t} \quad (4)$$

here, $Repurchase_{i,t}$ is a measure of the number of repurchased shares during a specific quarter. $Repurchase_{i,t}$ is defined by one of the three previously described definitions and is scaled by the number of shares outstanding at the end of a quarter. $Attention_{i,t}$ is defined as either the individual investor attention level, measured by Google's SVI, or the institutional investor attention level, measured by Bloomberg's daily readership aggregated into quarterly data points. $Controls_{i,l,t}$ refers to a set of control variables, which will be defined in the variable description later on. Finally, μ represent firm fixed effects and η represents quarterly time fixed effects.

Providing price support by performing share repurchases during periods of low attention is a potential motivation behind share repurchase programs. This regression will provide insights in the relation between investor attention towards a specific firm and share repurchases performed by that firm. However, there may be a potential reverse effect from performing share repurchase programs on investor attention. As described in the paper of Ben-Rephael, Da and Israelsen (2017), corporate events may increase the level of attention towards a specific stock. In their paper, this effect is shown for earnings announcements. The same relation may potentially exist between share repurchase announcements and investor attention. As a result, share repurchases may influence investor attention and reverse causality may arise. To tackle this problem, I lag $Attention_{i,t}$ by one period and thereby circumvent the problem of reverse causality.

I include firm and time fixed effects in every regression specification. By including these firm and time fixed effects, I overcome problems caused by unobserved heterogeneity due to unobserved factors in the cross-section or over time. In addition, the lagged dependent variable will control for current high or low differences in between-quarter share repurchases. A detailed description of the other control variables is given in Table A1.

4.7 Additional variables

An important objective of my analysis is to provide insight in the relation between relatively low levels of investor attention and share repurchases. In addition, this analysis tries to identify if firms provide price support following periods of low investor attention. Recent research by Liu and Swanson (2016) provides insight on price support as a motive to perform share repurchases. An increase in short interest during quarters in which firms repurchase is seen as an indication that firms provide price support during these quarters.

To investigate whether firms provide price support following a period of relatively low investor attention, I include the change in short interest in my analysis. Building upon the earlier described baseline regressions, change in short interest is used as a proxy for price support in the quarter after which investor attention is observed.

Hillert, Maug and Obernberger (2016) argue that share repurchases improve liquidity, especially during times of crisis or when other investors tend to sell the stock. Repurchase intensity in this context, may be driven by liquidity. To be sure that the results are not driven by a liquidity effect on share repurchases, I follow Busch and Obernberger (2016) and include *Turnover* and *Deviation* from a share price of $30 as control variables in my regression model.

4.8 Descriptive statistics

Table 1 below shows descriptive statistics of the variables used in the analysis. I compare the descriptive statistics to the papers of Busch and Obernberger (2016) and Liu and Swanson (2016) and confirm that these descriptive statistics are comparable to the reported statistics in their analysis. Comparing the dependent variables of repurchase volume with the paper of Busch and Obernberger (2016) yields different results. However, this difference in repurchase volume can be explained by the different time interval used (quarterly vs. monthly). Google attention shows a value of 79 for the 99th percentile. As Google attention is measured on a scale from 0 to 100 this may seem surprising. However, this difference arises due to meaning of the monthly Google attention data into quarterly data points. Price efficiency variables show slightly lower, but comparable results to the paper of Busch and Obernberger (2016). This difference may also be explained by the different time interval used in my analysis. Finally, the reported descriptive statistics in Table 1 refer to the sample period ranging from 2007 until 2017. The descriptive statistics for the sample period 2010 – 2017 are displayed in Table A2 and do not show any remarkable differences.

Table 1: Descriptive statistics

	Mean	Median	SD	SD (within)	1st Perc.	99th Perc.	N
Dependent variables: Repurchase measures							
Compustat I	4.30%	0	1.07%	0.96%	0	6.61%	85364
Compustat II	4.72%	0	1.20%	1.09%	0	7.37%	85364
CRSP	4.27%	0	1.13%	1.04%	0	6.92%	85310
Price efficiency variables							
Delay	0.3238	0.2245	0.2826	0.2229	0.0113	0.9973	85215
Coefficient-based Delay	1.5964	1.5207	0.6226	0.5238	0.4740	3.2542	85078
Market correlation	0.4323	0.4461	0.2253	0.1691	-0.1019	0.8685	85296
R-squared	23.76%	19.93%	19.08%	15.09%	0.02%	75.54%	85296
Attention variables							
Google attention	19.76	14.33	20.22	14.09	0	79.00	85364
Bloomberg attention	0.48	0.31	0.57	0.3486	0	2.36	58028
Control variables							
Assets	5745.57	841.02	24921.01	6127.98	11.92	91956	85069
Analysts (ln)	1.07	0.69	1.17	0.92	0	3.45	85364
Book to market	0.4933	0.04012	0.4254	0.2504	-0.4410	2.2959	84930
Cash to assets	0.2222	0.01291	0.2410	0.0870	0.0007	0.9590	85069
Dividend to assets	0.0164	0	0.0759	0.0671	0	0.2006	84934
Distance from $30	24.08	16.65	38.52	23.47	0.3566	308.89	85265
EBITDA to assets	0.0159	0.0291	0.0820	0.0521	-0.2697	0.1269	83562
Institutional ownership	0.6843	0.07587	0.2500	0.1095	0.0246	0.9929	66376
Market Capitalization	6346.93	918.37	25523.21	9239.80	18.07	115256	85265
Options exercised	0.0021	0.0000	0.0052	0.0048	0	0.0355	85049
Options outstanding	0.0624	0.0488	0.0553	0.0290	0	0.2589	79296
Return (holding period)	0.01659	.00119	0.1106	0.1088	-0.2024	0.3341	84914
Size (ln)	6.76	6.73	1.92	0.3952	2.47	11.42	85069
Turnover	0.0472	0.0206	0.0874	0.0596	0.0014	0.6318	85265
Change in short interest	0.0008	0	0.0209	0.0210	-0.0722	0.0823	85364

This table provides descriptive statistics for all the variables used in the analysis for the sample ranging from 2007 till 2017. The Bloomberg attention measure is reported from 2010 till 2017. A more detailed description of variables is documented in Table A1.

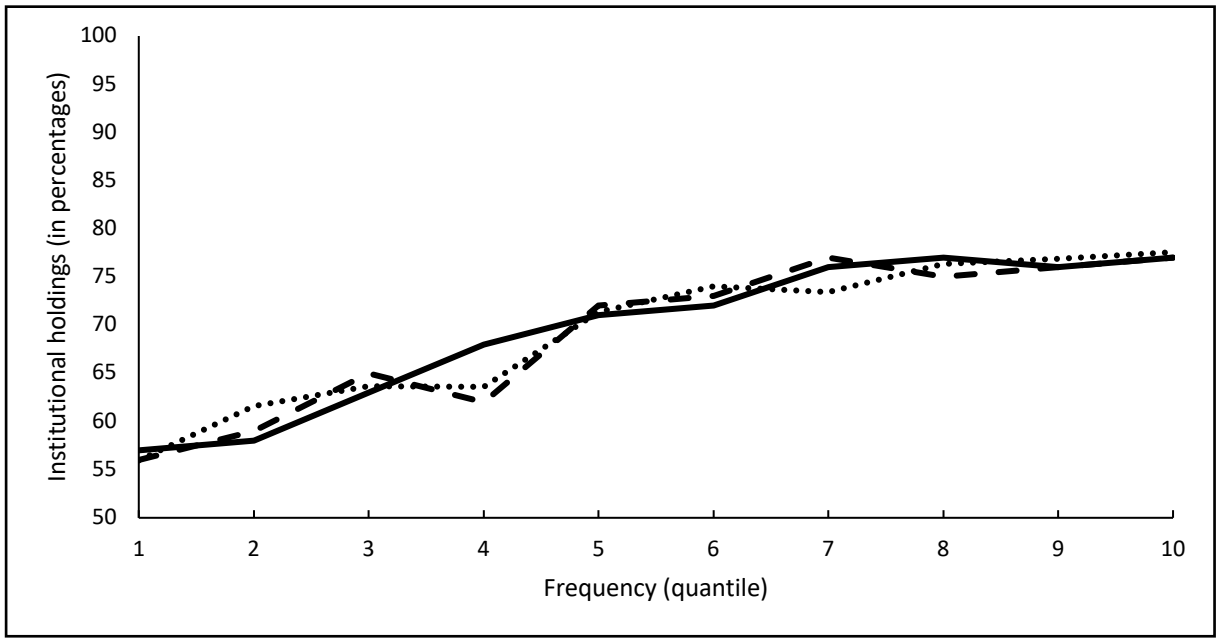
5. Results

In this section, I discuss the effect of investor attention on actual share repurchase activity by firms. I start by studying the investor preference for share repurchases. Thereafter, I perform analysis for both individual and institutional investor attention. Finally, I study differences between individual investor attention and institutional investor attention, and examine what factors may cause these differences.

5.1 Share repurchases and Investor preferences

This first part of my analysis is dedicated to insights in the distribution of individual and institutional investors across repurchasing firms. To analyze investor preferences, I study the relation between repurchase frequency of a firm and holdings of both individual and institutional investors. For the 2007 – 2017 sample, I divide firms into groups based on frequency using ten quantiles. The calculation of frequency is partly based on the method of Dittmar and Field (2015) and counts the number of quarters a firm repurchases during the sample period. To provide insight in the relation with investor preferences, I plot these frequency quantiles against institutional and individual holdings for all three repurchase

Figure 1: Institutional holdings by frequency



This figure plots the *Institutional Holdings* (in percentages) against frequency quantiles on share repurchases. Firms are assigned to a *Frequency* quantile based on the number of repurchase months within the sample period. The dotted line represents quantiles based on *Compustat I,* the striped line on *Compustat II* and the solid line on *CRSP.*

measures. Figure 1 shows the institutional holdings, in percentages, relative to repurchase frequency. The plotted lines show an upward trend for all three repurchase measures. For Compustat II, institutional holdings start at 56% for frequency quantile one and move up to 77% for the highest frequency quantile. The other two repurchase measures show a similar increase. These results are in line with previous results from Grinstein and Michaely (2005) that institutional investors prefer firms that repurchase shares. In addition, Figure 1 is in line with their results that institutions prefer regular repurchasers over non-regular repurchasers.

5.2 Analysis of Investor attention and Share repurchase activity

The analysis in this section is focused on the relation between investor attention and share repurchase activity. I start with performing quartile analysis to provide a baseline insight on this relation.

5.2.1 Share repurchase activity and Investor attention: Quartile analysis

In Table 2 below, firms are divided into four quartiles based on their investor attention score for every quarter. Thereafter, the means of all three repurchase measures are compared for these quartiles and statistical testing is performed to identify differences between the top and bottom quartile.

Table 2: Quartiles on Investor attention

Panel A: Google Attention					
			Quartile		
Repurchase measure	(1)	(2)	(3)	(4)	Diff. (1-4)
Compustat I	0.470%	0.438%	0.439%	0.396%	0.074% *(7.07)*
Compustat II	0.504%	0.485%	0.473%	0.445%	0.059% *(5.06)*
CRSP	0.459%	0.429%	0.426%	0.399%	0.060% (*5.40)*
Panel B: Bloomberg Attention					
			Quartile		
Repurchase measure	(1)	(2)	(3)	(4)	Diff. (4-1)
Compustat I	0.216%	0.290%	0.456%	0.555%	0.339% *(35.70)*
Compustat II	0.246%	0.325%	0.511%	0.671%	0.425% *(34.62)*
CRSP	0.278%	0.351%	0.451%	0.515%	0.237% *(20.44)*

Table 2 reports the quartile means of all three repurchase measures for quartiles based on investor attention. Google attention is a proxy for individual investor attention, Bloomberg attention proxies for institutional investor attention. Firms

are divided into quartiles based on their investor attention score for every quarter. Quartiles are formed based on empirical distribution. The last column represents the difference between the bottom and top quartile, t-statistics are in parentheses.

The results from the quartile analysis show two opposing relations. This is somewhat surprising since existing literature predicts that the relation between share repurchases and investor attention is negative. For individual investor attention, measured by Google attention, the relation is indeed negative. This indicates that firms increase their repurchase activity during times of low attention, and vice versa. This relation is in line with the paper of Hou and Moskowitz (2005) that investor attention / recognition is positively related to price efficiency. In addition, as stated in the paper of Busch and Obernberger (2016), firms may improve price efficiency by increasing their share repurchases.

More surprising, however, is the positive relation between institutional investor attention and share repurchases. From a price efficiency perspective, investor attention should be negatively related to repurchases. As higher investor attention leads to a faster incorporation of information into stock prices, increasing share repurchases would only increase upward pressure on the stock price. In contrast, when attention is low, the theoretical expectation is that firms increase repurchase activity to support their stock price.

5.2.2 Regression analysis on Share repurchases and Investor attention

The regression coefficients in Table 3 show a similar contradictory relation between investor attention and share repurchases. Panel A shows the OLS regression results from repurchase intensity on individual investor attention. As mentioned earlier, the combined results of Hou and Moskowitz (2005) and Busch and Obernberger (2016) predict that firms will increase share repurchases in times when investor attention is low. During times of low investor attention stock prices may experience downward pressure, and firms may step in to increase upward price pressure and price efficiency. In line with this expectation, the coefficient on *Google attention* shows a negative and significant relation between repurchase intensity and individual investor attention. This indicates that, indeed, firms increase share repurchase activity during times of low attention. This relation holds for analysis at *t* and using lagged values of *Google attention*. More importantly, all repurchase measures show a similar relation with individual investor attention. Looking at Column (1), a one unit decrease in individual investor attention will increase repurchase intensity by 0.0017%. A one unit decrease in this

relation means a one unit decrease in the average, quarterly GSVI attention measure. Looking at this relation from the perspective of economic significance, the coefficient is relatively small. The controls in Columns (1) – (6) show significant results for most of the variables, and most of the coefficients are in line with existing literature. *Analysts* shows a positive and significant relation with share repurchasing. Based on earlier literature that higher analyst coverage proxies for higher investor attention, this coefficient is not as expected. However, in line with the paper of Hribar, Jenkens and Johnson (2006), firms may increase share repurchases to meet analyst earnings-per-share forecasts. In this context, higher analyst coverage will increase the pressure to perform share repurchases. The coefficient on *Change in short interest* is positive and significant, this is in line with the paper of Liu and Swanson (2016) that firms increase their repurchase activity when short interest increases. The increase in short interest creates downward pressure on the firm's stock price. Increasing repurchase intensity will partly offset this downward price pressure. These coefficients and significance also hold when I only include a dummy for short interest in the model. The coefficient on *Book to market* shows a negative but insignificant coefficient. This negative relation is not in line with the undervaluation hypothesis, however the coefficient is insignificant. The effect of *EBITDA to asset*s is not consistent across all repurchase measures and for most of the regressions insignificant. This may be explained by *Cash to assets* absorbing this effect from EBITDA on repurchase activity. *Cash to assets* shows a positive sign and high significance, which is in line with the excess capital hypothesis. *Dividends to assets* does not show a significant effect for repurchase measures one and two, which is in line with earlier literature on the dividend substitution hypothesis. For repurchase measure three the results on dividend yield significant results, this may be caused by the CRSP measure understating actual share repurchases. Results on *Options outstanding* are positive, and in line with management reacting to a dilution in earnings per share. *Options exercised* does not show significant and consistent results for all repurchase measures in Panel A, this is not as expected based on previous literature on share repurchases. The coefficients on lagged *Return* show a highly significant, positive relation with repurchase intensity. This is in line with theory on firms repurchasing stock after times of declining stock prices to provide price support. Looking at *Leverage*, the negative and significant coefficient indicates that firms with a higher leverage position will perform less repurchases. This is supported by the paper of Dittmar (2000), which documents that firms use share repurchases to increase their leverage ratio.

Panel B of Table 3 reports the regression results on institutional investor attention. In line with the results from the quartile analysis, these results show a positive relation between institutional investor attention and repurchase intensity. Besides the coefficient on *Bloomberg attention* in Column (1), all other columns show t-statistics ranging from 1.37-2.54.

Table 3: Analysis of Repurchase intensity and Investor attention

Panel A: Individual investor attention

Dependent variable:	Compustat I		Compustat II		CRSP	
	(1)	(2)	(3)	(4)	(5)	(6)
Google attention$_t$	-0.0017***		-0.0012***		-0.0011***	
	-4.91		-3.05		-3.21	
Google attention$_{t-1}$		-0.0008**		-0.0010***		-0.0011***
		-2.29		-2.80		-3.03
Analysts(ln)$_{t-1}$	0.0592***	0.0593***	0.0598***	0.0598***	0.0640***	0.0641***
	6.05	6.06	5.48	5.48	7.15	7.15
Change in short interest$_t$	2.0261***	2.0220***	2.1435***	2.1414***	1.0270***	1.0251***
	9.08	9.06	7.90	7.89	4.13	4.13
Book to market$_{t-1}$	-0.0272	-0.0273	-0.0006	-0.0006	-0.0235	-0.0235
	-1.07	-1.07	-0.02	-0.02	-1.04	-1.04
Cash to assets$_{t-1}$	0.3363***	0.3358***	0.2552***	0.2551***	0.2245***	0.2245***
	5.98	5.98	4.07	4.07	3.49	3.49
EBITDA to assets$_{t-1}$	-0.0964	-0.0975	-0.1617*	-0.1620*	0.0222	0.0220
	-1.18	-1.18	-1.70	-1.70	0.27	0.26
Size(ln)$_{t-1}$	0.1222***	0.1226***	0.1013***	0.1014***	0.0505***	0.0506***
	6.88	6.91	5.43	5.44	3.04	3.04
Dividend to assets$_{t-1}$	0.0607	0.0630	0.0283	0.0294	0.0902**	0.0912**
	1.11	1.15	0.63	0.66	2.09	2.11
Leverage$_{t-1}$	-0.4247***	-0.4261***	-0.5933***	-0.5941***	-0.2453***	-0.2460***
	-7.53	-7.53	-8.84	-8.85	-4.47	-4.48
Options exercised$_t$	1.3054	1.3034	-2.1004	-2.0910	-0.4523	-0.4416
	1.35	1.34	-1.60	-1.60	-0.40	-0.39
Options outstanding$_t$	0.2166	0.2275	0.3154	0.3180	0.5633**	0.5647**
	0.95	0.99	1.26	1.27	2.55	2.55
Return$_{t-1}$	-0.1596***	-0.1607***	-0.1592***	-0.1599***	-0.2864***	-0.2870***
	-4.45	-4.47	-4.26	-4.28	-5.88	-5.88
Compustat I$_{t-1}$	0.2279***	0.2277***				
	21.73	21.71				
Compustat II$_{t-1}$			0.1218***	0.1217***		
			12.05	12.04		
CRSP$_{t-1}$					0.1541***	0.1539***
					18.02	17.99

Constant	-0.4495***	-0.4652***	-0.3309***	-0.3335***	0.0367	0.0362
	-3.79	-3.93	-2.61	-2.63	0.32	0.32
R-squared	0.0774	0.0770	0.0495	0.0494	0.0429	0.0429
Observations	69.262	69.262	69.260	69.260	69.260	69.260
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Institutional investor attention

Dependent variable:	Compustat I		Compustat II		CRSP	
	(1)	(2)	(3)	(4)	(5)	(6)
Bloomberg attention$_t$	0.0011		0.0212		0.0244*	
	0.10		1.37		1.70	
Bloomberg attention$_{t-1}$		0.0196*		0.0272*		0.0340**
		1.65		1.84		2.54
Analysts(ln)$_{t-1}$	0.0354***	0.0357***	0.0425***	0.0425***	0.0471***	0.0472***
	3.48	3.52	3.38	3.39	4.05	4.05
Change in short interest$_t$	1.8378***	1.8383***	2.1036***	2.1175***	0.7451***	0.7615***
	8.73	8.73	7.47	7.53	2.81	2.88
Book to market$_{t-1}$	0.0426*	0.0441*	0.0699**	0.0706**	0.0578**	0.0587**
	1.87	1.94	2.39	2.41	2.31	2.35
Cash to assets$_{t-1}$	0.1866***	0.1854***	0.0810	0.0803	0.1762**	0.1753**
	3.69	3.66	1.19	1.17	2.39	2.38
EBITDA to assets$_{t-1}$	-0.0205	-0.0165	-0.1881*	-0.1869*	0.0832	0.0849
	-0.29	-0.23	-1.86	-1.85	0.94	0.96
Size(ln)$_{t-1}$	0.0548***	0.0519***	0.0600***	0.0587***	-0.0027	-0.0046
	3.51	3.33	2.94	2.89	-0.14	-0.23
Dividend to assets$_{t-1}$	-0.0020	-0.0030	-0.0190	-0.0203	0.0120	0.0104
	-0.05	-0.08	-0.34	-0.36	0.25	0.21
Leverage$_{t-1}$	-0.2920***	-0.2914***	-0.5368***	-0.5367***	-0.1486**	-0.1485**
	-5.40	-5.38	-7.76	-7.76	-2.52	-2.52
Options exercised$_t$	1.5523*	1.5537*	-3.4972**	-3.4893**	0.2085	0.2183
	1.75	1.75	-2.54	-2.53	0.16	0.17
Options outstanding$_t$	0.3310	0.3254	0.1590	0.1578	0.6269**	0.6249**
	1.58	1.55	0.58	0.58	2.49	2.49
Return$_{t-1}$	-0.1903***	-0.1912***	-0.2134***	-0.2138***	-0.3129***	-0.3134***
	-5.62	-5.64	-4.26	-4.26	-5.65	-5.65
Compustat I$_{t-1}$	0.2303***	0.2303***				
	20.60	20.58				
Compustat II$_{t-1}$			0.0920***	0.0919***		
			7.66	7.64		
CRSP$_{t-1}$					0.1328***	0.1327***
					12.80	12.80
Constant	-0.1589	-0.1523	-0.1286	-0.1271	0.0995	0.1020

	-1.54	-1.47	-0.94	-0.93	0.74	0.76
R-squared	0.0689	0.0689	0.0422	0.0421	0.0316	0.0315
Observations	47.632	47.632	47.632	47.632	47.630	47.630
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

This table shows OLS regression results of Repurchase Intensity (Compustat I, Compustat II and CRSP) on Investor attention, lagged Repurchase intensity and control variables. Panel A and B report the results for individual and institutional investor attention, respectively. The t-statistics are reported below coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%. A more detailed description of the variables is documented in Table A1.

In addition, statistical significance ranges from 10% to 5% for the different repurchase measures. Looking at Column (3), a one unit increase in institutional investor attention increases repurchase intensity by 0.0272%. A one unit increase in this context means a one unit increase in the quarterly average of institutional investor attention from Bloomberg. As mentioned earlier in the quartile analysis, this relation is not as expected based on existing literature and may be attributable to, for example, literature on institutional power (Ryan and Schneider, 2003). Looking at the control variables in Panel B, I observe no remarkable differences in signs and significance from the results in Panel A. Important to mention is that the sign of *Book to market* is positive and significant in Panel B, which is in line with the undervaluation hypothesis. Furthermore, the coefficients on *Dividend to assets* show no statistical significance for any of the repurchase measures, which is in line with the undervaluation hypothesis.

To observe if the results on investor attention and repurchase intensity are not driven by an unobserved liquidity variable, I include *Turnover* and *Deviation from a stock price of $30* into the model. These results are shown in Table A3. The results show that the effect of investor attention on repurchase activity is not driven by unobserved liquidity. The coefficient on *Turnover* shows a negative sign. This is as expected, as existing literature predicts that higher turnover leads to higher price efficiency. As price efficiency is higher, firms are more likely to lower their share repurchases in accordance. *Deviation from $30* shows a negative and significant sign, indicating that as the stock price moves away from $30, repurchase activity will decline.

5.3 Repurchase activity and Investor attention in Up and Down markets

Based on the paper of Karlsson, Loewenstein and Seppi (2005) one might expect that share repurchase intensity is higher during down market conditions, compared to up market conditions. As investors pay less attention to their portfolio during down market conditions, deviations from fundamental values may be larger. In this context, the effect on individual investor attention should be more pronounced, as individual investor face more attention constraints compared to institutional investors. To test for differences between up and down-market state, I create a dummy variable for down market state taking value 1 if the quarterly S&P 500 return is below zero, and zero otherwise. Thereafter I let this dummy interact with investor attention to measure the effect on repurchase activity under both market conditions. The results in Table 4, Panel A show significant results for both the up and down-market state regressions, for both time periods.

Table 4: Regression of Repurchase activity in Up and Down-markets

Panel A: Individual investor attention

Dependent variable:	Compustat I		Compustat II		CRSP	
	(1)	(2)	(3)	(4)	(5)	(6)
Google attention	-0.0017***		-0.0014***		-0.0011***	
x Up market$_t$	-4.66		-3.45		-3.24	
Google attention	-0.0018***		-0.0005		-0.0009*	
x Down market$_t$	-3.63		-0.89		-1.76	
Google attention		-0.0008**		-0.0013***		-0.0012***
x Up market$_{t-1}$		-2.41		-3.32		-3.25
Google attention		-0.0006		-0.0003		-0.0007
x Down market$_{t-1}$		-1.15		-0.56		-1.35
R-squared (within)	0.0774	0.0770	0.0495	0.0495	0.0429	0.0429
Observations	69.262	69.262	69.262	69.262	69.260	69.260
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Wald (up-down) (t-test)	0.12	0.19	2.36	2.98	0.19	0.86
Wald (up-down) (p-value)	0.73	0.66	0.13	0.08	0.66	0.36

Panel B: Institutional investor attention

Dependent variable:	Compustat I		Compustat II		CRSP	
	(1)	(2)	(3)	(4)	(5)	(6)
Bloomberg attention	-0.0092		0.0287*		0.0391**	
x Up market$_t$	-0.71		1.67		2.33	
Bloomberg attention	0.0183		0.0063		-0.0024	

x Down market$_t$	1.25		0.30		-0.14	
Bloomberg attention		0.0069		0.0293*		0.0386***
x Up market$_{t-1}$		0.52		1.82		2.60
Bloomberg attention		0.0421***		0.0231		0.0257
x Down market$_{t-1}$		2.76		1.16		1.40
R-squared (within)	0.0690	0.0691	0.0422	0.0422	0.0316	0.0316
Observations	47.632	47.632	47.632	47.632	47.630	47.630
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Wald (up-down) (t-test)	3.39	5.35	1.10	0.10	4.44	0.46
Wald (up-down) (p-value)	0.07	0.02	0.29	0.75	0.04	0.50

This table shows the regression results of OLS regression of Repurchase Intensity (Compustat I, Compustat II and CRSP) on investor attention, lagged Repurchase Intensity and a set of controls during periods of Up and Down-market state. Up and down-market state are defined as the S&P 500 quarterly return being above or below zero. T-statistics are reported below coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%.

Looking at the overall coefficients for individual investor attention, the relation appears to be slightly higher during up market states compared to down market states. This is not as expected based on existing literature. However, overall statistical testing on the difference between up and down-market coefficients yields no significant results. This indicates that changes in repurchase intensity related to individual investor attention do not vary between different market states.

Panel B shows the results for institutional investor attention. Looking at the results in Panel B, the coefficients and significance levels do not provide a consistent view. Column (1) and (2) show evidence of a stronger, significant effect on repurchase intensity during down markets. However, Column (5) and (6) show evidence in the opposite direction. Column (3) and (4) show no evidence of differences between up and down-market periods. The lack of consistent results in Panel B may be caused by the fact that institutional investors do not experience the same constraints as individual investors and thus are differences between up and down-market periods not immediately observable. Looking at the t-statistics of each column, half of the columns show significant differences. However, as mentioned before, the overall results in Panel B do not provide convincing, consistent evidence on the effect being stronger during up or down-market state. Looking at the overall results in Table 4 and comparing them to the results in Table 3, both tables show the same relation between repurchase intensity and investor attention. In addition, the results in Table 4 do not provide

evidence of a stronger relation between investor attention and repurchase intensity during down-market periods.[7]

5.4 Repurchase activity, Investor attention and trading behavior

As mentioned earlier, the negative relation between a firm's repurchase activity and individual investor attention is in line with existing literature. Firms act as a trader of last resort when investors stay away from the stock. In contrast, the positive relation between institutional investor attention and share repurchases goes against existing literature on price support. There may be other motivational reasons for firms to increase share repurchases when institutions pay a large amount of attention to their stock. These motivations may be caused by institutional power forcing firms to increase repurchases, trading on undervaluation, or firms repurchasing their own stock to meet upon the requirements by institutions regarding stock performance (e.g. return). To show that the positive relation may be caused by institutional behavior against firms, it is valuable to analyze the relation between investor attention and trading behavior of both individual and institutional investors.

5.4.1 Repurchase activity, Investor attention and Turnover

Table 5 shows results of regressing *Turnover* on both individual and institutional investor attention measures. The table shows that institutional investor attention induces trading. In contrast, individual investor attention does not significantly increase turnover. The coefficient on individual investor attention is close to zero, which is in line with existing literature on the lack of power of individual investors. However, looking at Column (4), a one unit increase in institutional investor attention increases relative turnover by 0.59%. These results are in line with the results reported in the paper of Ben-Rephael, Da and Israelsen (2017) and hold for both time periods. As share turnover increases, the upward price pressure on the stock price will increase. As prices are partly supported by an increase in turnover, firms do not have to step in to support prices following higher institutional attention. However, earlier regressions in Table 3 show a positive relation between institutional attention and share repurchases. This is in line with the reasoning that firms may increase share repurchases

[7] Looking at the distribution of up and down-market periods over the sample, around 75% of the firm-quarters is defined as up-market. For this reason, I also performed analysis by defining the market state as down when the overall returns of the sample were negative in a quarter. The results remained qualitatively the same.

following high institutional attention based on other reasons than price support or price efficiency.

5.4.2 Repurchase activity, Investor attention and Short-interest

To further support the statement that institutional investor attention induces trading, I performed regressions of the change in short interest and investor attention. Existing literature documents that short sellers are often institutions, as the costs of selling short are often too high for individual investors. Therefore, I would expect that the effect of investor attention on changes in short interest, is stronger for institutional attention. The results of these regressions are reported in Table A4. In line with the results on turnover, higher institutional investor attention means a larger absolute change in relative short interest. For regressions using individual investor attention the sign remains positive but slightly insignificant. Columns (2) and (4) show results of regressions using a dummy variable taking value one if investor attention is above the median, and zero otherwise. These results show that for both groups of investor attention, higher attention means significantly higher changes in absolute short interest. Looking at Column (4), high institutional investor attention yields a 0.20% higher change in short interest compared to low attention situations. As higher institutional attention yields higher changes in relative short interest, this may partly explain the positive relation between share repurchases and attention. When institutional attention increases, so do changes in short interest. An increase in short interest increases the downward pressure on a firm's stock price. For this reason, firms may step in by repurchasing their own stock and partly offset the downward pressure on the stock price. However, while *Change in short interest* is included in the regressions in Table 3 as a control variable, the effect of institutional attention on share repurchase activity still holds.

Table 5: Regression of Turnover on Investor attention

Dependent variable:	Turnover		Turnover	
	(1)	(2)	(3)	(4)
Google attention$_t$	0.0000			
	0.93			
Google attention$_{t-1}$		0.0000		
		0.61		
Bloomberg attention$_t$			0.0059***	
			8.55	

Bloomberg attention$_{t-1}$				0.0020***
				3.32
Analysts(ln)$_{t-1}$	-0.0015***	-0.0015***	-0.0009*	-0.0010*
	-3.59	-3.59	-1.73	-1.91
Change in short interest$_t$	0.1749***	0.1750***	0.1938***	0.1978***
	15.85	15.86	13.69	13.78
Book to market$_{t-1}$	0.0082***	0.0082***	0.0088***	0.0085***
	4.72	4.72	3.68	3.55
Cash to assets$_{t-1}$	-0.0204***	-0.0204***	-0.0184***	-0.0182***
	-5.63	-5.63	-4.34	-4.29
EBITDA to assets$_{t-1}$	-0.0606***	-0.0606***	-0.0545***	-0.0555***
	-4.69	-4.69	-3.61	-3.68
Size(ln)$_{t-1}$	-0.0047***	-0.0047***	-0.0069***	-0.0064***
	-4.84	-4.84	-5.40	-4.96
Dividend to assets$_{t-1}$	0.0280***	0.0280***	0.0284***	0.0283***
	4.25	4.25	2.88	2.85
Leverage$_{t-1}$	0.0230***	0.0230***	0.0252***	0.0250***
	6.97	6.97	6.02	5.98
Options exercised$_t$	-0.0327	-0.0328	-0.0421	-0.0402
	-0.79	-0.80	-0.78	-0.74
Options outstanding$_t$	-0.0340**	-0.0340**	-0.0510**	-0.0496**
	-2.15	-2.15	-2.27	-2.20
Return$_{t-1}$	-0.0217***	-0.0217***	-0.0360***	-0.0358***
	-3.44	-3.44	-6.58	-6.53
Turnover$_{t-1}$	0.6542***	0.6542***	0.6297***	0.6304***
	57.43	57.43	44.41	44.39
Constant	0.0437***	0.0438***	0.0692***	0.0675***
	6.40	6.40	7.51	7.30
Observations	69.256	69.256	47.626	47.626
R-squared (within)	0.4746	0.4746	0.4519	0.4507
Firm fixed effects	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes

This table shows the regression results of OLS regression of Turnover on individual and institutional investor attention. The same set of control variables is used as in earlier regressions. A more detailed description of variables is documented in Table A1. T-statistics are reported below coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%.

5.4.3 Repurchase activity, investor attention and Undervaluation

To provide further explanation on the positive relation between institutional attention and share repurchases, I examine the ability of institutional investors to identify and trade on undervalued stock. According to the undervaluation hypothesis, firms increase share repurchases when they believe their stock is undervalued. If institutions identify the same

undervaluation and trade on this, we would expect institutional attention to be higher for these stocks with relatively high repurchase activity, which is in line with the positive relation between both.

To examine whether institutions pay more attention to undervalued stocks, and trade on these stocks, I look at the quarterly returns of these stocks. To do so, I form double sorted portfolios on share repurchase activity and institutional attention. Thereafter, I compare the mean quarterly returns of these portfolios. If the aforementioned relation with undervaluation drives the positive relation, I would expect the returns of the portfolio with high repurchases and high attention to outperform the portfolio with low values for both.

Looking at the results in Table A5, I observe that this hypothesis is not confirmed by the results.[8] The mean quarterly return for the high-high portfolio equals 1.33% for the Compustat II measure, this is lower than the 1.58% observed for the low-low portfolio. This shows that if there is any outperformance at all, this is an outperformance of the low-low portfolio of the high-high portfolio. The highest mean quarterly return of 2.11% is observed when institutional investor attention is high, and share repurchase activity is in the lowest part of the distribution. These results show no evidence that the positive relation between institutional attention and share repurchases is driven by undervaluation. The highest return is obtained for the high-low portfolio, which is in line with literature that share repurchases make prices more efficient and may reduce undervaluation by signaling. In addition, in terms of returns, the high return for this portfolio may indicate that institutions are able to profit from undervaluation if they trade on this before firms start repurchasing or identify this undervaluation. Overall, the portfolios show lower returns when repurchase activity is above median (high). This is in line with share repurchases reducing undervaluation and increasing price efficiency.

5.5 Repurchase activity, Investor attention and Information incorporation

As documented in the paper of Busch and Obernberger (2016), firms may improve price efficiency by repurchasing shares. As investor attention for a firm's stock decreases, providing price support by performing share repurchases may be of larger importance. To build upon the previous section that investor attention induces trading by institutions, I also analyze

[8] I performed similar double-portfolio analysis using 3x3 and 4x4 portfolios. The results remain qualitatively the same.

whether or not share repurchases increase price efficiency during these times of low attention. Based on existing literature, we would expect firms to increase share repurchases during times of relatively low investor attention. In this context, firms act as a 'last resort' when investors stay away from their stock and may increase price efficiency by performing the repurchase. As the earlier documented relation between institutional attention and share repurchases is positive, finding evidence for a negative relation between attention and repurchases on one side, and price efficiency on the other side, contributes to the explanation that other factors (e.g. institutional power) may influence this positive relation.

5.5.1 Repurchase activity, attention and Price efficiency

When the capital market is perfectly efficient, information is complete, and investors are rational, stock prices should reflect the fundamental value of a firm. However, when a firm's stock is neglected by investors this may cause efficiency to decrease. According to the paper of Hou and Moskowitz (2005) this decrease may cause delay of information incorporation into prices and increase idiosyncratic risk for a stock.

Table 6 provides support for the hypothesis that firms are able to increase price efficiency during times of low individual investor attention by performing share repurchases. I test for this relation by regressing *Delay* and *Coefficient-based Delay* on an interaction term of investor attention and Repurchase intensity. The dummy used for low attention in this regression takes value one if a firm's attention is in the bottom quartile of the distribution, and zero otherwise. The coefficients in Table 6 show that the increase in price efficiency is unambiguously higher when investor attention is low. Looking at Panel A, Column (1) shows that a one unit increase in relative *Repurchase intensity* reduces delay by approximately 0.28% during times of low attention. In comparison, this reduction is 0.07% during times of high attention, which is reasonably lower. Columns (2) and (3) show comparable results for regressions on *Delay.* Focusing on Columns (4) – (6) on *Coefficient-based Delay* yields similar results, although overall coefficients are higher in these regressions, the difference between low and high attention continues to exist. Results on statistical testing partly confirm this difference during low and high attention levels.

Table 6, Panel B provides the results regarding institutional investor attention. Results show that the difference between low and high attention is also present when analyzing institutional attention. For example, Column (4) shows that *Coefficient-based Delay* decreases

by 1.76% following a one unit increase in relative *Repurchase intensity* in times of relatively low attention. During times of high attention this effect is only 0.01%. Columns (1) – (3) on *Delay* and the other columns on *Coefficient-based Delay* confirm this view. For differences in institutional attention, statistical testing yields significant results for all of the performed regressions. When I look at the context of this regressions, I would expect firms to increase share repurchases during times of relatively low attention, thereby improving price efficiency.

Table 6: Share repurchases and price efficiency during Low and High attention

Panel A: Individual investor attention

Dependent variable:	Delay			Coefficient-based Delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Compustat I	-0.0028**			-0.0065**		
x Low Attention$_{t-1}$	-2.07			-2.09		
Compustat I	-0.0007			-0.0046**		
x High attention$_{t-1}$	-0.82			-2.12		
Compustat II		-0.0031***			-0.0077***	
x Low Attention$_{t-1}$		-2.75			-2.70	
Compustat II		-0.0009			-0.0034*	
x High attention$_{t-1}$		-1.26			-1.83	
CRSP			-0.0016			-0.0054*
x Low Attention$_{t-1}$			-1.25			-1.78
CRSP			-0.0011			-0.0028
x High attention$_{t-1}$			-1.36			-1.46
R-squared (within)	0.1747	0.1748	0.1747	0.1390	0.1390	0.1390
Observations	78.392	78.392	78.392	78.392	78.392	78.392
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Wald (up-down) (t-test)	1.80	2.94	0.13	0.27	1.78	0.57
Wald (up-down) (p-value)	0.18	0.09	0.72	0.61	0.18	0.45

Panel B: Institutional investor attention

Dependent variable:	Delay			Coefficient-based Delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Compustat I	-0.0099***			-0.0176**		
x Low Attention$_{t-1}$	-3.26			2.39		
Compustat I	0.0012			-0.0001		
x High attention$_{t-1}$	0.91			-0.04		
Compustat II		-0.0097***			-0.0231***	
x Low Attention$_{t-1}$		-3.94			-3.75	
Compustat II		0.0009			0.0018	

x High attention$_{t-1}$		0.92			0.71	
CRSP			-0.0049**			-0.0106**
x Low Attention$_{t-1}$			-2.15			-1.98
CRSP			0.0011			0.0012
x High attention$_{t-1}$			1.06			0.45
R-squared (within)	0.1895	0.1896	0.1894	0.1603	0.1604	0.1602
Observations	53.300	53.300	53.300	53.300	53.300	53.300
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Wald (up-down) (t-test)	12.04	17.06	6.07	5.07	15.07	4.15
Wald (up-down) (p-value)	0.00	0.00	0.01	0.02	0.00	0.04

This table presents OLS regressions of price efficiency measures, *Delay* and *Coefficient-based Delay*, on all three *Repurchase Intensity* measures. The *Repurchase Intensity* measures are interacted with a dummy variable, indicating relatively low or high attention levels. The set of controls consists of the variables *Lagged Delay (Coefficient-based delay), Return, Market capitalization, Book to market, Volatility, Analysts, Turnover, Deviation from $30 and Institutional ownership.* T-statistics are provided below regression coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%.

5.5.2 Repurchase activity, attention and Idiosyncratic risk

Table 7 builds upon the analysis presented in Table 6 by analyzing the effects of *Repurchase intensity* on *Idiosyncratic risk*. Reduced idiosyncratic risk is another implication of higher price efficiency. All Columns in Panel A show that idiosyncratic risk can be reduced by increasing repurchase intensity. Both *R-squared* and |*Market correlation*| increase when repurchase intensity increases, regardless of the amount of investor attention. This shows that idiosyncratic risk decreases with repurchase intensity. Looking at differences between low and high attention levels, the results are in line with Table 6. Again, the effect of price efficiency is higher when individual attention is relatively low, compared to when attention is high. In addition, statistical testing reveals significant statistical differences between both coefficients for Columns (1), (3) and (4).

Panel B shows that for institutional attention, price efficiency improvements appear mostly for relatively low attention situations. Looking at Column (4), a one unit increase in relative *Repurchase Intensity* increases |*Market correlation*| by approximately 1.03% in times of low attention. In contrast, during high attention periods this effect is only 0.06%. This difference between relatively low and high attention is similar for all other columns in Panel B and statistical testing shows that differences are highly significant. As with *Delay* and *Coefficient-based Delay*, these results indicate an increase in share repurchase activity to

increase price efficiency when investor attention is low. Furthermore, these results confirm that the increase in repurchase intensity during periods of high institutional attention are not driven by purposes related to price efficiency.

Table 7: Share repurchases and idiosyncratic risk during Low and High attention

Panel A: Individual investor attention

Dependent variable:	R-squared			|Market correlation|		
	(1)	(2)	(3)	(4)	(5)	(6)
Compustat I	0.0035***			0.0039***		
x Low Attention$_{t-1}$	4.02			4.08		
Compustat I	0.0015***			0.0016***		
x High attention$_{t-1}$	2.74			2.58		
Compustat II		0.0020**			0.0024***	
x Low Attention$_{t-1}$		2.43			2.76	
Compustat II		0.0007			0.0011**	
x High attention$_{t-1}$		1.38			1.97	
CRSP			0.0026***			0.0027***
x Low Attention$_{t-1}$			3.28			3.02
CRSP			0.0010*			0.0011**
x High attention$_{t-1}$			1.94			2.06
R-squared (within)	0.4337	0.4336	0.4336	0.3608	0.3607	0.3607
Observations	78.392	78.392	78.392	78.392	78.392	78.392
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Wald (low-high) (t-test)	4.49	2.22	3.40	4.68	1.99	2.37
Wald (low-high) (p-value)	0.03	0.14	0.07	0.03	0.16	0.12

Panel B: Institutional investor attention

Dependent variable:	R-squared			|Market correlation|		
	(1)	(2)	(3)	(4)	(5)	(6)
Compustat I	0.0084***			0.0103***		
x Low Attention$_{t-1}$	4.92			5.17		
Compustat I	0.0005			0.0006		
x High attention$_{t-1}$	0.61			0.67		
Compustat II		0.0063***			0.0081***	
x Low Attention$_{t-1}$		4.39			4.52	
Compustat II		-0.0005			-0.0006	
x High attention$_{t-1}$		-0.67			-0.78	
CRSP			0.0042***			0.0041***
x Low Attention$_{t-1}$			3.52			2.66
CRSP			-0.0003			-0.0003

x High attention$_{t-1}$			-0.48			-0.42
R-squared (within)	0.4713	0.4713	0.4712	0.3912	0.3912	0.3910
Observations	53.300	53.300	53.300	53.300	53.300	53.300
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Wald (low-high) (t-test)	17.76	18.68	12.00	20.26	20.93	7.22
Wald (low-high) (p-value)	0.00	0.00	0.00	0.00	0.00	0.01

This table presents OLS regressions of *R-squared* and *|Market correlation|* on all three *Repurchase Intensity* measures. The *Repurchase Intensity* measures are interacted with a dummy variable, indicating relatively low or high attention levels. The set of controls consists of the variables *Lagged R-squared (|Market correlation|), Return, Market capitalization, Book to market, Volatility, Analysts, Turnover, Deviation from $30 and Institutional ownership.* T-statistics are provided below regression coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%.

5.6 Robustness checks

In this section I evaluate the robustness of the results. I perform several robustness checks to assure that the results are robust to a number of assumptions or changes in the analytical framework.

First of all, I check if the results were influenced by including institutional ownership into the model. Institutional ownership shows a positive relation with institutional investor attention, which is understandable based on logical reasoning. However, institutional ownership does not show a consistent, significant relation with share repurchases. In addition, including institutional ownership into the model does not change the results for both measures of attention.

To check whether the results hold when excluding the financial crisis from the analysis, I exclude observation from Q3 - 2008 until Q2 – 2009. After excluding these quarters, I repeat my analysis and conclude that the results still hold after excluding financial crisis quarters.

In addition to the previous two robustness checks, I exclude all firm-quarters with values of 0 for individual investor attention. This robustness check is especially valuable for the GSVI attention measure. A value of zero for the Google Search Volume Index indicates that no person has searched for a particular firm during a particular quarter. This is a quite strong assumption and showing that the results are robust when relaxing this assumption is valuable from a robustness perspective. The Bloomberg attention measure is computed in a relative way, value 0 refers to Bloomberg readership below the 80th percentile and is therefore

a realistic outcome. For this reason, I only perform this robustness check for the Google attention measure. The results are reported in Table A6.

Finally, due to data availability there exists a difference in sample period between individual investor attention and institutional investor attention. As both measures are compared in this analysis, it is important that the results for individual investor attention also hold in the 2010 till 2017 sample. I exclude all firm-quarters before the second quarter of 2010 and perform the analysis on individual investor attention again. The results are reported in Table A7 and show that analyzing individual investor attention in this different time frame yields qualitatively the same results as in the full sample period.

6. Conclusion

In this paper, I study the role of investor attention on share repurchase activity by firms. The results show that there is no uniform relation between investor attention and share repurchases. Evidence on individual investor attention shows that firms significantly increase repurchase activity during times of relatively low investor attention. This evidence is in line with existing literature stating that firms may support their stock price if investors stay away from the stock. Looking at this effect from the perspective of economic significance, the effect is quite limited. In contrast, institutional attention shows a positive, significant relation with share repurchases. This relation indicates there may be other factors playing a role in determining a firm's repurchase policy. For both individual and institutional attention, I find no convincing evidence for a difference in both effects during up or down-market state.

Studying potential factors that drive the relation between share repurchases and investor attention, I find evidence that institutional attention induces trading. As turnover may improve a stock's price efficiency, an increase in institutional attention may therefore increase price efficiency. Such an effect is not observed for individual attention, which is in line with existing literature. Further evidence on the relation between share repurchases, investor attention and price efficiency shows that firms can increase price efficiency during times of low attention. This effect appears for both individual and institutional attention and is not observed during times of high attention. A similar effect is observed for the relation between repurchasing, attention and idiosyncratic risk of a firm's stock.

I conclude that the relation between share repurchases and investor attention differs between individual and institutional attention. As both measures show that repurchases can provide both upward price pressure and efficiency during times of low attention, there may be other factors that account for the positive relation between share repurchases. While higher investor attention increases short trading on a stock, compensation for this potential downward stock pressure may be one factor that causes an increase in share repurchases during times of high investor attention. However, the positive relation between attention and repurchases remains when including this factor into the analysis. Furthermore, I do not find evidence that the positive relation is driven by institutional trading on undervalued stocks. Other factors have not yet been observed in this analysis but may be related to literature on institutional power or identification of undervaluation by institutions.

7. Limitations and Further research

In this section I discuss limitations of the performed research. In addition, I elaborate on what the consequences of these shortcomings may be. Thereafter, I describe recommendations for further research on the topic.

7.1 Limitations

The first limitation is based on the wide variety of databases that is being used in this analysis. During the matching process of these variables, a lot of data is lost due to missing values from certain databases. Especially, the completeness of share repurchase data from Compustat is questionable. One example is the Compustat line *'Total shares repurchased',* which provides a direct measure for common stock repurchases during a quarter and is used as a proxy for repurchases in the first specification of *Repurchase Intensity*. This line shows a considerable amount of missing values from which it is not observable which part is missing, and which part is unreported. Such amounts of missing values may cause coefficients to move away from their values under fully available data. Another limitation related to share repurchases is the mismatch between actual repurchases and repurchases reported by Compustat. Compustat reports share repurchases on a quarterly basis, whereas share repurchases are often performed on a daily basis. This biases the reported impact in this paper downwards.

Another limitation is the difference in periodicity between variables. As a consequence, many of the variables are averaged or aggregated to quarterly data points to compare them with share repurchases. This averaging, or aggregating, may cause effects to be smoothened. For example, *'Average daily readership'* from Bloomberg, which proxies for institutional investor attention in this analysis, may be biased downwards by averaging daily into quarterly observations.

Finally, when looking at differences between up and down-market state, one has to realize that the distribution is skewed towards up market periods. Around 75% of the observed firm-quarters is marked as up-market. As the S&P 500 return is relatively stable, the index may identify a certain quarter as up-market while most of the firms in the sample experience down-market conditions. A similar skewness is observed in the distribution between individual and institutional investors. As the average amount of institutional ownership is significantly higher than individual ownership, the results are primarily based by the behavior of institutions.

7.2 Further research

While quarterly analysis provides a solid framework when using a wide variety of measures for repurchase activity, analysis on a monthly or daily basis might prove more valuable. As a shorter time period reduces the effects of averaging on the data, this kind of analysis might improve the robustness of the results. In addition, for some variables, analyzing data on a monthly frequency takes away the need to aggregate monthly data into quarterly data points. While the use of daily data has the potential to provide the strongest results, this analysis cannot yet be performed due to the lack of daily disclosure rules on actual share repurchases. As of such, further research should focus on the effects of investor attention on a monthly basis using SEC filings.

Furthermore, further research might limit the scope to institutional investor attention. As mentioned earlier, the measure on institutional investor attention might suffer from the effects of averaging daily data into quarterly data points. However, at this point in time, the daily readership from Bloomberg is the only direct measure of institutional attention available. When a more sophisticates, direct measure of institutional attention is accessible, perhaps in the nearby future thru Bloomberg, it would be interesting to see what the implications are for the relation between institutional attention and share repurchase activity. Of course, this recommendation requires a change in either the disclosure frequency of share repurchase, or a less frequent measure of institutional attention.

The last recommendation for further research is also related to institutional attention. As a positive relation between investor attention and share repurchases is not yet documented by existing literature, further research on what causes a positive relation may prove valuable. More intensive research on this relation may provide valuable insights in the behavior of both institutions and firms and interactions between both.

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Appendix

Table A1: Description of variables

Name	Definition	Source	Unit
Analysts	Number of analysts (ln)	I/B/E/S	Unit
Book to market	Book value equity divided by market capitalization (winsorized at 1%)	Compustat / CRSP	Ratio
Book value equity	Common equity (compustat: ceqq)	Compustat	Million
Cash	Cash and short-term investments (compustat: cheq)	Compustat	Million
Change in short interest	Change in short interest at the end of the quarter, scaled by shares outstanding (winsorized at 1%)	Compustat	Ratio
Coefficient-based delay	The ratio of the lag-weighted sum of coefficients of the market returns, relative to the sum of all coefficients	CRSP	Ratio
Compustat I	Number of shares repurchased during a quarter (compustat: cshopq), scaled by shares outstanding	Compustat / CRSP	Ratio
Compustat II	Purchase of common and preferred stock (compustat: prstkcy), corrected for decreases in preferred stock (compustat: pstkq), scaled by shares outstanding	Compustat / CRSP	Ratio
CRSP	Decrease in shares outstanding at the end of the quarter from CRSP, corrected for stock splits, scaled by shares outstanding	CRSP	Ratio
Delay	The ratio of R-squared estimates of the base model and extended model	CRSP	Ratio
Distance from $30	Absolute difference between stock price and $30 (winsorized at 1%)	CRSP	Unit
Dividends	Total dividends (compustat: dvt)	Compustat	Million
EBITDA	Operating income before depreciation (compustat: oibdpq)	Compustat	Million
Individual investor attention	Relative value of the (mean) Google search volume index (GSVI), aggregated into quarterly data points	Google Trends	Ratio

Institutional investor attention	Relative value of daily readership from Bloomberg, aggregated into quarterly data points	Bloomberg	Unit
Institutional ownership	Shares held by institutions, scaled by shares outstanding at the end of the quarter	TR Institutional	Ratio
Leverage	(Total assets – book value of equity) / (Total assets – book value of equity + market capitalization)	Compustat / CRSP	Ratio
Market capitalization	Quarterly average of monthly market capitalization	CRSP	Million
Market correlation	Correlation between a firm's daily stock return and market return	CRSP	Unit
Options exercised	Number of shares obtained from options exercise of insiders, scaled by shares outstanding at the end of the quarter (winsorized at 1%)	TR Insider	Ratio
Options outstanding	Number of options outstanding (compustat: optosey), scaled by shares outstanding at the end of the quarter (winsorized at 1%)	Compustat	Ratio
Return	Quarterly average of monthly holding period returns from CRSP	CRSP	Unit
R-squared	Base model R-squared estimate	CRSP	Ratio
Shares outstanding	Quarterly average of shares outstanding at the last trading day of each month within the quarter	CRSP / Compustat	Million
Total assets	Total assets (ln) (compustat: atq)	Compustat	Million
Turnover	Quarterly trading volume, scaled by market cap. at the end of the quarter (winsorized at 1%)	CRSP	Ratio
Volatility	Standard deviation of daily returns per quarter (ln)	CRSP	Unit

This table describes all control variables and repurchase variables used in the analysis. The table reports the variable name, definition, data source and unit of measurement.

Table A2: Descriptive statistics, 2010-2017

	Mean	Median	SD	SD (within)	1st Perc.	99th Perc.	N
Dependent variables: Repurchase measures							
Compustat I	3.76%	0	0.84%	0.7112	0	4.60%	58028
Compustat II	4.35%	0	1.04%	0.9082	0	6.26%	58028
CRSP	3.99%	0	1.02%	0.9039	0	6.13%	57990
Price efficiency variables							
Delay	0.3190	0.2279	0.2725	0.2225	0.0115	0.9960	57960
Coefficient-based Delay	1.5864	1.5193	0.6104	0.5255	0.4671	3.2162	57886
Market correlation	0.4341	0.4404	0.2171	0.1685	-0.0722	0.8742	57995
R-squared	23.56%	19.40%	18.95%	0.1526	0.03%	76.50%	57995
Attention variables							
Google attention	21.42	16	20.67	13.96	0	80.66	58028
Bloomberg attention	0.48	0.31	0.57	0.3486	0	2.36	58028
Control variables							
Assets	6402.14	989.39	25767.22	5650.91	14.743	104894	57841
Analysts (ln)	1.51	1.67	1.14	0.7262	0	3.51	58028
Book to market	0.4576	0.3765	0.3945	0.2077	-0.4710	2.0811	57753
Cash to assets	0.2242	0.1317	0.2419	0.0783	0.0008	0.9630	57841
Dividend to assets	0.0161	0	0.6788	0.0565	0	0.1923	57760
Distance from $30	24.48	16.82	34.84	19.42	0.3483	255.09	57965
EBITDA to assets	0.0162	0.0293	0.0798	0.0504	-0.2608	0.1209	57059
Institutional ownership	0.7114	0.7827	0.2344	0.0997	0.0447	0.9935	46870
Market Capitalization	7329.25	1144.06	28141.37	8565.36	24.08	136928	57965
Options exercised	0.0018	0.0000	0.0047	0.0042	0	0.0311	57836
Options outstanding	0.0560	0.0418	0.0526	0.0233	0	0.2435	54413
Return (holding period)	0.0180	0.0141	0.0963	0.0942	-0.1788	0.2955	57814
Size (ln)	6.94	6.90	1.87	0.3406	2.69	11.56	57814
Turnover	0.0432	0.0184	0.0806	0.0515	0.0015	0.5814	57965
Change in short interest	0.0011	0	0.0197	0.0197	0.0629	0.0784	58028

This table provides descriptive statistics for all the variables used in the analysis for the sample ranging from 2010 till 2017.

Table A3: Analysis of Repurchase intensity and Investor attention, including liquidity

Panel A: Individual investor attention

Dependent variable:	Compustat I		Compustat II		CRSP	
	(1)	(2)	(3)	(4)	(5)	(6)
Google attention$_t$	-0.0017***		-0.0011***		-0.0011***	
	-4.87		-2.95		-3.16	
Google attention$_{t-1}$		-0.0007**		-0.0010***		-0.0011***
		-2.25		-2.74		-2.98
Analysts(ln)$_{t-1}$	0.0613***	0.0614***	0.0648***	0.0648***	0.0707***	0.0707***
	6.25	6.26	5.96	5.96	7.91	7.92
Change in short interest$_t$	2.0245***	2.0203***	2.1450***	2.1429***	1.0348***	1.0329***
	9.07	9.05	7.89	7.88	4.16	4.16
Book to market$_{t-1}$	-0.0255	-0.0255	-0.0022	-0.0022	-0.0314	-0.0314
	-0.99	-0.99	-0.08	-0.08	-1.36	-1.36
Cash to assets$_{t-1}$	0.3414***	0.3410***	0.2667***	0.2666***	0.2390***	0.2390***
	6.06	6.05	4.24	4.24	3.69	3.69
EBITDA to assets$_{t-1}$	-0.0992	-0.1004	-0.1683*	-0.1686*	0.0131	0.0129
	-1.20	-1.21	-1.75	-1.76	0.16	0.15
Size(ln)$_{t-1}$	0.1263***	0.1268***	0.1119***	0.1120***	0.0651***	0.0652***
	6.89	6.91	5.82	5.83	3.78	3.78
Dividend to assets$_{t-1}$	0.0612	0.0635	0.0275	0.0286	0.0871**	0.0881**
	1.11	1.15	0.63	0.65	2.02	2.04
Leverage$_{t-1}$	-0.4157***	-0.4168***	-0.5828***	-0.5835***	-0.2431***	-0.2437***
	-7.37	-7.37	-8.50	-8.51	-4.33	-4.35
Options exercised$_t$	1.2979	1.2956	-2.1109	-2.1018	-0.4613	-0.4508
	1.34	1.34	-1.61	-1.60	-0.41	-0.40
Options outstanding$_t$	0.2151	0.2258	0.3199	0.3223	0.5778***	0.5791***
	0.94	0.98	1.27	1.28	2.60	2.60
Return$_{t-1}$	-0.1517***	-0.1525***	-0.1456***	-0.1462***	-0.2737***	-0.2743***
	-4.22	-4.24	-3.92	-3.94	-5.68	-5.69
Turnover$_{t-1}$	-0.1317	-0.1355	-0.1677**	-0.1687**	-0.0671	-0.0676
	-1.55	-1.59	-2.48	-2.50	-0.90	-0.90
Deviation from \$30$_{t-1}$	-0.0005*	-0.0005*	-0.0011***	-0.0011***	-0.0012***	-0.0012***
	-1.81	-1.83	-4.52	-4.52	-5.54	-5.55
Compustat I$_{t-1}$	0.2277***	0.2276***				
	21.70	21.67				
Compustat II$_{t-1}$			0.1212***	0.1211***		
			12.02	12.01		
CRSP$_{t-1}$					0.1535***	0.1533***
					17.95	17.92
Constant	-0.4649***	-0.4804***	-0.3761***	-0.3787***	-0.0323	-0.0328
	-3.80	-3.94	-2.90	-2.92	-0.28	-0.28
R-squared	0.0776	0.0772	0.0500	0.0499	0.0435	0.0435

Observations	69.262	69.262	69.260	69.260	69.260	69.260
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Institutional investor attention (2010 – 2017)

Dependent variable:	Compustat I		Compustat II		CRSP	
	(1)	(2)	(3)	(4)	(5)	(6)
Bloomberg attention$_t$	0.0030		0.0237		0.0267*	
	0.26		1.54		1.86	
Bloomberg attention$_{t-1}$		0.0223*		0.0305**		0.0364***
		1.88		2.07		2.72
Analysts(ln)$_{t-1}$	0.0369***	0.0373***	0.0455***	0.0456***	0.0510***	0.0511***
	3.64	3.68	3.63	3.64	4.36	4.37
Change in short interest$_t$	1.8385***	1.8403***	2.1095***	2.1252***	0.7573***	0.7751***
	8.72	8.73	7.48	7.54	2.85	2.93
Book to market$_{t-1}$	0.0461**	0.0481**	0.0695**	0.0706**	0.0500*	0.0514**
	1.98	2.07	2.31	2.36	1.96	2.02
Cash to assets$_{t-1}$	0.1930***	0.1918***	0.0931	0.0924	0.1915***	0.1905***
	3.79	3.77	1.36	1.35	2.59	2.58
EBITDA to assets$_{t-1}$	-0.0226	-0.0184	-0.1942*	-0.1929*	0.0728	0.0747
	-0.31	-0.25	-1.90	-1.89	0.81	0.83
Size(ln)$_{t-1}$	0.0575***	0.0544***	0.0670***	0.0655***	0.0081	0.0061
	3.58	3.39	3.20	3.14	0.40	0.30
Dividend to assets$_{t-1}$	-0.0020	-0.0031	-0.0189	-0.0203	0.0123	0.0106
	-0.05	-0.08	-0.33	-0.36	0.25	0.21
Leverage$_{t-1}$	-0.2823***	-0.2810***	-0.5284***	-0.5279***	-0.1487**	-0.1480**
	-5.18	-5.16	-6.62	-7.61	-2.48	-2.47
Options exercised$_t$	1.5374*	1.5391*	-3.5149**	-3.5063**	0.1936	0.2039
	1.73	1.74	-2.55	-2.54	0.15	0.16
Options outstanding$_t$	0.3171	0.3105	0.1474	0.1455	0.6280**	0.6251**
	1.50	1.47	0.54	0.53	2.48	2.47
Return$_{t-1}$	-0.1821***	-0.1828***	-0.2023***	-0.2024***	-0.3033***	-0.3035***
	-5.29	-5.30	-3.98	-3.98	-5.47	-5.46
Turnover$_{t-1}$	-0.1755***	-0.1857***	-0.1798***	-0.1876***	-0.0660	-0.0757
	-2.94	-3.10	-2.60	-2.71	-0.79	-0.90
Deviation from \$30$_{t-1}$	-0.0006**	-0.0006**	-0.0009***	-0.0009***	-0.0010***	-0.0011***
	-2.28	-2.33	-3.42	-3.43	-3.86	-389
Compustat I$_{t-1}$	0.2299***	0.2298***				
	20.55	20.53				
Compustat II$_{t-1}$			0.0914***	0.0913***		
			7.62	7.60		
CRSP$_{t-1}$					0.1322***	0.1321***
					12.74	12.74

Constant	-0.1635	-0.1560	-0.1552	-0.1527	0.0477	0.0513
	-1.55	-1.48	-1.12	-1.10	0.35	0.38
R-squared	0.0692	0.0693	0.0425	0.0426	0.0320	0.0320
Observations	47.632	47.632	47.632	47.632	47.630	47.630
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

This table shows OLS regression results of Repurchase Intensity (Compustat I, Compustat II and CRSP) on Investor attention, lagged Repurchase intensity and control variables. *Turnover* and *Deviation from $30* are added to the regression in Table 3 to proxy for liquidity of a firm's stock. The t-statistics are reported below coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%.

Table A4: Regression of change in short interest on investor attention

Dependent variable:	Change in short interest (abs)	Change in short interest (abs)	Change in short interest (abs)	Change in short interest (abs)
	(1)	(2)	(3)	(4)
Google attention$_{t-1}$	0.0008			
	1.56			
Google dummy$_{t-1}$		0.0421**		
		2.36		
Bloomberg attention$_{t-1}$			0.1552***	
			7.44	
Bloomberg dummy$_{t-1}$				0.1965***
				8.95
Observations	69.262	69.262	47.632	47.632
R-squared (within)	0.0700	0.0701	0.0345	0.0354
Controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes

This table shows the regression results of OLS regression of absolute change in short interest on individual and institutional investor attention. In Columns (2) and (4) a dummy is used taking value one if investor attention is above median and zero otherwise. The same set of control variables is used as in earlier regressions on Repurchase intensity. T-statistics are reported below the coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%.

Table A5: Returns for double-sorted portfolios on repurchases and institutional attention

		Compustat I		**Compustat II**		**CRSP**	
		Low	*High*	*Low*	*High*	*Low*	*High*
Bloomberg	*Low*	1.60%	1.30%	1.58%	1.34%	1.58%	1.30%
attention	*High*	2.29%	1.19%	2.11%	1.33%	2.07%	1.21%
	Low/Low-High/High	0.41%	(4.10)	0.25%	(2.47)	0.37%	(3.41)

This table shows the mean quarterly returns of double-sorted portfolios on repurchases and institutional attention. The split between *Low* and *High* is based on the sample median for each quarter. *Low/Low-High/High* indicates the difference in returns between both portfolios, t-statistics are reported in parentheses behind these differences.

Table A6: Regression of Repurchase activity, excluding zero Google attention quarters

Dependent variable:	Compustat I		Compustat II		CRSP	
	(1)	(2)	(3)	(4)	(5)	(6)
Google attention$_t$	-0.0020***		-0.0016***		-0.0014***	
	-4.73		-3.35		-3.42	
Google attention$_{t-1}$		-0.0009**		-0.0012***		-0.0016***
		-2.33		-2.83		-3.83
Analysts(ln)$_{t-1}$	0.0433***	0.0434***	0.0437***	0.0438***	0.0535***	0.0535***
	3.61	3.62	3.18	3.19	4.61	4.61
Change in short interest$_t$	2.2017***	2.1971***	2.0613***	2.0590***	1.0734***	1.0723***
	8.05	8.03	6.53	6.52	3.54	3.54
Book to market$_{t-1}$	0.0016	0.0014	0.0210	0.0210	0.0188	0.0189
	0.06	0.05	0.67	0.67	0.70	0.70
Cash to assets$_{t-1}$	0.2488***	0.2512***	0.1425*	0.1435*	0.1816**	0.1817**
	3.90	3.93	1.94	1.95	2.39	2.39
EBITDA to assets$_{t-1}$	-0.1460*	-0.1499*	-0.2569***	-0.2585***	-0.0506	-0.0508
	-1.71	-1.75	-2.63	-2.64	-0.58	-0.58
Size(ln)$_{t-1}$	0.1081***	0.1090***	0.1022***	0.1025***	0.0552***	0.0551***
	5.38	5.43	4.70	4.72	2.80	2.80
Dividend to assets$_{t-1}$	-0.0024	-0.0003	0.0124	0.0136	0.0405	0.0413
	-0.06	-0.01	0.27	0.30	1.08	1.11
Leverage$_{t-1}$	-0.4124***	-0.4129***	-0.6026***	-0.6030***	-0.2140***	-0.2144***
	-6.38	-6.37	-7.81	-7.82	-3.45	-3.46
Options exercised$_t$	2.0891*	2.0826*	-16.162	-16.102	0.2823	0.2963
	1.68	1.67	-1.04	-1.04	0.20	0.22
Options outstanding$_t$	0.1977	0.2073	0.2294	0.2330	0.4100	0.4098
	0.75	0.79	0.81	0.82	1.60	1.60
Return$_{t-1}$	-0.1553***	-0.1566***	-0.1827***	-0.1836***	-0.2626***	-0.2634***
	-3.61	-3.63	-4.39	-4.41	-4.96	-4.96
Compustat I$_{t-1}$	0.2003***	0.2001***				
	16.48	16.46				
Compustat II$_{t-1}$			0.1043***	0.1041***		
			9.07	9.07		
CRSP$_{t-1}$					0.1376***	0.1373***
					12.90	12.87
Constant	-0.3707***	-0.4023***	-0.2493*	-0.2569*	0.0177	0.0264
	-2.58	-2.82	-1.70	-1.75	0.13	0.19
R-squared	0.0627	0.0621	0.0435	0.0434	0.0365	0.0366
Observations	48.158	48.158	48.158	48.158	48.156	48.156
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

This table shows OLS regression results of Repurchase Intensity (Compustat I, Compustat II and CRSP) on Investor attention, lagged Repurchase intensity and control variables. For this robustness check, investor attention quarters with value 0 are excluded from the sample. The t-statistics are reported below coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%.

Table A7: Regression of Repurchase activity, 2010 – 2017 sample

Dependent variable:	Compustat I		Compustat II		CRSP	
	(1)	(2)	(3)	(4)	(5)	(6)
Google attention$_t$	-0.0018***		-0.0013***		-0.0011***	
	-4.57		-2.91		-2.69	
Google attention$_{t-1}$		-0.0011***		-0.0013***		-0.0012***
		-2.88		-3.12		-2.94
Analysts(ln)$_{t-1}$	0.0408***	0.0408***	0.0473***	0.0473***	0.0552***	0.0552***
	3.50	3.50	3.79	3.80	4.85	4.85
Change in short interest$_t$	2.4492***	2.4461***	2.5303***	2.5303***	0.9868***	0.9873***
	8.95	8.94	7.96	7.96	3.46	3.46
Book to market$_{t-1}$	0.0464	0.0463	0.0855***	0.0854***	0.0595**	0.0594**
	1.45	1.45	2.69	2.69	2.28	2.28
Cash to assets$_{t-1}$	0.2527***	0.2525***	0.1400*	0.1401*	0.2098***	0.2099***
	3.98	3.97	1.90	1.90	2.69	2.69
EBITDA to assets$_{t-1}$	-0.1220	-0.1234	-0.2843***	-0.2842***	-0.0330	-0.0328
	-1.36	-1.37	-2.63	-2.62	-0.37	-0.37
Size(ln)$_{t-1}$	0.0857***	0.0861***	0.0808***	0.0810***	0.0164	0.0165
	4.06	4.08	3.70	3.71	0.81	0.81
Dividend to assets$_{t-1}$	-0.0474	-0.0461	-0.0002	0.0007	0.0269	0.0278
	-0.87	-0.84	-0.00	0.01	0.51	0.53
Leverage$_{t-1}$	-0.3612***	-0.3620***	-0.6014***	-0.6019***	-0.1696***	-0.1701***
	-5.58	-5.57	-8.19	-8.20	-2.83	-2.83
Options exercised$_t$	11.331	11.384	-3.3161**	-3.3138**	0.7172	0.7177
	1.01	1.02	-2.30	-2.30	0.52	0.52
Options outstanding$_t$	0.5094**	0.5151**	0.3253	0.3258	0.6489**	0.6485**
	2.01	2.03	1.16	1.16	2.47	2.47
Return$_{t-1}$	-0.1779***	-0.1785***	-0.1677***	-0.1682***	-0.2763***	-0.2766***
	-4.28	-4.26	-3.70	-3.70	-4.96	-4.95
Compustat I$_{t-1}$	0.1961***	0.1959***				
	16.57	16.54				
Compustat II$_{t-1}$			0.0880***	0.0878***		
			7.75	7.73		
CRSP$_{t-1}$					0.1304***	0.1303***
					12.74	12.73
Constant	-0.3046**	-0.3179**	-0.2220	-0.2214	0.0273	0.0300
	-2.20	-2.31	-1.54	-1.54	0.20	0.22

R-squared	0.0549	0.0545	0.0381	0.0381	0.0300	0.0300
Observations	52.147	52.147	52.147	52.147	52.145	52.145
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

This table shows OLS regression results of Repurchase Intensity (Compustat I, Compustat II and CRSP) on Investor attention, lagged Repurchase intensity and control variables. For this robustness check, the sample for Google attention is reduced to the Bloomberg sample from 2010 until 2017. The t-statistics are reported below coefficients. *, ** and *** refer to significance levels of 10%, 5% and 1%.