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Share buybacks:
The effect of open-market share repurchases on price efficiency and the information content of stock prices

A study of share repurchases in a framework of individual investors' attention

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Abstract

This thesis examines the effect of share repurchases on price efficiency and the amount of idiosyncratic risk of the stock price in the United States by using different measures for share repurchases, price efficiency and idiosyncratic risk. The analysis consists of a manually collected dataset of open-market share repurchases for the period 2011 until 2017. The thesis finds that open-market share repurchases reduce the price delay in stock prices and the amount of idiosyncratic risk incorporated into stock prices. Both effects are more pronounced in quarters with overall negative market returns than in quarters with positive market returns. Moreover, this thesis finds evidence that investors' attention is negatively related to repurchase activity. Variations in the environment of the accounting standards of a firm show little evidence concerning the effectiveness of share repurchases on price efficiency. This empirical research enhances the current literature by putting both price efficiency and idiosyncratic risk into a framework of individual investors' attention and discrepancies in the environment of accounting standards.

Keywords: open-market share repurchases, price efficiency, idiosyncratic risk, individual investors' attention, accounting standards

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Table of Contents

List of Figures

List of Tables

Appendices

1. Introduction

The American President, Donal Trump, introduced one of the biggest corporate tax cuts in the history of the United States on April 16 of 2018. The corporate tax was reduced from 35% to 21%. The tax cut was induced to boost the economic growth of the firms and increase the wages of employees. However, in practice, a part of the tax savings of the firms is used to redistribute money back to the shareholders through buybacks, larger dividends or to boost equity-based compensation. The introduction of new tax ruling led to a severe boost to share repurchases in the United States. In the first three months of 2018, the amount of dollars spent on share repurchases has doubled the total expenses in the prior year. (Otani, Rubin and Francis, 2018). Moreover, Goldman Sachs expects that the overall buyback volume in 2018 will reach a record of $1 trillion (Wigglesworth, 2018).

Next to the introduction of the corporate tax cuts comes the fact that public firms have become larger in terms of total assets and market capitalization, while the number of shares repurchased as percentage of shares outstanding has slightly increased during the last decennia.[1] The larger capitalization leads to a higher value of share repurchase programs all things being equal. As example, a share repurchase by a firm of one per cent of the total shares outstanding accounts for more value than it used to in the past.

Busch and Obernberger (2016) mention that share repurchases have become the dominant form of payout in the United States between 2004 and 2010. In addition to this, the aforementioned arguments result, evidently, in an increase in the value spent on share repurchases lately, which increase the importance of the effects of share repurchases on the content of the stock price even more.

This thesis examines the effect of share repurchases on stock price efficiency and information content in a framework individual investors' attention and accounting environment with open-market share repurchases as type in particular.

The analysis consists of two group of measures, where the first group of measures determines the price delay with which new information is incorporated in the stock price. The second group of measures analyses the amount of idiosyncratic risk incorporated into the stock price. The first group of measures uses the market model and the extended market model including five lags of the market returns to explain returns following the methodology of Hou

[1] Busch and Obernberger (2016) report a repurchase intensity of 0.16% on a monthly basis, whereas new analysis shows a repurchase intensity of 0.20% while trading volume remained equal.

and Moskowitz (2005). The explanatory power of both models is compared to each other. The idea behind this method is that the higher the explanatory power of the lagged returns of the extended market model defines a higher price delay and hence a less efficient price stock price. The second group of measures tests the amount of idiosyncratic risk incorporated in a stock price. The amount of idiosyncratic risk is measured using the R-squared of the market model following the methodology of Roll (1988). The second proxy to measure the amount of idiosyncratic risk is the absolute market correlation between the stock returns and market returns. If share repurchases reduce the amount of idiosyncratic risk and hence reduce the noise in the stock price, the R-squared and the absolute market correlation should increase as well. The research question can be formulated as follows.

What is the effect of open-market share repurchases on the efficiency and information content of stock prices?

To address this question, I manually compile a dataset including all open-market share repurchase programs between 1st of January 2011 until 31st December 2017 recorded by SDC ThomsonOne. The final dataset consists of 2.521 unique repurchase programs of 1.255 unique United States firms. The final sample includes 35.578 firm-quarters with 18.364 quarters in which an actual open-market share repurchase program has occurred. The sample is constructed as a panel data set of quarterly observations. In the analysis, I regress several different measures of price efficiency and idiosyncratic risk on a measure of individual investors' attention, repurchase measures and the control variables.

To calculate the proxies for repurchase activity, I follow the methodology of Busch and Obernberger (2016) using two distinct measures. The first measure calculates the number of shares repurchased, scaled by the total number of shares outstanding. The second measure takes the number of shares targeted initially by the firm minus the number of shares repurchased until date under the specific repurchase program. All models in the analysis use firm and time fixed effects. The use of a fixed effects model overcomes that any results are driven by unobserved heterogeneity.

This thesis first analyses the relationship between repurchase activity and which factors are driving repurchase activity. I observe that the size of the program and the state in which the repurchase program is, in terms of length, drives the intensity of share repurchases. This is mainly because firms front-load execute the repurchase programs. Thereafter, I analyse the

effect of repurchase intensity on the individual investors' attention and find evidence that firms repurchase shares when the relative investors' attention is low.

Subsequently, I regress the different repurchase measures on two distinct measures for price efficiency. The results show evidence that share repurchases reduce the price delay on a quarterly basis. In other words, share repurchases increase the efficiency of stock prices. Thereafter, the repurchase measures are put in a framework of different accounting environments of the firm. Variances in accounting standards do not affect the repurchase activity, nor the price efficiency level or the amount of risk incorporated into the stock price.

Afterwards, I test the relationship between the share repurchase measures and the amount of *Idiosyncratic risk*. These results show evidence that share repurchases reduce the amount of *Idiosyncratic risk* incorporated into the stock price when zoomed out on a quarterly basis.

Thereafter, I test both the effect of share repurchases on the price efficiency and the amount of idiosyncratic risk in up and down markets, whereas markets are either up or down based on the summed returns of the quarter. I find that the effectiveness of share repurchases towards the reduction in price delay is more pronounced in down markets than up markets. Furthermore, I observe a reduction in the amount of *Idiosyncratic risk* when share repurchases are performed in down markets, while share repurchases increase the amount of *Idiosyncratic risk* in up markets in the long run. The immense growth in share repurchases during the last quarters is not a potential area for research yet, however, the findings in this thesis expose the effect of share repurchases nonetheless and are not bound to temporal time frames as some of the results are comparable to previously performed research on this subject.

Subsequently, I frame share repurchases in relative levels of high and low individual investors' attention within the firm and examine if the effectivity of share repurchases is affected by the level of individual investors' attention. The results are not unambiguously and therefore no hard conclusions can be drawn. However, there are indications that share repurchases are more effective when the level of attention is low. This means that firms might use share repurchases as a last resort when investors forsake to keep the price efficient.

Busch and Obernberger (2016) find evidence that share repurchases increase the speed or accuracy with which available information is incorporated into stock prices and consequently increase the price efficiency. According to Busch and Obernberger (2016), repurchase activity is negatively related to stock price delay. Repurchase activity measures the portion of shares which are repurchased in a quarter scaled by the number of shares outstanding. An increase in repurchase activity should decrease the price delay and hence share repurchases should increase

the efficiency of stock prices. As mentioned by Busch and Obernberger (2016) this reasoning is based on the unique characteristic of share repurchases that they can only incorporate positive information into stock prices because firms engage as a buyer of their own stock. Firms can intervene in the stock market using two different channels either a market order or a limit order. A market order means that the firm buys the share at the best current market price, which directly reveals positive information to the market, resulting in a more efficient priced stock. A limit order means that the firm buys the share at a predetermined price, which sets a lower bound for the stock price (Busch and Obernberger, 2016). The use of either one of the two different channels and actively trading on positive information which is not yet incorporated into the stock price should increase the price efficiency.

Hou and Moskowitz (2005) reason that stock prices might be less efficiently priced because some stocks are neglected by or less visible for investors. According to Gordon and Wu (2018), price delay is partially a result of attention constraints of investors. Investors are constrained by limited cognitive ability and limited availability of time and information. These constraints lead to different rates of price reflection in stock prices. Firms which perform share repurchases attract attention towards their stock which should result in a more efficiently priced stock. This thesis builds further upon the hypothesis of Busch and Obernberger (2016) by addressing the effect of share repurchases on price efficiency.

The analysis in this thesis contributes to the existing literature because this time period has not been analysed before. The results from this thesis can be used for further research on this topic. It provides insights in the effect of share repurchases on price efficiency and the information content in the long run in a framework of individual investors' attention. The effect of individual investors' attention on and the link with share repurchases has not been made before. This insight helps in the understanding when firms perform share repurchases. This insight can be used and extended for further research on both price efficiency of stock prices and share repurchases.

This thesis is structured as follows; Chapter 2 describes the theoretical framework in which share repurchases can be placed along with the motives of firms for share repurchases, share repurchase characteristics and the legislation. Chapter 3 discusses the considerations for the hypothesis development. Chapter 4 provides an overview on the data and methodology, which includes the construction of the dataset, the variables and the models used for the empirical analysis. Chapter 5 presents the results of the empirical analysis. Chapter 6 provides a conclusion of the results found in Chapter 5. At last, Chapter 7 postulates the limitations of this thesis together with recommendations for further research.

2. Theoretical Framework

To apprehend the way share repurchases work and the reason why managers perform share buybacks, a detailed description will be given in the following chapter. Furthermore, an overview of the types of share repurchases, the motivational background and the legislation on share repurchases will be provided. Share repurchase programs are a popular way of distributing money because it is a relatively flexible method in comparison with dividends. Dividends have to be paid immediately, whereas share repurchase programs can be conducted over a self-determined time period.

One of the tasks managers have, is financial management, and therefore, as part of financial management, creating value for shareholders. A manager can use different distribution policies to create value, for example, by paying dividends to shareholders or by increasing the stock price. Even though based on historical evidence share repurchases were not of vital importance, the last two decades share buybacks have become increasingly popular over time, with the United States as the forerunner in this area (Wesson, Smit, Kidd and Hamman, 2017). By the year 2005, the dollar value spent on share repurchases has exceeded the amount spent on dividend payouts for the first time. Nonetheless, there was a slight reversal during the financial crisis, however thereafter the repurchase programs exceeded the dividend payouts ever since. This phenomenon makes share repurchases the dominant form of payout in the United States. It has even become the preferred way of distributing capital globally (Wesson, Smit, Kidd and Hamman, 2017). The increase in the value of share repurchases and the substitution of dividend for share repurchases are partially due to changes in the disclosure rules. Additionally, share repurchases give firms more flexibility in the payout relative to dividend payments. Dividend payments are commitments that make firms obligated to follow their statement, whereas share repurchases are not mandatory.

2.1 Types of Share Repurchases

The following section describes the different categories of share repurchase programs. Share repurchase programs can occur in four different types depending on the firms' preferences. The different types are open-market share repurchases, Dutch auction, fixed price tender offer and privately negotiated repurchases. Each program type has its specific characteristics with peculiar advantages and disadvantages which will be discussed in the following paragraphs.

2.1.1 Open-Market Share Repurchase

According to Busch and Obernberger (2016), open-market share repurchase is the most dominant and most common form of share repurchases and accounts for approximately 90% of the total repurchase volume in the United States. This phenomenon holds for both the number of announcements and the summed dollar value. In an open-market share repurchase program, the firm buys back its own shares from the market over time. An open-market share repurchase announcement does not commit a firm to actually buy back its' shares neither does it restrict them to repurchase a specific number of shares. However, to buy back shares, it is mandatory to make an announcement before the actual repurchase. Since it is not obligatory to commit to the initial repurchase announcement many firms either buy a much higher or a much lower percentage of the initially targeted shares as can be derived from the results of the research of Stephens and Weisbach (1998). On the one hand, this can decrease the credibility of a firm and hence the impact of the share repurchase. On the other hand, this increases the flexibility of the firm to adjust if necessary. An open-market share program includes information about the dollar value and the period in which it wants to repurchase the shares. If the open-market share repurchase program is effectively implemented it can be a cost-effective way to repurchase shares.

2.1.2 Fixed-Price Tender Offer

The second share repurchase program type is the fixed-price tender offer. This type only accounts for a small amount of the total repurchase volume with respect to the open-market share repurchase program and is, therefore, a much less frequently discussed subject in the literature. A fixed-price tender offer is a repurchase program type where the firm offers an equal amount of value for a specific number of shares to all shareholders. This offer is only valid for a specified time period. The firm can set a minimum threshold for the number of shares it wants to obtain to let the program be successful. Furthermore, the managers can expand the program if the initial target of shares are oversubscribed but are not obliged to do so. These characteristics increase the flexibility of the firm to adjust the number of shares considerably. However, a fixed price tender offer is less flexible than an open-market share repurchase program, because the firm has to propose a specific number of shares in advance.

2.1.3 Dutch Auction

The Dutch auction repurchase program uses, like the fixed price tender offer, a fixed price in advance. However, the difference from fixed-price tender offer is that managers seek information from shareholders prior to the acknowledgment of an offer to determine a price.

The managers will set a price range where shareholders can select a single rate at which they are willing to tender their shares. Subsequently, the shares will be repurchased in ascending order until the targeted number of shares have been repurchased. The actual price is set after all bids have been collected. Shareholders will offer a price and the number of shares they are willing to sell. Afterwards, the shareholder will be paid the highest bid accepted, instead of the single price bid per shareholder. Managers have the incentive to minimize the payment to shareholders, whereas shareholders have the incentive to overbid to optimize their value (Gay, Kale and Noe, 1996). The shareholders' value is nonetheless affected. The shareholders' shares are either affected because their shares are sold, or because the shareholders are the remaining ones and therefore must pay their contribution to the other shareholders. The former mentioned is in contradiction to other share repurchase programs, where the shareholder is not affected (Gay, Kale and Noe, 1996). In the end, managers will have to pay a higher price for their shares relative to open-market share repurchase programs, because shareholders tend to overbid their reservation price. Furthermore, managers have to pay the highest bid accepted from the Dutch auction price. However, Dutch auction repurchase programs still tend to be cheaper than tender offers, because of the fixed rate. Dutch auctions are typically preferred over fixed price tender offers when a large number of shares is sought, but managers are willing to pay less of a premium. Both fixed-price tender offers and Dutch auction repurchases are an efficient way to repurchase many shares in a short time period (Grullon and Ikenberry, 2000).

2.1.4 Privately Negotiated

The fourth share repurchase program type is the privately negotiated share repurchase program. This type is unique because shareholders can take the initiative to sell shares to the firm instead of the managers. This type of program is initiated when the stock is very commonly traded or when the shareholder has a significant share in the firm. There are four different ways in which a privately negotiated repurchase program can be performed. The first is a hostile approach where the firm pays a premium above the market price and is called greenmail. The second approach is to repurchase shares from employees whose restrictions are overdue. The third approach is to offer a price at a premium if the managers believe that the firm is undervalued. Lastly, the fourth strategy is to offer a lower price and to repurchase at a discount.

2.1.5 Accelerated Share Repurchase

An accelerated share repurchase is a specific method of a share repurchase program in which an intermediary is hired to buy a certain number of shares at a predetermined price. The intermediary is typically an investment bank and the predetermined price will be close to the

most recent closing price. The intermediary is responsible for the purchase of the shares from other shareholders and the sale to the specific firm. The intermediary borrows the shares from the institutions and takes a short position. Subsequently, the intermediary purchases the shares back in the regular market over time. The difference in price between the initial price and the estimated price per share that would have occurred in an open market repurchase program is the compensation for the intermediary if the estimated price is higher and the repurchasing company will be compensated (Bargeron and Kulchania, 2011). Performing an accelerated share repurchase is a specific method, which means that it does not exclude the other types, but it is an addition to the types. By including an accelerated share repurchase in the program, the firm commits to repurchase the shares and receives the shares immediately. An accelerated share repurchase reduces the flexibility of a firm that is dependent on the fraction of the accelerated share repurchase relative to the total program. On the other side, it increases the credibility of the firm to actually perform and complete the repurchase program. This is beneficial when firms initiate a program to signal information to shareholders or as a use for takeover deterrence (Bargeron and Kulchania, 2011).

In this thesis, only open-market share repurchases will be in the scope of research because this type accounts for both the most prominent part of the share repurchase value and the number of occurrence of share repurchase program type.

2.2 Motives for Share Repurchases

In the literature, several different arguments are suggested and discussed which are related to share repurchase announcements. The following section gives an overview of the background on the academic research related to share repurchase motives.

2.2.1 Signalling Hypothesis

Firms might induce share repurchase programs because of several different reasons. A popular reason in the academic literature for share repurchases is the signalling hypothesis. Several studies have found that the signalling hypothesis is a plausible explanation (Dann 1981; Constantinides and Grundy, 1989). Managers signal their optimism about the positive firm's prospects (Grullon and Ikenberry, 2000). However, this signal can be ambiguous to investors. For example, investors might reason that the firm has no internal growth opportunities to invest their excess cash flow in. On the other hand, the firm might be undervalued, which makes it relatively cheap to buy back its own shares. The signalling hypothesis is based on asymmetric information; the fact that managers have complete and better information about the firm than

outsiders. Shareholders only have access to public information, therefore the managers have more complete information and can make better predictions about future cash flows and earnings (Vermaelen, 1981). If managers believe that the actual share price fails to reflect the future cash flows and earnings then the manager can induce a share repurchase program and reveal information that the stock price should be higher or to communicate their dissatisfaction about the stock price. Previous literature has found positive abnormal returns around share repurchase announcements when considering the relation between undervaluation and announcement returns (Vermaelen 1981; Comment and Jerrel, 1991; Stephens and Weisbach, 1998; Ikenberry, Lakonishok and Vermaelen, 1995), as an extension, research of Busch and Obernberger (2016) shows that repurchase announcements are followed by positive abnormal returns if the stock price falls below its fundamental value. However, if the stock price equals its fundamental value then no abnormal returns are perceived.

2.2.2 Free Cash Flow Hypothesis

Another argument to perform a share repurchase is the free cash flow hypothesis as proposed by Jensen (1986). Free cash flow is the excess cash flow that is abundant when all projects with a positive net present value are funded and discounted at the cost of capital (Jensen, 1986). This hypothesis is based on the principal-agent theory, where the managers are the agents and the shareholders are the principals. There is a separation between ownership and control in a firm. Furthermore, the interests of managers and shareholders are not perfectly aligned, and therefore managers and shareholders behave in their own interests. An agency conflict can arise when managers have excess cash available. Managers have the incentive to let the firm grow beyond its optimal size and are inclined to use the excess cash for profitless investment projects, which is called empire building. The risk for empire building is specifically high for companies with an abundant amount of free cash flow. The growth of a firm and the managers' power and control are positively related. Subsequently, the growth of the firm increases the compensation of the manager. The hypothesis prevents managers from overinvesting. In contradiction to the signalling hypothesis, the free cash flow hypothesis sends only a positive signal to investors (Jensen, 1986). The hypothesis states that the redistribution of cash prevents managers from overinvesting and reduces the control and power of managers. This results in lower agency costs and less risk. (Jensen, 1986); Grullon, Michaely and Swaminathan, 2002).

2.2.3 Capital Structure Hypothesis

The capital structure hypothesis tells the firm how and why a firm can benefit from share repurchases. By performing a share repurchase, the firm changes its capital structure. Research

of Dittmar (2000) shows that one of the reasons to perform share repurchases is to increase the leverage position. A share repurchase decreases the equity of a firm by reducing the number of shares outstanding and consequently, this increases the leverage ratio of the firm. This theory takes into account two main components, the target leverage ratio and the fact that equity might be mispriced. According to the trade-off theory, a firm makes a trade-off between the amount of debt financing and the amount of equity financing to obtain an optimal position concerning costs and benefits. Firms may not be operating in line with the optimal target leverage ratio due to asymmetric information or financing costs. The trade-off theory suggests that firms move towards their optimal leverage ratio by repurchasing equity.

The market timing theory, a theory of the capital structure of a firm and often contrasting to the trade-off theory, also makes a trade-off between the benefits and costs of capital. However, the trade-off theory and the market timing theory do not necessarily rule out each other. The market timing theory mainly focuses on the fact that mispricing exists and explains that managers exploit this mispricing by issuing equity if overvalued and repurchasing equity if undervalued. In the paper of Warr, Elliott, Johanna and Özde (2012), they state that overvalued firms move back towards their optimal target leverage ratio more quickly than undervalued firms due to significantly higher adjustment costs. According to Bonaimé, Öztekin and Warr, (2014), this is evidence towards the fact that managers exploit the mispricing of equity and towards the market timing theory.

2.2.4 Dividend Substitution Hypothesis

The substitution hypothesis states that firms make a trade-off between either a payout in dividends or by repurchasing shares. According to the model of Miller and Modigliani (1961), dividends and share repurchases are perfect substitutes if capital markets are perfect and complete. This means that a firm is indifferent in redistributing the residual cash between the payout as a dividend or increasing the shareholders' value through a share repurchase. Later models, like the model of John and Williams (1985) and the model of Allen, Bernardo and Welch (2000) show that dividends and share repurchases are not substitutes after all. Allen, Bernardo and Welch (2000) reason that institutional investors prefer dividend over share repurchases. They argue that institutional investors can detect undervaluation or overvaluation better than individual investors due to better information gathering. And firms which are undervalued are the ones that want exposure or signal that they are undervalued and hence these firms will pay higher dividends. Grullon and Michaely (2002), find evidence towards a substitution effect between open-market share repurchases and dividends. As an argument, they say that firms

consider it to be more efficient to redistribute cash to their shareholders in the form of share repurchases due to a reduction in the long-term capital gains tax rate. In this case, the tax rate over capital gains (share repurchases can be qualified as capital gains) is lower than the tax rate of dividends. Furthermore, investors can choose to pay the taxes on capital gains in a later period, since capital gain taxes induce when the shares are sold. This argument could explain why investors and managers prefer to redistribute cash through share repurchases instead of dividends. The higher the tax benefit of capital gains is over dividend tax, the higher the tendency of a firm to repurchase shares instead of dividends.

2.2.5 Undervaluation Hypothesis

The undervaluation hypothesis is based on the asymmetric information between the marketplace and the managers (Ikenberry, Lakonishok and Vermaelen, 1995). This hypothesis states that managers buy back shares when the stock price is believed to be undervalued. This makes share repurchases a relatively low-cost method for firms to repurchase stocks at this point. Furthermore, it offers firms more flexibility to redistribute money to their shareholders relative to dividend payments. On the other side, firms might not be able to push the price upwards enough. The positive abnormal returns after an announcement should correct the misvaluation in the long run. However, Ikenberry, Lakonishok and Vermaelen (1995) mention that there are positive abnormal returns in the four year time period after the announcement, assuming that a share repurchase announcement is not enough to correct the misvaluation. However, as aforementioned in the signaling hypothesis, there is a thin line between signaling undervaluation to shareholders and the lack of growth opportunities. Managers need to be careful and think thoroughly before issuing a share repurchase program.

2.2.6 Price Support Hypothesis

Closely related to the undervaluation hypothesis is the price support hypothesis. Managers can use share repurchases again as a form of price support of the stock price. However, it is different from the undervaluation hypothesis that managers repurchase shares when the stock price has shown a decline in the stock price, which is not necessarily when the stock price is below its fundamental value. The price support hypothesis states that managers buy back shares whenever there has occurred a decline in the stock price. Following the efficient market hypothesis, the stock price should converge towards its fundamental value in the long run.

Busch and Obernberger (2016) find evidence for the price support hypothesis that stock prices are lower on days where firms repurchase shares than on prior non-repurchase days.

However, there is no need for statistical difference whenever there are subsequent non-repurchase days.

2.2.7 Takeover Deterrence Hypothesis

As the name states, the takeover deterrence hypothesis helps a targeted firm to deter a takeover. This helps to better protect against acquirers due to the fact that Bagwell (1992) points out. He mentions in his research that the supply curve of shares is upward sloping. As a result of this, the more shares are repurchased, the higher the price is and hence the acquisition costs increase. This is because shareholders who are prepared to tender their shares are usually the ones with the lowest valuations (Bagwell 1991). Thus, the targeted firm can increase the share price by acquiring its' own shares. By repurchasing shares, the firm can buy back the shares at the reservation price. This way, the firm can increase the price of a stock by increasing the lowest price available and pushes the remaining shareholders to a higher price. The targeted firm has a small benefit over the acquirer since the targeted firm only needs to repurchase a small amount of the total shares, but enough to push the price upwards, while the acquirer has to buy at least fifty percent of the total shares. Dittmar (2000) documents that firms that have a higher probability of being a target in a takeover are more likely to perform a share repurchase program. From this, he deduces that targeted firms use share repurchase programs as a takeover deterrence.

2.2.8 Managerial Overconfidence

The managerial overconfidence hypothesis can be framed in a more behavioural concept. This theory is based on the fact that humans believe that they are better than the average and supported by the bias that good outcomes are attributed to yourself and bad outcomes are bad luck or the cause of others (Chu, Yeh, Chiang and Hung, 2013). Overconfident managers believe that the stock of their firm is undervalued, and because of the undervaluation, they initiate a share repurchase program to push the stock price upwards. The concept of overconfidence is somewhat abstract, but in the literature defined as general miscalibration in beliefs (Ben-David, Graham and Harvey, 2007). This results in an overestimation of their own precision and an underestimation of their perceived risk. However, this theory distincts itself from the undervaluation theory because empirical research finds no undervaluation (Ben-David, Graham and Harvey, 2007).

2.2.9 Market Timing Ability

The market timing ability hypothesis states that managers are able to time the market. In the context of share repurchases, this means that managers are able to determine when the price is the lowest. Hence, the repurchase price must be lower on repurchase days than on subsequent non-repurchase days. The issue here is whether inside managers can outperform the market and repurchase the shares on days that the stock price is relatively undervalued. Despite the numerous investigations, academics are still in dispute whether managers can time the market (Dittmar, 2015).

The hypotheses above give a summary of motives that managers use to justify a share repurchase program. Important to notice is that one motive for share repurchases does not necessarily invalidate the other motive. Multiple motives can be the foundation of a share repurchase program at the same time. All hypotheses previously mentioned have been tested in empirical research, but in different market conditions and with varying samples of firms and are therefore hard to translate one to one in the real world. However, this chapter gives insight into the reasoning and decision making of managers.

2.3 Share Repurchase Characteristics

This section presents a short overview on the background of developments that have occurred over the past decades concerning share repurchases accompanying with characteristics of share repurchases different than firm-specific characteristics like growth opportunities or valuations. Over the last decades, anomalies tend to disappear and characteristics of share repurchase have a tendency to change. Trends in the completion rates, abnormal returns and the rate of repeating announcements are observed and will be elaborated on to provide some background on this subject.

2.3.1 Frequent Announcements versus Infrequent Announcements

In the literature on share repurchases, there is an increasing trend in the number of repeating announcements. Ding, Koerniadi and Krishnamurti (2017) show that firms tend to announce a share repurchase announcement more often than before. Although more managers observe share repurchase more often as a solution to the aforementioned motives, they also have the tendency to regularly initiate a program after they initiated a program once before. In their sample, the number of repeated share repurchase announcements went from roughly 50% around 1998 to approximately 73% around 2012. This means that 73% of the firms perform at least twice a share repurchase program in the sample period between 1996 and 2014.

Furthermore, of all repurchase announcements, repeating announcements are the vast majority of the total number of announcements. Repeating announcements are interesting because firms which repeat an announcement appear to have contradicting characteristics in comparison to non-repeating firms. On average, firms that repeat announcements more often are larger, more profitable, have more excess cash flow and are less undervalued than non-repeating announcement firms.[2] Furthermore, the institutional ownership of frequent firms is higher and the managerial ownership is lower. This might be because frequent repurchasing firms use share repurchases to increase the share price or provide price support to make shareholders content. Also, the reason for a repurchase program is motivated differently by frequent and infrequent repurchasing firms. Infrequent repurchase programs are more often motivated by undervaluation than frequent ones.

Ding, Koerniadi and Krishnamurti (2017) show that share repurchase announcements are followed by positive abnormal returns, however, the more a firm is repeating a repurchase announcement, the lower the positive abnormal return will be for their sample between 1996 and 2014. Ding, Koerniadi and Krishnamurti (2017) find evidence that firms which repeat repurchase announcements have an abnormal return of 1.33% after their initial repurchase program, then a 0.90% abnormal return after their second announcement and then a significantly lower abnormal return of 0.27% when repurchasing five times or more in the sample period. Contradicting is that firms which obtain negative abnormal returns in the past are more likely to initiate a repurchase program again. However, this is in line with the manager's overconfidence hypothesis trying to achieve higher personal wealth instead of creating shareholders value and the price support hypothesis that states that managers repurchase shares after a decline in the stock price. Based on the literature of Ding, Koerniadi and Krishnamurti (2017), it can be stated that the fraction of repeating announcements has increased. The total number of announcements is very unstable because this is highly positively correlated with market conditions. In economic prosperous times the number of share repurchases increases severely and decreases heavily during depressions.

2.3.2 Cumulative Abnormal Returns

The majority of empirical research on share repurchases has been devoted to the relation between abnormal returns and share repurchase announcements. It is important to notice that

[2] Similar results to the analysis of Ding, Koerniadi and Krishnamurti (2017) are found for the sample used in this thesis.

there is a difference between the short run and the long run abnormal returns when observing abnormal returns.

When observing share repurchase programs for a sample period between 1970 and 1981 Vermaelen (1981) finds a cumulative abnormal return of 3.62% with a three-day event window around the announcement. Subsequently, Comment and Jarrell (1991) found a cumulative abnormal return of 2.30% for the sample period 1984 until 1989. After that, research of Stephens and Weisbach (1998) examined the abnormal returns around the announcement date and found a three day geometrically calculated cumulative abnormal return of 2.69% for the years 1981 until 1990. Empirical research of Yook and Gangopadhyay (2011) shows that the cumulative abnormal return had dropped from 2.59% in 1994 to 1.62% in 2007. A considerable decrease in the abnormal returns in the short run since 2003 is noticed. Obernberger (2014) finds cumulative abnormal returns of 0.65% for a three-day event period for the years 2004 until 2010 around the announcement date. However, research of Ding, Koerniadi and Krishnamurti (2017) finds cumulative abnormal returns of 2.4% on average for a two-day event period. However, for this sample significantly lower returns are shown from 2003 and later.

Concerning the abnormal returns in the long run, evidence shows a different pattern than the short run abnormal returns in the literature. Long run abnormal returns are used as an explanation for and imply misvaluation or are provided as a reason to justify market timing ability of managers. Ikenberry, Lakonishok and Vermaelen (1995) observe a four-year-buy-and-hold abnormal performance of 12.1% after the initial announcement for a sample for the period 1980 until 1990. The analysis of Peyer and Vermaelen (2008) shows evidence that the long run abnormal performance anomaly is still valid for the sample period of 1991 until 2001. They find an average long-run abnormal return of 24.25% for the whole sample and claim that the buyback anomaly still persists. However, Fu and Huang (2015) show that the long-run abnormal returns diminish during a sample period between 2002 and 2013. They mention a changing market environment as a reason for the disappearance. By changing market environment, the authors mean better liquidity, more transparent and credible disclosure rules and lower trading costs. The changing market conditions are also consistent with a higher level of price efficiency (Fu and Huang, 2015).

Concluding, from the previous literature it can be deduced that there has been a descending trend in the cumulative abnormal returns around the share repurchase announcement dates in the short run and a diminishing effect on the long-run concerning the abnormal returns.

2.3.3 Length, Size and Completion Rates

When observing the length of the average repurchase program, only a meaningful remark can be made for the years 2004 until the present time, because of the new disclosure rules of 2004 which will be further elaborated on in chapter 2.4 ‘’Legislation in the United States’’. Until the year 2004, academics were unable to estimate the number of shares repurchased exactly and unable to define the real length of a program. The length of repurchase programs is defined as the number of quarters since the announcement. Busch and Obernberger (2016) find that the average length of a repurchase program is 16 months.

With respect to the size of the program, there has been little to no change over the years. The program size is measured as the shares targeted in the initial plan divided by the total shares outstanding. In the early years of the academic literature on share repurchases, Stephens and Weisbach (1998) find target ratios of 7.0% for a sample period of 1981 until 1990. Thereafter, research of Bonaimé (2012) shows that the size of the repurchase plans has slightly dropped to 6.5% for a sample period of 1988 until 2007. Subsequently, Busch and Obernberger (2016) show that program size is 6.6% for their sample period of 2004 until 2011.

The completion rate is the number of shares that are repurchased as a percentage of the initiated number of shares sought in the statement. Stephens and Weisbach (1998) found an estimated completion rate of between 73.9% and 82.0% in the three years after the announcement for a sample period between 1981 and 1990. However, this completion rate is based on an estimation of the shares decreasing in the shares outstanding instead of the actual shares repurchased by the firm. Nonetheless, Bonaimé (2012) calculates a completion rate of approximately 72.57% for a sample period between 1988 and 2007. As mentioned before, it was unable to exactly calculate the actual share repurchase until 2004 due to the non-existence of the current disclosure rules. According to Busch and Obernberger (2016), the completion rate is 59.31% three years after the announcement date for a sample period between 2004 and 2010. This completion rate is measured by analyzing SEC filings and therefore very accurate. Though, from these results, it can be deduced that many firms fail to repurchase the number of shares initially announced. Firms do not feel obligated to fulfill their statement made before. Furthermore, a descending tendency in the completion rate is noticed. In the last two decades, the completion rate has dropped by an estimated 15%. Firms announce more share repurchase programs in both absolute and relative terms than ever before. Bonaimé (2012) finds that completion rates are positively related to lagged returns and market to book ratio, meaning that firms which are less undervalued show higher completion rates. Hence, firms with a low completion rate show different firm characteristics than firms with a high completion rate.

2.4 Legislation in the United States

This section provides a brief overview of the legislation of open-market share repurchase announcements in the United States. It gives insights into the current ruling and the latest changes in the ruling to give a better understanding of the process. It should also help to put the share repurchase programs in a more complete framework.

2.4.1 The Process

There is a small set of basic rules firms are subject to in order to perform a share repurchase program. First of all, before a share repurchase program is announced, the board of directors of a firm has to approve and authorize the program. The board of directors must agree upon the issue whether redistributing money to shareholders through a share repurchase program is beneficial to the firm and the shareholders and whether this is possible concerning the cash position or that another possible outcome might be a better alternative.

Secondly, to begin repurchasing shares, it must publicly disclose the share repurchase program by using a press release, a form 8-K, 10-K, 10-Q or 20-F depending upon the timing. This announcement should include the length of the program, the number of shares targeted to repurchase, the reason for the repurchase program and the execution of the program. However, the firm is not legally bound by the announcement and may deviate from the initial plan without any consequences.

Thirdly, firms must disclose the number of shares repurchased during the previous period in the following periodic financial report. The SEC adopted this rule in December 2003. Before this time, academics had to estimate the number of shares repurchased. The financial report should include the total number of shares repurchased, the average price paid per share, the total number of shares repurchased as part of the initially announced repurchase program and the maximum total number of shares which may still be repurchased under the repurchase program.

2.4.2 Safe Harbor Rule

Additionally, for open-market programs to avoid any fraudulent practices rule 10b-18 has been adopted. Rule 10b-18 is also known as the safe harbor rule, which is a non-prescriptive rule introduced in 1982 by the SEC to prevent prosecution for fraudulent acts and not pursuing this rule can lead to lawsuits for market manipulation. By not following all of the following conditions the firm loses the protection of the safe harbor rule. This does not automatically

imply that the firm is performing illegal activities. In this ruling, the SEC included four conditions which firms can voluntarily follow to avoid prosecution.

(1) *Manner of purchase*: The firm must purchase all shares through one broker on a single day.
(2) *Timing condition:* The firm is not allowed to make the opening transaction. Furthermore, the firm is unable to trade in the last 30 minutes of a trading day or if the trading value on that day is above $1 million dollars or the public float value is above $150 million dollars per day, then it is unable to trade in the last 10 minutes of a trading day.
(3) *Price condition: T*he price that the firm bids may not exceed the highest independent bid or sale price.
(4) *Volume condition:* The firm is not allowed to buy more than 25% of the average daily traded volume. Only by fully applying these safe harbor rules a firm is assured of avoiding prosecution. Furthermore, the SEC applies some disclosure requirements which will be discussed in the next paragraph.

2.4.3 New Disclosure Rule

As of 15 March 2004 and later, a new disclosure rule regarding share repurchases is in force. This new ruling obliges firms to disclose the number of shares purchased in the 10-Q and 10-K filings at the SEC on a monthly basis. Hence, this gives better and more clear insights into the actual number of shares purchased, which was only available by approximation using a proxy variable for share repurchases in previous years. Furthermore, the new ruling requires firms to publish the average price paid per share, the number of shares purchased until then and the remaining number of shares that may be purchased in either dollar value or the total number of shares. This rule gives a far more detailed description of the repurchase programs than was previously available. Moreover, the firm has to announce the type of repurchase program. This new disclosure rule helps us to give a better understanding of share repurchases and the effect on the stock price.

3. Hypothesis Development

This chapter provides the hypothesis development delineated by the previously mentioned theories and will be further deepened. The hypotheses are based on the relationship of share repurchases and either the effect on price efficiency, individual investors' attention, accounting environment or idiosyncratic risk.

3.1 Individual Investors

This paragraph gives insights in how individual investors are related to share repurchase programs and share repurchase activity. It helps understanding when firms perform share repurchase programs.

Ding, Koerniadi and Krishnamurti (2017) have examined the difference in firm characteristics and stock returns. One of the difference in firm characteristics that are studied is the frequency of share repurchases. Frequency is referred to as the number of times a firm announces and performs a share repurchase. Ding, Koerniadi and Krishnamurti (2017) point out that there are differences between firms that announce a share repurchase program once and firms that announce a share repurchase program multiple times in their sample. For example, frequent repurchasing firms are positively related to higher insider ownership and a higher probability of block shareholders. Frequency in this context is related to the number of repurchase programs as defined by Jagannathan and Stephens (2013) instead of the number of quarters that a firm is repurchasing as defined by Dittmar and Field (2015). Frequency in this context is the number of share repurchase programs a firm announces in the preceding five years of the sample period. Since frequency is negatively related to a lower probability of block shareholders, the lower the share of individual investors if frequency increases because a block shareholder is typically an institutional investor. Consequently, more repurchase programs in the five preceding years would, in general, mean less individual investors. Therefore, the share of institutional investors increases with frequency. Given the reasoning above, I construct the following hypothesis.

Hypothesis 1a: *The share of individual investors is lower in frequent repurchasing firms than in infrequent repurchasing firms.*

As mentioned by Gordon and Wu (2018), price delay can partially be explained because of investor attention constraints. Managers exploit the mechanism of share repurchases when the market, hence investors, remain absence in keeping the prices efficiently priced. Because of the absence of investors stock prices may diverge from their fundamental value. Hence when there is low attention among investors towards a specific stock. After the announcement of a share repurchase program, the attention should increase because it draws attention towards the firm. All firms are obliged to report the progress of their program. This may lead to an increase in individual investors' attention as the quarters of the repurchase program go by. So, as a result of share repurchases, the level of individual investors' attention increases with the progress of the share repurchase program.

The arguments given above result in a lower individual investors' attention in the first quarters. The fact that individual investors' attention increases by program quarter and the notion that repurchase activity decreases by program quarters causes a negative relationship between individual investors' attention and repurchase activity. Therefore, the hypothesis is as follows:

Hypothesis 1b: *Share repurchases are negatively related to individual investors' attention.*

3.2 Price Efficiency

In a capital market where investors are rational and information is complete, stock prices should process new information instantaneously. If markets are strictly fully efficient, according to the semi-strong efficient market hypothesis, then, stock prices should reflect the true fundamental value of a firm. However, due to price delay, the stock price does not reflect the true fundamental value. Based on research of Merton (1987) regarding incomplete information, it can be stated that stocks which are less known, less visible or neglected and have smaller investor bases have on average larger expected returns, and hence could explain the stock price delay. Hou and Moskowitz (2005) also find similar results with respect to firm recognition and stock price delay for a sample of stocks in the United States. They find that delayed firms are relatively smaller, more volatile and less recognized by investors (Hou and Moskowitz, 2005). Increasing the investors' attention towards the firm should increase the price efficiency. A share repurchase announcement can draw the investors' attention. One can argue that if a firm announces a share repurchase program multiple times within a relatively short time period that the investors' attention has already increased. If there was a recent repurchase program than it already has investors' attention and therefore the stock price should be already efficient. In this

thesis, price efficiency acts as a proxy for price delay measured as the degree to which all available information is incorporated in the stock price. Price delay measures the speed with which new information is incorporated into stock prices.

By using the method as developed by Hou and Moskowitz (2005), a price efficiency measure can be calculated. As mentioned by Busch and Obernberger (2016), share repurchases have the unique characteristics that they can only incorporate positive information into the stock price, because firms engage in the stock market as the buyer of their own stock. Firms can use two different channels to perform share repurchase, either through a market order or a limit order. If a firm performs a market order it buys the share at the best current market price. Placing a market order can directly reveal positive information to the market, resulting in a more efficient stock price. If a firm performs a limit order, it buys shares at a predetermined price, with this, the firm can set a limited price and create a lower bound for the stock price (Busch and Obernberger, 2016). Using either one of these two channels and actively trading on positive information which is not yet reflected in the stock price should increase the speed with which prices are incorporated, therefore the following hypothesis is as follows:

Hypothesis 2: *Share repurchases increase the speed with which new market information is incorporated into the stock price.*

3.3 Accounting & Disclosure Standards

Based on the research of Ho, Lee and Sun (2017), the price efficiency of a stock price is related to the disclosure quality of a firm. If firms show a higher disaggregation in the annual reports, the disclosure quality is higher. This is based on the idea that if firms give more detailed and precise information, investors can make better valuations. Ho, Lee and Sun (2017) mention that firms with a better disclosure quality reflect both market-wide and firms-specific information better. Therefore the better the disclosure quality of a firm, the higher the price efficiency should be. If the disclosure quality is higher, investors will have better information available and therefore they are able to make a better price prediction. A higher disclosure quality reduces the information asymmetry which results in a lower risk premium. Thereby, Gul, Kim and Qiu (2010) find evidence towards a lower level of price delay when the audit quality is higher for firms listed in China. Audit quality is proxied by having a Big-4 firm as client.

Another research in the context of accounting standards, Callen, Khan and Lu (2013) examine the relationship between accounting quality, price delay and future stock returns. They use the definition of accounting quality as defined by Dechow, Ge, and Schrand, 2010), namely,

accounting quality is the precision with which financial statements convey information to equity investors about the firm's expected cash flows. Financial statements are one of the informational channels for these investors to predict the future cash flows of a firm. These statements are only issued on a periodically basis, while other firms-specific and market-wide information is released between the issuance of the current financial statement and the successive financial statement. Every time value-relevant information reaches investors, they update the forecast for the firm's cash flow and therefore the stock price estimate. The update of the new price estimate exists of two components, the newly arriving information and the current information priced into the stock price which is proxied by the accounting quality. Callen, Khan and Lu (2013) examined the speed of price adjustments, price delay, when the accounting quality differs across firms. They mention that updating initial cash flow forecasts which are based on poor accounting quality takes longer. Furthermore, if information is uncertain, investors are more likely to change their initial pricing, because they understand the information better over time. The price correction continues until prices reach their fundamental value. Therefore, the following hypothesis can be formulated as follows:

Hypothesis 3a: *Accounting quality has a positive effect on price efficiency.*

Share repurchases, in the context of Callen, Khan and Lu (2013), are perceived as new value-relevant information for firms. The notion that the price efficiency of firms with a higher accounting quality is higher might reduce the effectiveness of share repurchases. The stock price inefficiency should be more pronounced compared to whenever accounting quality is high. Therefore, share repurchases should be less effective when firms are currently more efficiently priced. Hence, the following hypothesis can be formulated:

Hypothesis 3b: *The effect of share repurchases on the increase in price efficiency is less pronounced when accounting standards are higher.*

3.4 Idiosyncratic Risk

One of the tasks of a manager is to create shareholder value. One way to create shareholder value is to increase the stock price. Next to the argument of creating shareholder value, managers might have the incentive to increase the stock price because a part of their compensation is equity-based. Their wealth is directly affected through stock options or stock appreciation rights or indirectly affected through salaries based on performance. And even if

the reason for the self-interest of the manager is not present, the manager still has to keep shareholders content. This results in a motivation to push the stock price beyond its fundamental value. In particular, they reason, if firms provide price support above fundamental values, both price delay and idiosyncratic risk will increase with share repurchases. This notion is in line with the price manipulation hypothesis. According to the research of Busch and Obernberger (2016) managers might, unintentionally, increase the noise in the stock price. Hence, share repurchases might increase the information content in the stock price and increase the amount of idiosyncratic risk. Furthermore, as of the introduction of the safe harbor rules in 2004 as discussed in section 2.4.2 'Safe Harbor Rule', the ruling around share repurchases has become stricter. Literature before 2004 of, for example, Chan, Ikenberry, Lee and Wang (2010) find evidence in consensus with the notion that share repurchases are used to manipulate stock prices. Research of Roll (1988) entails that a higher comovement of a stock with the market is determined by the amount of systematic information and idiosyncratic information. Another argument may be that when a firm initiates a share repurchase program, it releases private information to the market, which will be incorporated into the stock price. This private information is firm-specific, and therefore idiosyncratic. This results in a decrease of the information content, and an increase in idiosyncratic risk.

However, Busch and Obernberger (2016), who performed research on share repurchases after the introduction of the safe harbour rules, find evidence towards a significant negative relationship between repurchase activity and idiosyncratic risk. In other words, share repurchases increase the comovement of stock prices with the market. Therefore a decrease in the amount of idiosyncratic risk provides evidence that managers do not use share repurchases to manipulate the stock price. Busch and Obernberger (2016) find evidence towards the notion that share repurchases are not a mechanism to manipulate stock prices. Therefore the hypothesis is as follows:

Hypothesis 4a: *Share repurchases reduce the amount of idiosyncratic risk.*

Ginglinger and Hamon (2007) and Busch and Obernberger (2016) as well, find evidence that firms repurchase shares against market trends and hence confirmation of the price support hypothesis. Therefore the effect of share repurchases on the amount of idiosyncratic risk should be more pronounced when the market is in a downward trend. I expect that firms provide price support when the market is in a downward trend to prevent the stock price from diverging from its' fundamental value. The fourth hypothesis can be formulated as follow:

Hypothesis 4b: *The reduction in idiosyncratic risk is more pronounced in down markets than in up markets.*

4. Data & Methodology

This chapter describes how the final dataset is constructed, gives a description of all variables used and it elaborates on the methodology of the analysis.

4.1 Sample Construction

The scope of this paper is open-market share repurchases in the United States. In order to construct the final dataset, a number of restrictions must be made. For the purpose of this research, I use open-market repurchase announcements from 1st of January 2011 until 31st of December 2017, announced by firms in the United States. Furthermore, only firms that have at least one repurchase announcement in the SDC database during the time period will be taken in perspective and only repurchase announcement programs with open-market repurchase as a type are considered. All firms must be publicly listed on any of the following exchanges: the New York Stock Exchange (NYSE), the American Stock Exchange (AMEX) or the National Association of Securities Dealers Automated Quotations (NASDAQ) Furthermore, only ordinary shares with share code 10 or 11 will be considered. Subsequently, the repurchase programs are matched with the CRSP, Compustat, Thomson Reuters and I/B/E/S databases. In total, the sample consists of 3.928 unique repurchase announcements, of which 91 of the announcements have no program size available. Further, I exclude 28 repurchase announcements which are announced in the same quarter. Subsequently, I drop 920 repurchase announcements because there is not sufficient data available in CRSP and or in Compustat. Thereafter, I drop the repurchase program if the data is not available in I/B/E/S, Execucompustat, Thomson Reuters or if not found in the Google trends database. This leaves us with a sample of 2.521 repurchase announcements of 1.255 unique firms and 35.578 firm-quarters.

4.2 The Price Efficiency & Idiosyncratic Risk Model

To give an answer to the research question, I establish two different regressions to estimate the effect of repurchase intensity on price efficiency and idiosyncratic risk. By using the two regressions given below, the impact of the intensity of repurchases can be measured while controlled for other factors influencing price efficiency. Both regressions are estimated on a quarterly basis for every firm.

$$Efficiency_{i,t} = \alpha + \delta Efficiency_{i,t-1} + \beta_1 Rep_{i,t} + \beta_2 GSVI_{i,t} + \sum_{l=1}^{l=k} y_l Control_{i,l,t} + \mu_i + \eta_t + u_{i,t} \quad (1)$$

$$Idiosyncratic\ risk = \alpha + \delta Idiosyncratic\ risk_{i,t-1} + \beta_1 Rep_{i,t} + \beta_2 GSVI_{i,t} + \sum_{l=1}^{l=k} y_l Control_{i,l,t} + \mu_i + \eta_t + u_{i,t} \quad (2)$$

In the formula presented above, *Efficiency* measures the price delay with which prices are incorporated into the stock price. Price efficiency means the degree to which prices reflect all available information in terms of speed and accuracy (Saffi and Sigurdsson, 2010). *Efficiency* is indicated as either one of the price efficiency measures: *Delay* or *Delay coefficient-based. Idiosyncratic risk* is measured by either the R-squared of the base market model or the absolute value of the market correlation. For the estimation of the price efficiency of a firm's stock price, I regress the price efficiency on the one quarter lagged *Efficiency*, *Repurchase intensity* or the *Remaining volume* of the initial program, the increase in GSVI and several controls. *Rep* can denote either *Repurchase intensity* or the *Remaining volume*, whereas *Repurchase intensity* is calculated as the total shares purchased in a quarter divided by the total number of shares outstanding at the end of the previous quarter. *Remaining volume* represents the remaining number of shares sought by the firm as part of the initial repurchase program at the beginning of each quarter divided by the total shares outstanding at the beginning of the repurchase program. The repurchase program ends either when the effective date of the program has passed or if the program has lasted for over a year. Some repurchase programs have a longer duration than a year, but I am unable to determine the actual length of the program. The repurchases may be influenced exogenously because Compustat reports also repurchased shares outside repurchase programs. *Control* in both equations refers to the control variables, μ denotes the time-invariant fixed effects and η denotes the quarter fixed effect.

Busch and Obernberger (2016) address the problem of endogeneity and the effect of reverse causality related to repurchase intensity because repurchase intensity captures precisely the firms' activity in the stock market. Therefore, repurchase intensity also captures the effect of unobserved market conditions. That is if a firm intervenes in the stock market to prevent mispricing of the stock and the level of price efficiency remains the same, activity is observed, but repurchase intensity reflects no effect. To overcome this endogeneity problem, I implement, as proposed by Hillert, Maug and Obernberger (2016), *Program quarter*, which measures the number of quarters between the announcement date and the current date and *Program size*,

which measures the number of shares sought. The *Program size* is fixed for from the start of the program until the end to ensure that the effect is exogenous with respect to future variation in one of the dependent variables (Busch and Obernberger, 2016). Hillert, Maug and Obernberger (2016) find evidence towards a negative relationship between *Program quarter* and *Repurchase intensity*. The reason is that firms repurchase more intensively in early quarters than in later quarters, causing to frontload execute their repurchase program. Subsequently, I add the lagged repurchase intensity to the second specification, to overcome the reverse causality problem, equal to the methodology of Busch and Obernberger (2016).

For the third specification, I replace *Repurchase intensity* by *Remaining volume* to predict the effect on *Remaining volume*. Busch and Obernberger (2016) argue that *Remaining volume* is beneficial over *Repurchase intensity* because it is predetermined and thereby it bypasses the reverse causality problem. In all specifications, I include firm and month fixed effect to prevent unobserved heterogeneity caused by unobserved variables which might be correlated with the observed dependent or independent variables.

4.2.1 Price Efficiency Measure

To measure the price efficiency of the stock price, the method as developed by Hou and Moskowitz (2005) is used. Two different measures of price delay are utilized to examine the effect of the repurchases measures on the price efficiency. A distinction between a base model and an extended market model is made. The delay measure captures to what degree all available information is incorporated into stock prices in terms of speed and accuracy (Saffi and Sigurdsson, 2010).

First of all, Hou and Moskowitz (2005) estimate the returns using two different models. In line with the methodology of Boehmer and Wu (2013) and Phillips (2011), I estimate the daily returns on the contemporaneous value-weighted market returns in the base model. In the extended market model, the daily returns are estimated on the contemporaneous five days lagged value-weighted market returns to include all trading days in a week, in line with the methodology of Busch and Obernberger (2016). I use the following two formulas to estimate the returns based on the base market model and the extended market model:

$$r_{i,t} = \alpha_i + \beta_i^0 r_{m,t} + \varepsilon_{i,t} \quad \text{(Base model)}, \tag{3}$$

$$r_{i,t} = \alpha_i + \beta_i^0 r_{m,t} + \sum_{n=1}^{5} \beta_i^n r_{m,t-n} + \varepsilon_{i,t} \quad \text{(Extended market model)}. \tag{4}$$

In the formula given above $r_{i,t}$ denotes the daily stock return of firm *i* on day *t*, $r_{m,t}$ is the daily return on the value-weighted market return index for day *t* and $r_{m,t-n}$ is the market return *n* days prior to *t*, which represents the lagged market return

The first price delay measure as suggested by Hou and Moskowitz (2005) is one minus the ratio between the *R-squared* of the base model divided by *R-squared* of the extended market model. The logical reasoning behind this measure is that a part of the variation of the base model is explained by the variation of the extended market model. The higher the variation, and thus the explanatory power, in the base model, or the lower the variation of the extended market model the higher the price efficiency is, and vice versa. *Delay* is calculated by using the following formula:

$$Delay = 1 - \frac{R^2_{base}}{R^2_{extended}}. \tag{5}$$

The second measure is based on the coefficients of the base model and the extended market model. This measure takes the lag weighted sum of the absolute β coefficients of the extended market model and divides it by the sum of all β coefficients. All coefficients are scaled by the standard error of the specific coefficient. As Hou and Moskowitz (2005) remark, the β at day 0 must be significantly different from zero if market news is immediately incorporated into the stock price. However, the β of the lagged market returns of the five previous days should not be different from zero. Hence, a higher β indicates a higher level of stock price inefficiency. Concluding, lower levels of coefficient-based delay indicate a higher degree of price efficiency and thus a faster incorporation of information because the explanatory power of the lagged market return coefficients reduces. The following formula presents the estimation for the coefficient-based delay:

$$Coefficient\text{-}based\ delay = \frac{\sum_{n=1}^{5} n \times \frac{abs(\beta_i^n)}{se(\beta_i^n)}}{\frac{abs(\beta_i^0)}{se(\beta_i^0)} + \sum_{n=1}^{5} \frac{abs(\beta_i^n)}{se(\beta_i^n)}}. \tag{6}$$

4.2.2 Idiosyncratic Risk Measure

To measure of the amount of *Idiosyncratic risk* in the stock price, the *R-squared* and the |*Market correlation*| are estimated by using daily returns for each firm and every quarter. Following the methodology of Bris, Goetzmann, and Zhu (2007), I estimate the amount of *Idiosyncratic risk* by using the *R-squared* of the base market model and the correlation between individual stock returns and the market return. In the specifications concerning *Idiosyncratic risk*, the repurchase factors and the *Controls* will be regressed on both the *R-squared* and the |*Market correlation*| to determine the effect of share repurchase activity on the amount of *Idiosyncratic risk*.

4.3 Individual Investors' Attention

Gordon and Wu (2018) find empirical evidence based on research of Lo and MacKinlay (1990), Brennan, Jegadeesh, and Swaminathan (1993) and Badrinath, Kale and Noe (1995), that stock prices of larger firms with a higher volume, firms with a higher institutional ownership or a higher financial analyst coverage have less price delay than stocks which are less known at investors. Investors' attention can be broken down into two components; individual investors' attention and institutional investors' attention. Gordon and Wu (2018) mention individual investors' inattention as a complementary factor as one of the causes of the inefficiency of stock prices. For the measurement of attention, the use of news articlesas can be used. The measurement of attention using news articles or other media has a long lasting history, however, the use of the Google search volume index is a relatively new one. Smith (2012) uses the Google search volume index to examine the effect of keywords in the prediction of the volatility of the foreign currency market. He finds evidence that keywords like "financial crisis" and "recession" can be linked to the week ahead volatility for at least five different currencies. Research of Joseph, Wintoki and Zhang (2011) shows that by using the tickers of firms the abnormal future returns and abnormal trading volumes can be predicted and they argue that the index can proxy for retail investor sentiment. However, the use of the Google search volume index, particularly as a measure for individual investors' attention, is a reasonably novel approach and has not been applied to share repurchases before.

Fink and Johann (2014) performed research on individual investors' attention and used the Google Search Volume Index (GSVI) as a proxy for investors' attention. On days with a high frequency on the GSVI, the investors' attention is marked as relatively high and vice versa. Furthermore, Da, Engelberg and Gao (2011) have found that the GSVI is a good proxy to measure individual investors' attention. Investors are more likely to search for data on Google than institutional investors. Despite the fact that the proxy for individual investors' attention is

positively and significantly correlated to the abnormal institutional attention proxy of Ben-Raphael, Da and Israelsen (2017), it explains less than 2% in each other's variation. Therefore, it can be said that the individual investor's attention and abnormal institutional attention proxy both capture a different effect. In the analysis, I use the GSVI to proxy for individual investors' attention.

The method of Da, Engelberg and Gao (2011) captures the specific attention paid to a particular stock by individual investors by examining the ''Google Trends'' for the ticker symbol of the stock. Google Trends is a feature made by Google that shows the frequency of searches for a specific word or combination of words in a specific period of time relative to the total search volume across the world or country. The Google search volume is calculated on a monthly basis by the following formula:

$$GSVI = \frac{number\ of\ queries_{\ i,t}}{maximum\ number\ of\ queries_t}. \quad (7)$$

Here, $number\ of\ queries_{\ i,t}$ denotes the specific number of queries for firm *i* in month *t.* Subsequently, the number of queries is divided by the number of queries of the month with the highest number of queries in the time period between 2011 until 2017. This provides the relative factor of individual investors' attention.

First of all, I obtain all ticker symbols for every stock included in the sample. Subsequently, I manually download all the trend reports on a monthly basis one by one from ''Google Trends'' by entering the ticker symbol + 'stock'. Additionally to the method of Da, Engelberg and Gao (2011), I add 'stock' behind the ticker symbol to overcome ambiguous search requests as ''Fb", "Ice" or "Hd". This returns values between 0 and 100 and represents the relative number of research requests on Google. The relative number of requests symbolizes the individual investors' attention as demonstrated by Da, Engelberg and Gao (2011). Hereafter, the GSVI is transformed into quarterly data points to estimate the effect of repurchase measures and the efficiency measures on quarterly individual investors' attention.

4.4 Accounting Standards

Following the methodology of Dechow and Dichev (2002), I use three different proxies to capture the accounting quality of the firm, namely *Accrual quality*, *Special items* and *Earnings surprise*. These measures are able to capture the quality of working capital accruals and earnings and proxy for the level of accounting quality of the firm.

4.4.1 Accrual Quality

In the definition, *Accrual quality* captures the uncertainty between the forecast of future cash flows and the current numbers in the financial statement. *Accrual quality* is based on the estimates of non-cash earnings resulting from differences in the provision or consumption of those goods or services and the receipt or disbursement for those goods or services. *Accruals* change with the receipt or disbursement of cash, therefore Callen, Khan and Lu (2013) state that *Accrual quality* is associated with the uncertainty of accrual to cash-flow mapping. The total accruals are calculated using the following formula:

$$Total\ accruals_t = \frac{[\Delta(Current\ Assets_t\ -\ Cash_t\ -\ Current\ Liabilities_t\ +\ Debt\ in\ Current\ Liabilities_t)]}{Total\ Assets_t} - \frac{Depreciation_t}{Total\ Assets_t}. \quad (9)$$

Subsequently, the *Current accruals* are calculated by taking the *Total accruals* plus *Depreciation*. The following model is estimated annually for each of the 48 industry groups as defined by Fama and French (1997) using the following regression.

$$CAcc_t = y_{1,t} + y_{2,t}CFO_{t-1} + y_{3,t}CFO_t + y_{4,t}CFO_{t+1} + y_{5,t}\Delta rev_t + y_{6,t}PPE_t + \varepsilon_t \quad (10)$$

In the formula above $CAcc_t$ denotes the current accruals or the change in working capital on day *t*, *CFO* denotes the operating cash flow, Δrev is the change in revenue and *PPE* is property, plant and equipment. All variables are scaled by the total assets of the firm. For simplicity, the firm notation is suppressed. A higher (lower) value of accrual quality implies a higher (lower) level of uncertainty and therefore represents a poorer accounting quality.

4.4.2 Special Items

Special items includes restructuring charges and write offs, which are associated with low accrual estimates. Cain, Kolev and McVay (2011) reason that special items might be used to shift expenses out of the earnings and therefore are associated with lower precision of the forecast of future cash flows based on the current financial statement. *Special items* is calculated by taking the special items as reported by Compustat and dividing it by the one-lagged total assets.

4.4.3 Earnings Surprise

Earnings surprise, both positive and negative, can reflect the imprecision of prior expectations, which are associated with poor quality of financial statements. It can also be associated with more uncertainty towards future forecasts of cash flows based on financial statements. There is a positive relationship between the absolute value of earnings surprise and price delay. The higher the level of *Earnings surprise*, the poorer the accounting quality and hence the higher the price delay. *Earnings surprise* is measured as the absolute value of annual earnings surprise scaled by the standard deviation of earnings surprise over the last five years, whereas earnings surprise is the difference between the forecast and the actual earnings.

4.4.4 Big-4 client

Furthermore, Eshleman and Guo (2014) examine the accounting quality between Big 4 auditors and mid-tier auditors. They find that Big 4 auditors perform higher quality audits. As Callen, Kahn and Lu (2013) reason, accounting quality is negatively related to stock price delay, indicating that the higher the accounting standards of the firm, the lower the stock price delay should be. Big-4 auditors are known to provide better audit quality than non-Big-4 auditors, therefore, being a client of a Big-4 should reduce price delay.

4.5 Frequency

Ding, Koerniadi, and Krishnamurti (2017) point out the differences between announcement period returns as a result of repeat announcements. They find evidence that the more a firm repeats a repurchase announcement, the lower the announcement return will be. As suggested by Hou and Moskowitz (2005), *Delay* can be explained by investor neglect or inattention. However, the more a firm announces a repurchase program, the more attention is drawn towards the stock and hence the level of stock price efficiency should be more efficiently priced already. Ding, Koerniadi and Krishnamurti (2017) measure frequency as the number of share repurchase announcements in the five years prior to the sample period.

4.6 Instrumental Variables

The simple ordinary least squares (OLS) regression is a method to determine the unknown parameters by using explanatory variables. However, a major complication might arise due to endogenous regressors leading to an inconsistent parameter estimation. The estimated β may be biased when where there is an association between the error term, explanatory variable and the dependent variable exists. This problem can be overcome by implementing instrumental

variables into the model. The instrumental variable affects the explanatory variable, but is not associated with the error term. The two main requirements for the use of instrumental variables are:

1) The instrumental variable must be correlated with the endogenous explanatory variable.
2) The instrumental variable may not be correlated with the error term in the explanatory equation.

If the first requirement is met, the relationship between the instrumental variable and the endogenous explanatory variables indicates a strong first stage. The second criteria means that the instrumental variable affects the dependent variable through the explanatory variable, but does in itself affect the dependent variable. This is also referred to as the exclusion restriction.

When the IV estimator is used, the number of instrumental variables must equal the number of regressors. Therefore, in the model only two instrumental variables are used at a time to prevent the model from overidentification problems.

In line with the methodology of Hillert, Maug and Obernberger (2016), I add *Program quarter* and *Program size* to the model as instrumental variables. This guarantees that the repurchase intensity is not driven by differences in future levels of price efficiency. *Program quarter* is calculated at the announcement date as the starting point as the first quarter and increases by one for every consecutive quarter. *Program size* is calculated as the percentage of shares sought as of the date announced as reported by the firm. If the percentage of shares sought is unavailable, the value of the deal amount is taken and divided by the market capitalization at the date of announcement of the firm. Therefore, *program size* is fixed for the subsequent quarters.

4.7 Liquidity Instruments

To prevent the results from being driven by any spurious correlations I add several control variables to the analysis. The calculation for the *Relative spread* will be elaborated in the following paragraph. In line with the methodology of Busch and Obernberger (2016) I use three instruments for liquidity, *Relative spread*, lagged *Trading volume* and *Deviation* of the stock price from $30. Research of Hillert, Maug and Obernberger (2016) shows that share repurchases have an unambiguously positive effect on liquidity. Furthermore, the repurchase intensity is driven by the liquidity of the firm.

4.7.1 Relative Spread

The bid-ask spread, also known as the *Relative spread*, measures the stock market liquidity. Liquidity is defined as the degree to which an asset can be bought or sold without affecting the price of the asset. Thus, market liquidity is described as the degree to which assets can be bought or sold in the stock market at stable prices. As mentioned by Hillert, Maug, and Obernberger (2016), liquidity affects the way how firms execute a share repurchase program and share repurchase provide liquidity for the firm when investors sell their stock. Academic research uses the TAQ database to calculate the relative spread, however, this data is only available up to 2013. The simple CRSP-based bid-ask spread is highly correlated and is the best proxy for the TAQ-based spread (Chung and Zhang, 2014). The CRSP-based bid-ask spread provides a better approximation than other low-frequency measures in cross-sectional settings therefore, I use the simple CRSP bid-ask spread instead. CRSP provides a continuous series of the closing bid and the closing ask prices. The following formula calculates the relative spread:

$$Relative\ spread = \frac{Ask_{i,t} - Bid_{i,t}}{Mean_{i,t}}. \quad (11)$$

In the formula above, $Ask_{i,t}$ represents the closing ask price of firm *i* on day *t*, $Bid_{i,t}$ the closing bid price and $Mean_{i,t}$ is the mean of $Ask_{i,t}$ and $Bid_{i,t}$.

4.8 Fixed Effects

In each and every specification of the analyses I implement firm and time fixed effects to overcome the problem of unobserved heterogeneity caused by unobserved factors that are constant over time and correlated with the other variables in the cross-sectional model. By adding a lagged dependent variable to the model, I am able to control for any differences in the level of price efficiency. Furthermore, *Program initiation* is added to control for any announcement effects. *Program initiation* is strictly defined as 1 for the quarter of the announcement, 0 otherwise.

4.9 Descriptive Statistics

Table 1 presented below provides an overview of the descriptive statistics of the variables used in the analysis. In the analysis, we are only interested in repurchasing firms, therefore all non-repurchasing firms are excluded from the dataset. The sample consists of 1.255 firms with 35.578 firm quarters and with 18.364 quarters in which a repurchase took place. The efficiency measures (*Delay* and *Delay coefficient-based)* both show comparable values to the analysis of

Table 1: Descriptive Statistics

	Mean	Median	SD	SD (within)	1st Perc.	99th Perc.	N
Dependent variables							
Delay	0.444	0.424	0.215	0.168	0.067	0.941	35.578
Delay coefficient-based	1.894	1.887	0.429	0.366	0.946	2.898	35.578
R-squared	30.99%	29.02%	17.88%	13.86%	1.60%	76.94%	35.578
|Market correlation|	0.493	0.508	0.196	0.147	0.029	0.876	35.578
Investors' attention level	35.82	34.35	22.53	13.87	0.00	100.00	35.578
Repurchase measures							
Repurchase volume (mill.)	80.8	0.5	394.7	291.0	0.0	1375.5	35.578
Repurchase intensity	0.61%	0.00%	1.65%	1.53%	0.00%	6.28%	35.578
Repurchase intensity (TV)	1.66%	0.00%	4.56%	4.16%	0.00%	15.78%	35.578
Remaining volume	3.57%	0.00%	10.91%	7.08%	0.00%	47.04%	35.578
Repurchase measures in repurchase quarters							
Repurchase volume (mill.)	138.3	17.3	508.7	353.3	0.0	1915.8	18.364
Repurchase intensity	1.05%	0.56%	1.85%	1.65%	0.00%	7.22%	18.364
Repurchase intensity (TV)	2.84%	1.49%	5,68%	4.57%	0.00%	21.47%	18.364
Remaining volume	4.51%	1.87%	12.19%	7.48%	0.00%	51.96%	18.364
Program descriptives							
Frequency	1	1	1.36	0.00	0	5	2.521
Program quarter	8	6	6.7	3.6	1	27	2.521
Program size (scaled)	9.66%	6.87%	10.15%	6.12%	0.74%	55.34%	2.521
Accounting standards							
Accrual quality	0.011	0.005	0.017	0.007	0.000	0.094	35.578
Special items	-0.002	0.000	0.028	0.027	-0.049	0.012	30.839
Earnings surprise	4.128	3.670	2.911	1.616	0.072	13.855	14.370
Control variables							
Analysts	11.057	9	8.236	2.412	1	34	29.941
Book to market	0.529	0.433	0.406	0.192	-0.200	2.157	35.578
Cash to assets	16.1%	9.9%	16.6%	6.4%	0.1%	71.7%	35.578
Deviation from $30	30.3	17.3	108.9	35.5	0.3	208.9	35.578
Dividends to assets	1.50%	0.00%	4.97%	3.89%	0.00%	14.29%	35.578
EBITDA to assets	0.032	0.030	0.033	0.022	-0.047	0.125	31.090
Insider ownership	0.49%	0.06%	2.36%	1.62%	0.00%	9.32%	19.988
Institutional ownership	63.9%	76.9%	33.8%	27.3%	0.0%	100.0%	35.578
Leverage	0.386	0.337	0.247	0.076	0.025	0.942	35.578
Market cap (mill.)	10478.2	1896.2	33661.3	9875.2	25.5	165503.1	35.578
Options exercised	0.67%	0.13%	0.18%	0.16%	0.00%	11.11%	35.578
Options outstanding	4.82%	3.29%	6.24%	3.80%	0.00%	22.82%	35.578
Relative spread	2.84%	2.53%	1.31%	0.82%	1.09%	7.18%	35.578
Return	0.038	0.042	0.150	0.147	-0.379	0.407	35.578
Total assets (mill.)	19124.6	2060.1	112818.1	8398.2	31.1	277653.0	35.578
Trading volume (scaled)	0.549	0.432	0.524	0.376	0.038	2.278	35.578
Volatility	0.019	0.017	0.008	0.005	0.007	0.042	35.578

This table provides descriptive statistics for the dependent variables grouped in efficiency measures (*Delay* and *Delay coefficient-based*, idiosyncratic risk (*R-squared* and |*Market correlation*|) and Google

search volume. It further gives an overview of the descriptive statistics on the repurchase measures, program descriptives, accounting standards and the control variables for the firms which performed at least one repurchase program between 2011 until 2017. None of the variables is expressed as a natural logarithm.

Busch and Obernberger (2016). As they point out in their paper, the mean and median of the efficiency measures demonstrated have similar values, meaning that the variable is not skewed. This reasoning also applies to *R-squared* and |*Market correlation*|. *Delay* and *Delay coefficient-based* are strictly defined between 0 and 1, and 0 and 5 respectively. *R-squared* and |*Market correlation*| are strictly defined between 0 and 1. The panel regarding repurchase measures, *Repurchase volume* in particular, indicates that firms spend on average $80.8 million per quarter on the repurchase of shares if involved in a repurchase program between 2011 and 2017. This equals to 1.66% of the total number of outstanding shares. The average repurchase volume per quarter if a firm repurchases any shares during a quarter equals to 2.84% of the total number of outstanding shares. The median of *Remaining volume* is 1.87% which is defined as the remaining shares that can be repurchased in the specific quarter as of the start of the program. Most of the repurchase measures exhibit similar values as obtained by Busch and Obernberger (2016). The significantly higher values for *Repurchase volume* can be explained because of the difference in time frame, where Busch and Obernberger (2016) use monthly share repurchases and I examine the effect in a quarterly time frame. In the panel with program descriptives, the average frequency is 1, which indicates that a firm has performed on average 1 repurchase program in the five years prior to the sample. A repurchase program lasts on average 8 quarters and is slightly higher than what Busch and Obernberger (2016) observe which can be justified by a difference in measurement. Moreover, the *Program size* equals an average of 9.66% and a median of 6.87%, which means that the distribution is right-skewed and the average is increased by several large repurchase programs. The total set consists of 2.521 number of repurchase programs. The description and explanation of the remaining (control) variables can be found in Appendix 1A.

5. Results

In this chapter, I will discuss the effect of share repurchases on price efficiency, *Idiosyncratic risk* and *Individual investors' attention*. The analysis of share repurchases on price efficiency will be split in two subsections, namely up and down markets and accounting quality. The analysis of share repurchases, *Idiosyncratic risk* and *Individual investors' attention* will only be deepened an up and down markets analysis.

Prior to the analysis on the effect of *Repurchase intensity* on stock price efficiency, I first determine the importance of the instrumental variables, *Program quarter* and *Program size*, on *Repurchase intensity* while controlling for other factors that influence the *Repurchase intensity* in the following section. In the second specification, I examine the effect of lagged *Repurchase intensity* on *Repurchase intensity*. In the third specification, I perform an analysis on the factors driving the *Remaining volume* of a repurchase program. Thereafter, I analyse the effect of repurchase activity on investors' attention. Subsequently, I examine the effect of repurchase activity on the efficiency measures and the Idiosyncratic risk measures.

5.1 Analysis of Repurchase Activity

The analysis in this section is comparable to the analysis of Busch and Obernberger (2016). The first step is to examine the effect of *Program quarter* and *Program size* on the *Repurchase intensity* and *Remaining volume* of the firm. According to Hillert, Maug and Obernberger (2016), they hypothesize and find evidence that to reduce the price impact, the repurchases must be spread over time, but firms should front-load the execution of the program. Hence, this means that the intensity of the repurchase program is higher in the earlier quarters than in the latter quarters. A front-load execution of the repurchase program results in a negative relationship between *Program quarter* on *Repurchase intensity*. *Program size* is expected to have a positive impact on *Repurchase intensity*, which is logically reasoned. The more shares targeted by the firm, the higher the *Repurchase intensity* will be. All columns of Table 2 show that *Program quarter* and *Program size* are highly significant, where the coefficients come in with the right sign, in line with expectations of previous literature. A positive coefficient for *Program quarter* provides evidence for the fact that firms front-load execute repurchase programs as illustrated by Figure A1 in the Appendix. An increase in *Program size* positively affects *Repurchase intensity*. The more shares targeted at the date of announcement, the higher the *Repurchase intensity* is. In the second specification, I add lagged *Repurchase intensity* to the model to test if *Repurchase intensity* could proxy for repurchase activity. As mentioned by

Table 2: Analysis of Repurchase Measures

Dependent variable:	Repurchase intensity		Remaining volume
	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Repurchase intensity$_{t-1}$		0.0743***	
		(13.46)	
Program quarter$_t$ (ln)	-0.0010***	-0.0010***	-0.0345***
	(-6.48)	(-6.14)	(-78.27)
Program size$_t$	0.0231***	0.0219***	0.9505***
	(17.15)	(16.24)	(256.26)
Investors' attention level$_t$	-0.0000**	-0.0000**	-0.0000**
	(-2.14)	(-2.02)	(-2.05)
Options exercised$_t$	0.0752***	0.0755***	-0.0418***
	(14.40)	(14.50)	(-2.90)
Options outstanding$_t$	0.0001***	0.0001***	0.0003***
	(2.89)	(2.80)	(6.60)
Return$_{t-1}$ > 0	-0.0040***	-0.0037***	0.0055**
	(-4.15)	(-3.85)	(2.09)
Return$_{t-1}$ < 0	-0.0048***	-0.0047***	0.0016
	(-3.77)	(-3.68)	(0.45)
Book to market$_{t-3}$	0.0044***	0.0044***	0.0062***
	(9.21)	(9.26)	(4.79)
Total assets$_{t-3}$ (ln)	0.0019***	0.0020***	0.0241***
	(5.54)	(5.93)	(25.24)
Cash to assets$_{t-3}$ (ln)	0.0095***	0.0099***	-0.0038
	(7.66)	(7.95)	(-1.11)
EBITDA to assets$_{t-3}$	-0.0076**	-0.0090**	-0.0227**
	(-2.00)	(-2.36)	(-2.16)
Dividends to assets$_{t-3}$	0.0013	0.0013	0.0021
	(0.60)	(0.60)	(0.36)
Leverage$_{t-3}$	-0.0101***	-0.0103***	-0.0680***
	(-7.95)	(-8.11)	(-19.38)
Relative spread$_{t-1}$ (ln)	-0.0028***	-0.0026***	0.0042***
	(-5.95)	(-5.54)	(3.26)
Constant	-0.0173***	-0.0181***	-0.1348***
	(-6.08)	(-6.33)	(-6.93)
R^2 (within firm)	0.025	0.30	0.681
Observations	33.860	33.860	33.860
Firm fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes

This table presents the results of the OLS regression *Repurchase intensity* and *Remaining volume* on lagged *Repurchase intensity* in column (2), the instrumental variables (*Program quarter* and *Program size*), *Investors' attention level*, the returns and the control variables. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

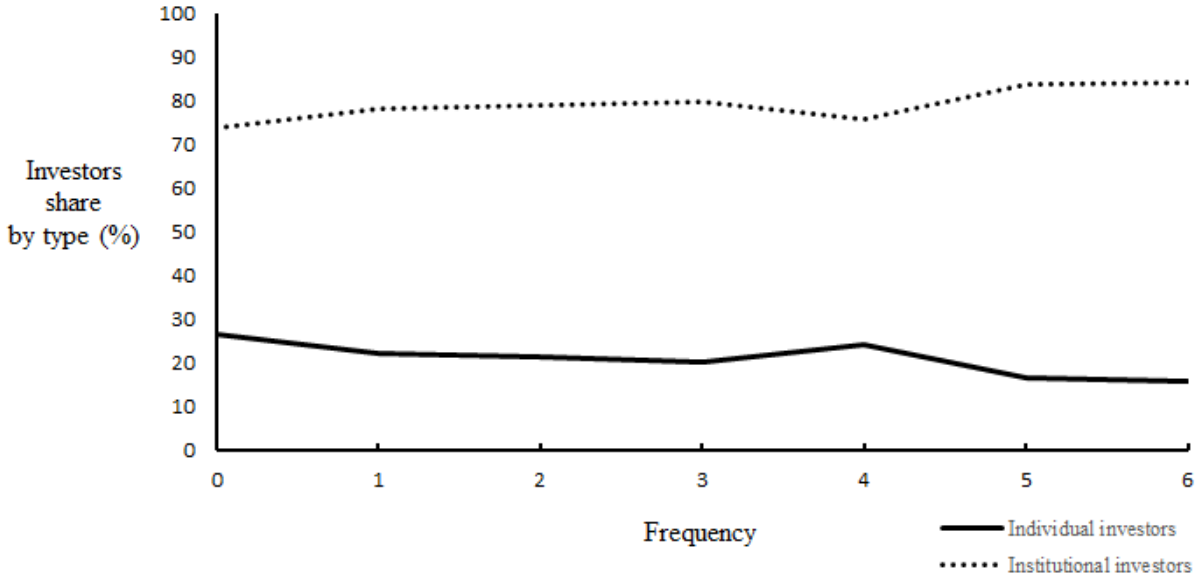
Busch and Obernberger (2016), the use of a noisy independent variable, lagged *Repurchase intensity*, could cause attenuation and biases the coefficient towards zero, which makes it harder to obtain significant results. However, I obtain, in line with Busch and Obernberger (2016) a positive significant coefficient of 0.0743. Admittedly, the coefficient and significance are both lower. This difference might be caused because of the use of quarterly data instead of monthly data, whereas only quarterly data on share repurchases is available in Compustat. *Investors' attention level* shows a significant negative coefficient, indicating a higher level of attention decreases the number of shares a firm repurchases. An increase of 1% in the base level of investors' attention results in a decrease of 0.002% of *Repurchase intensity.* However, I find that the coefficient is very small and economically negligible. The controls in specification (1) – (3) show significant results for most of the variables and are in line with the existent literature. I observe a significant positive effect for *Options exercised* and *Options outstanding*. According to research of Fenn and Liang (2001) stock options and share repurchases are positively related and therefore, the number of options can explain an increase in *Repurchase intensity*. The relationship between *Options outstanding* and *Remaining volume* remains significant, however, *Options exercised* does not. For both positive and negative lagged returns, I observe significant values with a negative coefficient. If the firm deals with any changes in the stock price, the *Repurchase intensity* will decrease. If a firm provides price support, the firm will decrease its *Repurchase intensity* after an increase in the stock price. Furthermore, lagged *Book-to-market* shows a significant positive effect. This can be interpreted as that the valuation of the firm drives *Repurchase intensity*. It suggests that a relatively higher undervaluation results in an increase in *Repurchase intensity,* which provides evidence towards the undervaluation hypothesis. Both *EBITDA to assets* and *Dividends to assets* do not show or only merely show statistical significance. As mentioned by Busch and Obernberger (2016), this is in line with the literature on dividend substitution hypothesis, which states that share repurchases are complements for dividends instead of substitutes. One of the reasons for managers to perform a share repurchase program is to increase the leverage position of the firm. Hence, firms with a higher leverage position are less likely to perform share repurchases. Therefore, leverage has a significant negative impact on the *Repurchase intensity*, which is in line with the capital structure hypothesis. I observe a significant negative coefficient for lagged *Relative spread*. The higher the relative spread, the less liquid the asset of the firm's stock is. A significant coefficient indicates that liquidity is one of the drivers of *Repurchase intensity*, a negative coefficient indicates that less liquid stocks have on average lower *Repurchase intensity*.

Column (3) in Table 2 shows an analysis of the drivers of *Remaining volume*, which represents the remaining shares sought by the firm scaled by the total shares outstanding. Both *Program quarter* and *Program size* remain highly significant and the signs come in as expected, negative and positive respectively. The interpretation of *Program quarter* is that the longer the repurchase program lasts, the lower the remaining shares sought by the firm. Additionally, the more shares a firm seeks to repurchase in its' initial announcement as displayed by *Program size*, the higher the *Remaining volume* is. This is in line with research of Busch and Obernberger (2016) and Hillert, Maug and Obernberger, 2016). *Program size* determines most of the variation of *Remaining volume*. In contradiction to Busch and Obernberger (2016), I observe significant results for both positive and negative lagged returns. The higher the prior returns the higher *Remaining volume* is. A negative lagged return leads to a decrease in the stock price, which makes it less expensive for firms to repurchase shares and results in a higher level of undervaluation. The chance to announce a new repurchase program increases, which results in a higher *Remaining volume*, however, only positive lagged returns are significant. A positive lagged return leads to an increase in the stock price. This makes it for firms more expensive to repurchase shares. Additionally, it decreases the level of undervaluation if present, which is the primary reason for share repurchases (Ikenberry, Lakonishok and Vermaelen, 2000). However, both coefficients are more or less economically negligible. The coefficient of *Total assets* is significantly positive, which indicates that the more assets a firm has, the higher the *Remaining volume* is. This is explained by the fact that the mean of the relative *Program size* increases with the total value of assets a firm has. *EBITDA to assets* is negative and statistically significant which means that higher earnings in previous quarters result in a lower *Remaining volume* that can be repurchased in the next quarter. Logical reasoning states that the firm has more cash left to spend on repurchases, which reduces *Remaining volume. Leverage* shows a negative and significant coefficient. Dittmar (2000) finds evidence that firms use share repurchases to increase the leverage position, hence firms with a higher leverage position have a lower *Remaining volume.*

5.2 Analysis of Investors Share by Type

The expectation, based on the empirical research of Ding, Koerniadi and Krishnamurti (2017), is a decreasing share of individual investors and hence an increasing share of institutional investors. They argue that frequency is positively related to a higher probability of block shareholders. Figure 1 plots the percentages of investors by type against the *Frequency*. The dotted line represents the percentage of institutional investors and the solid line presents the

Figure 1: The share of investors by Type



This figure plots the distribution of individual investors and institutional investors against the *Frequency*. *Frequency* is measured as the number of repurchase announcements in the five years prior (2006 – 2010) to the sample.

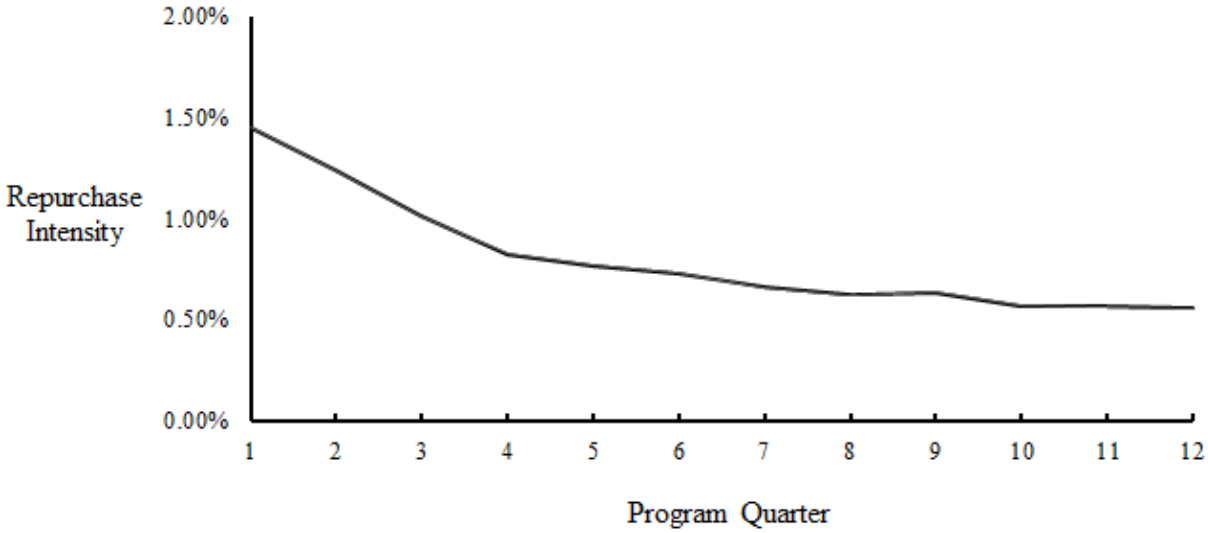
percentage of individual investors. Frequency denotes the number of share repurchases a firm performed in the five years prior to the sample. Figure 1 graphically displays minor differences in the type of investors with respect to the frequency levels. The share of individual investors decreases, almost unambiguously, from a rough 28% to 20%. This means that the number of share repurchases a firm performs in the preceding years of the sample is dependent of the distribution of investors. Therefore, the null hypothesis of Hypothesis 1a, which states that the share of individual investors is lower in frequent repurchasing firms than in infrequent repurchase firms can be rejected.

Moreover, Figure 1 gives insight in the distribution between institutional investors and individual investors. Figure 1 displays that, on average, individual investors account for 25% of the shares in a firm.

5.3 Analysis of Repurchase Activity on Individual Investors' Attention

In this section, I link repurchase activity, individual investors' attention and the progress of the repurchase program with each other. First, I visually deploy the analysis of *Repurchase intensity* by *Program quarter* to show the relationship between repurchase activity over time during a repurchase program. Thereafter, I visually show the analysis between *Individual investors'*

Figure 2: Repurchase Intensity per Quarter



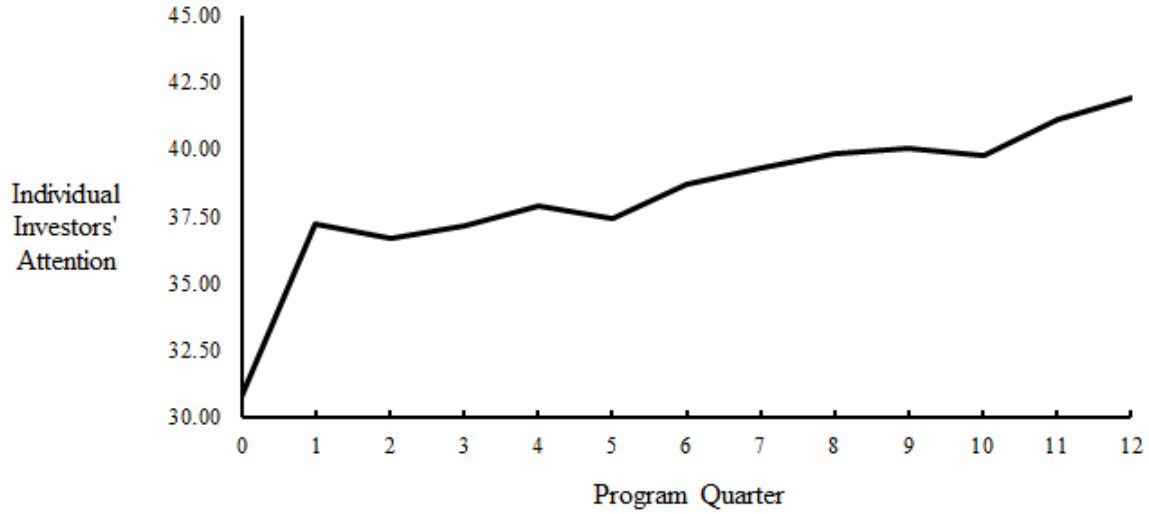
This figure provides gives a visual presentation of the average *Repurchase intensity* per *Program quarter*. *Repurchase intensity* denotes the number of shares repurchased scaled by the total number of outstanding shares at the last trading day of the previous quarter. *Program quarter* is defined as the number of the quarter since the repurchase program is announced.

attention and *Program quarter* to find a relationship between the relative investors' attention towards a stock during a repurchase program.

Figure A1 shows that firms frontload execute share repurchase programs. Repurchase intensity is highest in the early quarters of the program and decreases over time. Hillert, Maug and Obernberger (2016) reason that firms frontload execute share repurchase programs because they can be viewed as risk-averse block holders who want to buy share over a limited time period. This reduces risk and uncertain market prices.

Figure 2 shows that the relative level of *Individual investors' attention* towards a specific firm is on average relatively low when firms are not performing a share repurchase. This point is denoted as 0 at the x-axis *Program quarter* and the value of 31 at the y-axis *Individual investors' attention*. After the firm has announced a repurchase program, the level of *Individual investors' attention* steeply increases to a value of approximately 37. In the quarters following the announcement, the attention towards the firm steadily increases during almost every quarter. The interpretation of this result is that share repurchases draw attention towards the firm. Figure 2 shows that the attention towards a firm increases as a result of the announcement of a share repurchase program. Thereafter, the effect of the progress of the

Figure 3: Individual Investors' Attention per Quarter



This figure provides a visual presentation of the average *Individual investors' attention* per *Program quarter*. *Individual investors' attention* denotes the attention towards a specific firm at a specific point of time calculated as the relative attention towards that firm over the complete sample. *Program quarter* is defined as the number of the quarter since the repurchase program is announced. Program quarter has a maximum of 12 quarters because the end of a repurchase program is sometimes undeterminable.

repurchase program has a minor but evident effect on the level of individual investors' attention. Furthermore, there is no difference in individual investors' attention between quarters prior to a share repurchase announcement and quarters with no successive share repurchase announcement.

Table 3 presents an analysis of the effect of *Repurchase intensity* and *Remaining volume* on the level of individual investors' attention. Specification (1) - (3) demonstrate that *Repurchase intensity*, lagged *Repurchase intensity* and *Remaining volume* are negatively related to the *Investors' attention level*. This indicates that firms perform share repurchases when the level of attention is low rather than announce a program when the attention is low as discussed in Figure 2. Contemporaneous *Repurchase intensity* shows significance at the 5% level, however, *Remaining volume* shows no significance. An increase in contemporaneous *Repurchase intensity* by one within-firm standard deviation decreases the level of investors' attention by 11.92% (= 0.0165 * 7.2248, where 7.2248 is the coefficient of *Repurchase intensity* in column (1) of Table 3), which corresponds to 0.34% of median *Investors' attention level* (0.1192 / 34.85, where 13.87 is the median of investors' attention level as presented in Table 1). The results show semi-strong evidence towards a relationship between contemporaneous

Table 3: Analysis of Repurchase Activity on Individual Investors' Attention

Dependent variable:	Investors' attention level	Investors' attention level	Investors' attention level
	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Repurchase intensity$_t$	-7.2248**		
	(-2.02)		
Repurchase intensity$_{t-1}$		-5.8678*	
		(-1.66)	
Remaining volume$_t$			-0.4242
			(-0.19)
Investors' attention level$_{t-1}$	0.3977***	0.3978***	0.3979***
	(38.04)	(38.05)	(38.05)
Program quarter$_t$ (ln)	-0.3368**	-0.3339**	-0.3441**
	(-2.39)	(-2.37)	(-2.13)
Program size$_t$	0.1010	0.0344	0.3415
	(0.09)	(0.03)	(0.14)
Options exercised$_t$	22.4165***	21.8258***	21.8435***
	(5.63)	(5.50)	(5.51)
Return$_{t-1} > 0$	8.1216***	8.1295***	8.1597***
	(10.34)	(10.35)	(10.39)
Return$_{t-1} < 0$	-10.2985***	-10.2731***	-10.2740***
	(-11.15)	(-11.13)	(-11.14)
Book to market$_{t-3}$	-1.1831**	-1.2178**	-1.2111**
	(-2.17)	(-2.24)	(-2.22)
Total assets$_{t-3}$ (ln)	2.6217***	2.6014***	2.6183***
	(7.10)	(7.06)	(7.11)
Dividends to assets$_{t-3}$	5.2579**	5.2587**	5.2537**
	(2.26)	(2.25)	(2.26)
Leverage$_{t-3}$	-2.3273*	-2.2271*	-2.2602*
	(-1.73)	(-1.66)	(-1.68)
Constant	2.7152***	2.8451***	2.6880***
	(40.77)	(42.74)	(40.27)
R^2 (within firm)	0.175	0.175	0.175
Observations	34.320	34.320	34.320
Firm fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes

This table presents the results of the OLS regression *Investors attention level* on contemporaneous *Repurchase intensity* in column (1), lagged *Repurchase intensity* in column (2) and *Remaining volume* in column (3) . The instrumental variables (*Program quarter* and *Program size*), the returns and the control variables. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

Repurchase intensity and weak evidence towards a relationship between lagged *Repurchase intensity* and *Individual investors' attention*.

Lagged *Investors' attention level* shows that the dependent variable is highly correlated to the lagged level of attention, which can be explained by logical reasoning. If an investor is checking up on its' investments last quarter, he will probably do so again the next quarter. Furthermore, I observe that *Program quarter* is negatively significantly related to the level of investors' attention, which suggests that the level of attention decreasing over time during the repurchase program. The size of the repurchase program cannot explain the level of attention. The number of options exercised is highly significant and shows a positive coefficient. As expected, positive lagged returns increase the level of investors' attention and negative lagged returns reduce the attention. Logical reasoning tells that when stocks perform badly, the attention level is lower and vice versa. *Book-to-market* is significantly negatively related, indicating that the valuation of a firm drives investors' behaviour of attention towards a stock. A *book-to-market* ratio above 1 indicates overvaluation and a ratio below 1 indicates undervaluation, hence if a firm has performed well in the past, the *Book-to-market* ratio will decrease. This suggests that undervalued stocks have a lower attention level. Additionally, the attention increases with the size of the firm, denoted by *Total assets*. The level of attention is higher when the firm pays more dividends to investors. Moreover, the leverage of a firm causes the firm's attention level to lower.

Concluding, a combination of the results from the previously performed analysis shows a negative relationship between share *Repurchase intensity* and *Individual investors' attention*. *Repurchase intensity* is high in the early quarters, whereas *Individual investors' attention* is rather low in these quarters. Both, *Repurchase intensity* and *Individual investors' attention* move in contradicting ways over time as displayed in Figure 1 and Figure 2. As displayed in Table 3 the negative relationship is enhanced. In Figure 1 and Figure 2 the contradicting movement is addressed to explain this negative relationship. Therefore the null hypothesis of Hypothesis 1b can be rejected, which states that share repurchases are not related to individual investors' attention. Firms perform share repurchase programs when attention towards their firm is relatively low. Furthermore, the attention increases with the intensity of the repurchase.

5.4 Analysis of Individual Investors' Attention in Up and Down Markets.

In this section I discuss the effect of repurchase activity on *Investors' attention level* by deepening the repurchase measures. I let the repurchase measures interact with a dummy for up and down markets. The market is defined as an up market if the returns over the quarter were

Table 4: Analysis of Repurchase Activity on Individual Investors' Attention in Up and Down Markets

Dependent variable:	Investors' attention level	Investors' attention level	Investors' attention level
	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Repurchase intensity$_t$	-7.8091*		
x Up market$_t$	(-1.82)		
Repurchase intensity$_t$	-5.2770		
x Down market$_t$	(-0.93)		
Repurchase intensity$_{t-1}$		-5.1658	
x Up market$_t$		(-1.30)	
Repurchase intensity$_{t-1}$		-8.1697	
x Down market$_t$		(-1.17)	
Remaining volume$_t$			-0.4153
x Up market$_t$			(-0.18)
Remaining volume$_t$			0.2697
x Down market$_t$			(0.11)
R^2 (within firm)	0.175	0.175	0.175
Observations	34.320	34.320	34.320
Firm fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Wald (up - down) (test)	0.13	0.15	0.26
Wald (up - down) (p-value)	71.73%	69.73%	60.95%

This table presents the results of the OLS regression *Investors attention level* on contemporaneous *Repurchase intensity* in column (1), lagged *Repurchase intensity* in column (2) and *Remaining volume* in column (3). The instrumental variables (*Program quarter* and *Program size*), the returns and the control variables. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

overall positive, and is defined as down market if the returns over the quarter were overall negative. The results show that for both up and down markets repurchase activity is negatively related with the level of individual investors' attention in specification (1) and (2). However, in specification (3) the result show that remaining volume is negatively related to investors' attention level in up markets and positively in down markets. Nonetheless, I observe that the effect of contemporaneous *Repurchase intensity* is more pronounced in up markets than down markets. On the other side, the effect of lagged *Repurchase intensity* is more pronounced in

down markets. Overall, the investors' attention level is lower in up markets than in down markets. The overall effect for both contemporaneous and lagged *Repurchase intensity* is 20.71% (= (7.8091 + 5.1658) * 0.0169, where 7.8091 is the coefficient for *Repurchase intensity* in up markets in column (1) Table 4, 5.1658 is the coefficient for lagged *Repurchase intensity* in down markets in column (2) of Table 4 and 0.0169 the one within-firm standard deviation of *Repurchase intensity* in up markets), which corresponds to 0.58% (= 0.2071 / 35.67, where 35.67 is the median of *Investors' attention level* in up markets). The effect of share repurchases in down markets is 23.53% (= (5.2770 + 8.1697) * 0.0175, where 5.2770 is the coefficient for *Repurchase intensity* in down markets in column (1) Table 4, 8.1697 is the coefficient for lagged *Repurchase intensity* in down markets in column (2) of Table 4 and 0.0175 the one within-firm standard deviation of *Repurchase intensity* in up markets), which corresponds to 0.81% (= 0.2353 / 29.19, where 29.19 is the median of *Investors' attention level* in down markets). This means that the relationship between share repurchases and the level of individual investors' attention is less pronounced in up markets than in down markets. However, both, share repurchases in up and in down markets, are associated to a lower level of individual investors' attention. This indicates that firms use share repurchases as a last resort when investors remain absent in both up and down markets.

5.5 Analysis of Repurchase Activity on Price Efficiency

Table 5 below presents the results of actual share repurchases on the price efficiency of a firm's stock price. Specifications (1) - (3) report the results on *Delay* as estimated by the base market model. Specifications (4) - (6) present results on *Delay coefficient-based* as calculated by the extended market model. Specifications (1) and (4) use a generalized method of moments (GMM) regression using *Program quarter*, *Program size* as instruments for repurchase activity. I implement the GMM method because it estimates the average of the unknown parameter. The ordinary least squares estimator can be biased when there is any potential endogeneity in the model. The GMM method is a proper method to overcome this bias (Woolridge, 2001). The Hansen's J test indicates the level of overidentification of the instruments, whereas the Kleibergen-Paap test gives information on the underidentification of the instruments. The Kleibergen-Paap underidentification test rejects the null hypothesis for both specification (1) and (4), which indicates that the instruments are not weak and sufficient enough to identify endogeneity. The interpretation of Hansen's J overidentification test is that it tests if the instruments are relevant and that the model is correctly specified. In this model, a rejection of the null hypothesis is indicating that it cannot be said that the model is correctly specified. The

Table 5: Analysis of Share Repurchases on Delay

Dependent variable:	Delay			Coefficient-based delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$\widehat{\text{Repurchase intensity}}_t$	-1.5526***			-3.4472**		
	(-2.62)			(-2.35)		
Repurchase intensity$_{t-1}$		-0.1248**			-0.3792***	
		(-2.31)			(-3.77)	
Remaining volume$_t$			-0.0344***			-0.0772***
			(-2.66)			(-2.61)
Delay$_{t-1}$	0.1257***	0.1246***	0.1242***			
	(17.49)	(17.61)	(17.59)			
Coefficient-based delay$_{t-1}$				0.0436***	0.0429***	0.0425***
				(6.72)	(6.74)	(6.70)
Accrual quality$_{t-1}$	0.1217	0.1095	0.1056	0.0174	-0.0090	-0.0189
	(1.07)	(0.96)	(0.93)	(0.07)	(-0.04)	(-0.08)
Big-4 client$_{t-1}$ (dummy)	-0.0016	-0.0023	-0.0021	0.0318***	0.0302**	0.0307**
	(-0.25)	(-0.37)	(-0.34)	(2.60)	(2.50)	(2.53)
Return$_{t-1}$ > 0	-0.0909***	-0.0839***	-0.0833***	-0.1433***	-0.1283***	-0.1266***
	(-8.26)	(-8.15)	(-8.08)	(-5.85)	(-5.73)	(-5.65)
Return$_{t-1}$ < 0	-0.0549***	-0.0521***	-0.0518***	-0.0609*	-0.0546*	-0.0539*
	(-3.90)	(-3.79)	(-3.78)	(-1.94)	(-1.77)	(-1.75)
Program initiation$_t$	0.0108***	0.0104***	0.0127***	0.0182**	0.0172**	0.0224***
	(3.49)	(3.39)	(4.06)	(2.57)	(2.49)	(3.15)
Market cap$_{t-1}$ (ln)	-0.0500***	-0.0518***	-0.0515***	-0.0807***	-0.0845***	-0.0838***
	(-13.08)	(-13.70)	(-13.55)	(-10.42)	(-11.12)	(-10.99)
Book to market$_{t-3}$	0.0022	-0.0036	-0.0034	0.0091	-0.0035	-0.0033
	(0.32)	(-0.58)	(-0.53)	(0.61)	(-0.25)	(-0.23)
Volatility$_{t-1}$ (ln)	-0.0219***	-0.0216***	-0.0221***	-0.0263	-0.0253	-0.0266
	(-2.79)	(-2.77)	(-2.84)	(-1.50)	(-1.46)	(-1.54)
Analysts$_{t-1}$ (ln)	-0.0047	-0.0052	-0.0050	-0.0139*	-0.0151**	-0.0148*
	(-1.31)	(-1.48)	(-1.43)	(-1.84)	(-2.00)	(-1.95)
Relative spread$_{t-1}$ (ln)	-0.0036	0.0014	0.0023	-0.0226	-0.0120	-0.0096
	(-0.34)	(0.14)	(0.23)	(-0.98)	(-0.54)	(-0.44)
Deviation from \$30$_{t-1}$	0.0037***	0.0037***	0.0037***	0.0056**	0.0055**	0.0056**
	(3.29)	(3.33)	(3.36)	(2.25)	(2.24)	(2.29)
Trading volume$_{t-1}$ (scaled)	0.0088**	0.0083**	0.0082**	0.0142	0.0129	0.0128
	(2.07)	(1.99)	(1.98)	(1.40)	(1.31)	(1.30)
Institutional ownership$_{t-3}$	-0.0430***	-0.0449***	-0.0454***	-0.0788***	-0.0824***	-0.0840***
	(-3.65)	(-3.86)	(-3.91)	(-3.03)	(-3.21)	(-3.27)
Constant		0.7313***	0.7305***		2.3596***	2.3581***
		(10.07)	(9.95)		(23.33)	(23.47)

(*continued*)

Dependent variable:	Delay			Coefficient-based delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
R^2 (within firm)	0.019	0.044	0.044	-0.010	0.014	0.014
Observations	31.787	31.787	31.787	31.787	31.787	31.787
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Hansen's J (test)	0.84			0.81		
Hansen's J (*p*-value)	35.83%			36.90%		
Kleibergen-Paap (test)	62.66			62.62		
Kleibergen-Paap (*p*-value)	0.00%			0.00%		

This table presents GMM and OLS regressions of the efficiency measures (*Delay* and *Delay coefficient-based*) on either one of the repurchase measures (*Repurchase intensity* and *Remaining volume*), *Investors' attention change*, returns, liquidity measures (*Relative spread, Deviation from $30* and *Trading volume*), accounting standards (*Accrual quality or Big-4 client*) and several controls. Specifications (1) – (3) use *Delay* and specifications (4) – (6) use *Delay coefficient-based* as dependant variable. In specifications (1) and (4) *Repurchase intensity* is instrumented using *Program quarter*, *Program size* and *Individual investors' attention*. Specifications (2) and (5) use lagged *Repurchase intensity* as repurchase measure, specifications (3) and (6) use *Remaining volume* as repurchase measure. Standard errors are clustered at the firm level. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

Kleibergen-Paap test for underidentification, as presented in Table 5 below, shows that I can reject the fact that the instruments used are weak. Moreover, the null hypothesis of the Hansen's J test is not rejected, indicating that the model is not overidentified. These two factors indicate that the model is likely to be working.

Table 5 reports that share repurchases unambiguously decrease the delay in stock prices which is presented by *Repurchase intensity* and *Remaining volume*. Both repurchase measures are significant and come in with the right sign. An increase of one within-firm standard deviation in *Repurchase intensity* results in a decrease of 2.56% (=0.0165 * -1.5526, whereas -1.5526 is the coefficient of Repurchase intensity presented in column (1) of Table 5) in price delay. This corresponds to 6.04% (=0.0256 / 0.4240, where 0.4240 is the median of *Delay* in Table 1) of median of *Delay*. This result is statistically significant, indicating that share repurchases reduce the delay in stock prices. Specification (2) and (5) both show for lagged *Repurchase intensity* a significantly lower coefficient in comparison to *Repurchase intensity* in specification (1) and (4). As mentioned by Busch and Obernberger (2016), lagged *Repurchase intensity* is a more noisy measure of contemporaneous share repurchases and might therefore

suffer from an attenuation bias, which means that the coefficient is estimated towards zero due to an error in the estimation of *Repurchase intensity*. Specifications (3) and (6) show that *Remaining volume* has an unequivocally negative effect on the efficiency measures (*Delay* or *Delay coefficient-based*) and is statistically significant. An increase by one with-firm standard deviation in *Remaining volume* decreases *Delay* by 0.02% (=0.0708 * -0.0344) where -0.0344 is the coefficient of *Remaining volume* in column (3) of Table 5), which corresponds to 0.57% (= 0.0024 / 0.4240, where 0.4240 is the median of *Delay*) of median *Delay*. I find that a higher *Repurchase intensity* or *Remaining volume* is negatively and significantly related to price delay. From these results, it can be deduced that share repurchases unambiguously decrease price delay of the stock price and therefore increase the price efficiency. The null hypothesis of Hypothesis 2 is rejected, which states that share repurchases do not affect the efficiency of the stock price. Furthermore, the inclusion of *Individual investors' attention* as instrumental variable to the model highly increases both the coefficient and statistical significance.

Subsequently, in Table 5 presented above, I find that *Accrual quality*, a proxy for accounting standards of a firm is statistically insignificant and therefore I cannot draw any conclusions from this measure with respect to price efficiency on the stock price. However, I do find little evidence that accounting standards are positively related to the level of price efficiency. For *Big-4 client,* I observe a significant psotive relationship for specification (4) – (6), which means that if a firm is client of a Big-4 auditor *Delay coefficient-based* increases by 0.0318 as indicated by the coefficient in specification (4). However, I observe an inverse relationship for specification (1) – (3).

The results regarding the controls are sensible and comparable to previous academic research. Additionally, *Delay* decreases and hence the efficiency of a firms' stock price increases, when returns, size or analysts increase. In line with research of Philips (2011), *Book-to-market* has the right sign but is insignificant for the OLS estimation. *Program initiation* shows positive coefficients with statistical significance, which can be reasoned because of abnormal returns around the announcement date. Moreover, I observe that *Delay* decreases with volatility in line with Philips (2011). As stated by Hillert, Maug and Obernberger (2016) in their research on the relationship between share repurchases and liquidity, I find similar results for the effect of the liquidity measures (*Relative spread*, *Trading volume* or *Deviation from $30*) on the efficiency measures. All liquidity measures come in with the right sign, however *Relative spread* is statistically insignificant. Furthermore, *Delay* decreases when *Trading volume* increases, however, Boehmer and Wu (2013) find the opposite results. At last, *Institutional ownership* increases the stock price efficiency, in line with Boehmer and Kelley

(2009). Results of the regressions of specification (1) – (3) regarding *Delay* are comparable to the results of the regressions of specification (4) – (6) regarding *Coefficient-based delay* except for *Big-4* client, which shows statistical significance with an opposite sign.

Concluding, the repurchase measures show unambiguously that share repurchases decrease the delay in the stock price and therefore increase the price efficiency and the information content. In other words, evidence from this analysis shows that share repurchases increase the speed with which information is incorporated into the stock price. As noticed by Busch and Obernberger (2016), an increase in the efficiency measures would mean that share repurchases are used to manipulate the stock price. There is no evidence towards this notion.

5.6 Analysis of Share Repurchases of Firms with Different Accounting Standards

To examine the effect of accounting quality on price efficiency, I use a simple linear regression to determine the relationship between various different accounting proxies on the price efficiency measures.

Table 6 presents the effect of accounting quality on delay. A higher *Accrual* means that a firm has a lower accounting quality. Therefore, *Accrual quality* shows that a higher accounting quality reduces delay in stock prices. However, *Accrual quality* in column (1) shows significance at the 5% level, in column (2) there is not significance. The other proxies for accounting quality, Earnings surprise, Special Items and Big-4 client also come in with the right sign. However, there is a lack of statistical significance for some of the accounting proxies. Therefore, it is hard to draw unambiguously conclusions from these result. The null hypothesis of Hypothesis 3a, which states that accounting quality does not influence price efficiency cannot be rejected for accounting quality based on *Earnings surprise*, but not for the other accounting quality proxies.

Table 6: Analysis of Accounting Proxies on Delay

Dependent variable:	Delay	Coefficient-based delay
	(1)	(2)
Method:	OLS	OLS
Accrual quality$_{t-1}$	0.2637**	0.0104
	(1.98)	(0.04)
Earnings surprise$_{t-1}$	-0.0032***	-0.0052***
	(-3.24)	(-2.85)
Special items$_{t-1}$	-0.0324	-0.1015*
	(-0.86)	(-1.73)
Big-4 client$_{t-1}$ (dummy)	-0.0223***	-0.0145
	(-3.14)	(-1.14)
Observations	35.578	35.578
Firm fixed effects	Yes	Yes
Quarter fixed effects	Yes	Yes

This table presents OLS regressions of the efficiency measures (*Delay* and *Delay coefficient-based*) on either one of the accounting quality proxies (*Accrual quality, Earnings surprise, Special items or Big-4client*) Specification1 uses *Delay* and specification (2) uses *Delay coefficient-based* as dependant variable. Standard errors are clustered at the firm level. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

To examine the effect of accounting standards in relation with share repurchases, I regress the repurchase measures on the similar set of variables as used in Table 5, except for the variables of accounting standards, which are interacted with *Repurchase intensity*. *Repurchase intensity* interacts with either *Accrual quality* or *Big-4 client*. Table A2 in the Appendix presents the results of the effect of the different accounting standards proxies, either *Accrual quality*, *Special items* or *Earnings surprise* on the *Repurchase intensity*. The results show that *Accrual quality* only has a significant effect on *Repurchase intensity*. However, *Special items* and *Earnings surprise* are not significantly related to *Repurchase intensity*. Hence, I find that *Accrual quality* is the best proxy for accounting standards at my disposal and *Accrual quality* has proven to be positively related to price delay as presented in Table 6 below. Since the results in Table 5 of *Accrual quality* on *Delay* did not provide any hard evidence towards the notion that share repurchases are less pronounced when accounting standards are higher, I divide the sample into two subsamples based on the relative level of *Accrual quality*, which measures the accounting standards of a firm. I let the subsamples, based on the relative

Table 7: Analysis of Share Repurchases on Delay in Accounting Standard Subsamples

Dependent variable:	Delay			Delay coefficient-based		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$\widehat{\text{Repurchase intensity}}_t$	-0.5738			-1.4956		
X High accounting standards$_t$	(-0.74)			(-0.77)		
$\widehat{\text{Repurchase intensity}}_t$	-3.2302***			-6.3554***		
X Low accounting standards$_t$	(-3.34)			(-2.91)		
Repurchase intensity$_{t-1}$		-0.0434			-0.3582***	
X High accounting standards$_t$		(-0.67)			(-2.74)	
Repurchase intensity$_{t-1}$		-0.2236***			-0.4051***	
X Low accounting standards$_t$		(-2.74)			(-2.60)	
Repurchase intensity$_{t-1}$			-0.0527			-0.2101
X Big 4-client$_t$			(-0.64)			(-1.04)
Repurchase intensity$_{t-1}$			-0.1507**			-0.4408***
X No Big 4-client$_t$			(-2.30)			(-3.90)
R^2 (within firm)	-0.006	0.044	0.044	-0.024	0.014	0.014
Observations	31.787	31.787	31.787	31.787	31.787	31.787
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Hansen's J (test)	11.61			5.41		
Hansen's J (*p*-value)	0.03%			6.69%		
Kleibergen-Paap (test)	54.63			54.43		
Kleibergen-Paap (*p*-value)	0.00%			0.00%		
Wald (high - low) (test)	4.80	3.03	1.52	3.03	0.02	2.31
Wald (high - low) (*p*-value)	2.86%	8.18%	21.74%	8.20%	89.85%	12.90%

This table presents OLS regressions of the price efficiency measures (*Delay or Delay coefficient-based) on Repurchase intensity* and control variables, where *Repurchase intensity* is interacted with relative levels of *Accrual quality*. All five groups are equally divided. The control variables are equal to the variables from Table 5. Standard errors are clustered at the firm level. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

level of accounting standards, interact with *Repurchase intensity* to analyse any differences. I observe that the coefficients of *Repurchase intensity* interacted with high accounting standards and *Repurchase intensity* interacted with *Big-4 client* are smaller than when interacted with low accounting standards. This means that firms with a higher accounting standards decrease *Delay* less than when firm have low accounting standards. Consequently, I perform a Wald test to examine if the coefficients are statistically significantly different from each other. I obtain mixed results. The evidence suggests that the coefficients of *Repurchase intensity X High*

accounting standards and *Repurchase intensity X Low accounting standards* as presented in specifications (1), (2) and (4) of Table 7 are statistically different from each other. However, on the other hand, specifications (3), (5) – (6) are not significantly different from each other. Therefore, the null hypothesis of Hypothesis 3b, which states that the effect of share repurchases on price delay is equal in different accounting environments, cannot be fully rejected.

5.7 Analysis of Repurchase Activity on Idiosyncratic Risk

The following section is devoted to the analysis of the impact of share repurchases on idiosyncratic risk. If firms use share repurchases to manipulate stock prices to a higher value than the fundamental value or incorporate firm-specific information, *Idiosyncratic risk* should increase (Busch and Obernberger, 2016). On the other hand, if *Idiosyncratic risk* decreases, then share repurchases increase the accuracy by which information is incorporated into the stock prices and firms may provide price support as suggested by Hong, Wang, and Yu (2008). Table 8 below shows the results of the effect of share repurchases on R-squared, presented in column (1) – (3), and the absolute market correlation, presented in column (4) – (6). Specifications in column (1) and (4) are estimated using GMM and specifications in column (2) – (3) and (5) – (6) are estimated using OLS. The Kleibergen-Paap test shows that the null hypothesis, the fact that the instruments used are weak, can be rejected. The Hansen J statistic states that the null hypothesis is not rejected, therefore the model is not overidentified.

Idem to the previous analysis, I observe a significant effect for *Repurchase intensity* and *Remaining volume,* which suggests that share repurchases reduce the amount of idiosyncratic risk. *Repurchase intensity* in specifications (1) and (4) are instrumented using *Program quarter*, *Program size* and *Individual investors' attention*. Including *Individual investors' attention* as instrumented variable increases both the significance and coefficient, however, the Hansen J statistic also increases, indicating that *Individual investors' attention* might cause overidentification. Specification (1) shows that an increase by one within-firm standard deviation in *Repurchase intensity* results in an increase of 1.79% in *R-squared* (=0.0165 * 1.0822, where 1.0822 is the coefficient of *Repurchase intensity* presented in column (1) of Table 8). This corresponds to 6.15% of median *R-squared* (=0.0179 / 0.2902, where 0.2902 is the median of *R-squared*). Based on the effect of *Repurchase intensity* and *Remaining volume* on *R-squared,* I do conclude that share repurchases decrease *Idiosyncratic risk*. The findings are in line with the results of Busch and Obernberger (2016). Moreover, the results in specifications (1) – (3) are comparable to the ones in (4) – (6), however, the effect of share

Table 8: The Impact of Share Repurchases on Idiosyncratic Risk

Dependent variable:	R-squared			|Market correlation|		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
Repurchase intensity$_t$	1.0822**			1.6460***		
	(2.27)			(3.06)		
Repurchase intensity$_{t-1}$		0.0284			0.0686	
		(0.70)			(1.43)	
Remaining volume$_t$			0.0247**			0.0328***
			(2.45)			(2.84)
R-squared$_{t-1}$	0.1923***	0.1907***	0.1905***			
	(25.97)	(26.31)	(26.33)			
|Market correlation|$_{t-1}$				0.1818***	0.1786***	0.1784***
				(23.06)	(23.40)	(23.40)
Accrual quality$_{t-1}$	-0.0569	-0.0491	-0.0468	-0.0981	-0.0709	-0.0679
	(-0.65)	(-0.56)	(-0.53)	(-0.98)	(-0.72)	(-0.69)
Big-4 client$_{t-1}$ (dummy)	-0.0101**	-0.0097**	-0.0098**	-0.0015	-0.0004	-0.0006
	(-2.40)	(-2.32)	(-2.35)	(-0.27)	(-0.08)	(-0.11)
Program initiation$_t$	-0.0107***	-0.0102***	-0.0119***	-0.0254***	-0.0108***	-0.0130***
	(-4.43)	(-4.32)	(-4.88)	(-5.70)	(-4.15)	(-4.84)
Market cap$_{t-1}$ (ln)	0.0359***	0.0370***	0.0368***	0.0460***	0.0489***	0.0486***
	(13.28)	(13.75)	(13.66)	(13.55)	(15.25)	(15.11)
Book to market$_{t-3}$	0.0065	0.0104**	0.0100**	-0.0044	0.0046	0.0042
	(1.37)	(2.37)	(2.29)	(-0.71)	(0.83)	(0.75)
Analysts$_{t-1}$ (ln)	-0.0000	0.0005	0.0003	0.0004	0.0015	0.0013
	(-0.01)	(0.19)	(0.14)	(0.12)	(0.48)	(0.42)
Relative spread$_{t-1}$ (ln)	0.0196***	0.0156***	0.0155***	0.0276***	0.0200***	0.0197***
	(4.18)	(3.58)	(3.55)	(4.69)	(3.57)	(3.52)
Deviation from \$30$_{t-1}$	-0.0028***	-0.0028***	-0.0028***	-0.0034***	-0.0035***	-0.0035***
	(-3.26)	(-3.29)	(-3.29)	(-3.48)	(-3.79)	(-3.80)
Trading volume$_{t-1}$ (scaled)	-0.0071**	-0.0067**	-0.0066**	-0.0080**	-0.0072**	-0.0071**
	(-2.48)	(-2.40)	(-2.39)	(-2.25)	(-2.11)	(-2.10)
Institutional ownership$_{t-3}$	0.0315***	0.0335***	0.0337***	0.0349***	0.0408***	0.0412***
	(3.51)	(3.79)	(3.82)	(3.36)	(4.09)	(4.13)
Constant		0.0165***	0.0173***		0.0890***	0.0901***
		(23.47)	(25.06)		(14.08)	(14.03)
R^2 (within firm)	0.036	0.060	0.060	0.020	0.063	0.063
Observations	31.787	31.787	31.787	31.729	31.729	31.729
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Hansen's J (test)	2.25			2.35		
Hansen's J (*p*-value)	13.38%			12.50%		
Kleibergen-Paap (test)	62.62			61.78		
Kleibergen-Paap (*p*-value)	0.00%			0.00%		

This table presents GMM and OLS regressions of the *Idiosyncratic risk* measures (*R-squared* and |*Market correlation*|) on either one of the repurchase measures (*Repurchase intensity* and *Remaining volume*), *Investors' attention*, returns, liquidity measures (*Relative spread, Deviation from \$30* and *Trading volume*), accounting standards (*Accrual quality or Big-4 client*) and several controls. Specification (1) – (3) use *R-squared* and specification (4) – (6) use |*Market correlation*| as dependant variable. In specification (1) and (4) *Repurchase intensity* is instrumented using *Program quarter* and

Program size. Specifications (2) and (5) use lagged *Repurchase intensity* as repurchase measure, specifications (3) and (6) use *Remaining volume* as repurchase measure. Standard errors are clustered at the firm level. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

repurchases on correlation is slightly smaller. In particular in specification (4) an increase by one with-firm standard deviation of *Repurchase intensity* results in an increase of 2.72% in |*Market correlation*| (=0.0165 * 1.6460, where 1.6460 is the coefficient of *Repurchase intensity* presented in column (4) of Table 8). This corresponds to 5.35% of median of |*Market correlation*| (=0.0272 / 0.5080, where 0.5080 is the median of |*Market correlation*|). In column (2), the results show that an increase in one within-firm standard deviation in *Repurchase intensity* increase *R-squared* by 0.04% (=0.0165 * 0.0284, where 0.0284 is the coefficient of lagged *Repurchase intensity* in column (2) of Table 8). This corresponds to 0.16% (=0.0002 / 0.2902) of median *R-squared*. This means that the effect of share repurchases estimated by the OLS regression is approximately a factor ten smaller compared to when estimated using the GMM model. This may be caused by any unobserved heterogeneity in the OLS regression. Furthermore, remarkable is that Repurchase intensity in column (2) and (5) is not significant, in contradiction to Busch and Obernberger (2016), which use repurchase measures on a monthly basis. This phenomenon may arise because of two reasons, either a misfit of the data or share repurchases do not decrease the *Idiosyncratic risk* on a quarterly basis. Since *Remaining volume* in column (3) and (6) of Table 8 is significant but *Repurchase intensity* in column (2) and (5) of Table 8 is insignificant, I conclude that share repurchases do not decrease *Idiosyncratic risk* undeniably from a quarterly point of view.

Furthermore, I also observe a negative effect when accounting standards (*Accrual quality* and *Big-4 client*) are higher, indicating that a better accounting environment increases the amount of *Idiosyncratic risk* of the firm. Nonetheless, the results are partially insignificant and therefore, I cannot state a clear effect of the accounting environment on the amount of *Idiosyncratic risk* incorporated into the stock price.

Most of the controls show comparable results to the analysis of Busch and Obernberger, 2016). Firms which have a higher *Market capitalization* have a higher *R-squared*, which means that the noise is lower for these firms (Busch and Obernberger, 2016). *Book-to-market* shows weakly partially significant results. The higher the *Book-to-market* ratio, the higher the undervaluation, the higher the undervaluation, the lower the Idiosyncratic risk. Additionally, I notice that the *Relative spread* is positively related to *R-squared* and |*Market correlation*|,

which can be explained by previous literature. Bris, Goetzmann and Zhu (2007) suggest that higher liquidity implies higher *R-squared* and hence lower *Idiosyncratic risk*. In contradiction to *Relative spread, Deviation from $30* and *Trading volume* both show a negative and significant effect.

Concluding, the results support the notion that share repurchases increase the contemporaneity between the stock and the market. Nevertheless, I do not find evidence towards the fact that share repurchases increase *Idiosyncratic risk* and therefore the amount of noise or incorporate private information into the stock price. However, I cannot completely reject the null hypothesis of Hypothesis 4a, which states that share repurchases reduce the amount of *Idiosyncratic risk*.

5.8 Analysis of Repurchases in Up and Down Markets

Thus far, I have confirmed the notion that share repurchases increase the efficiency of stock prices and reduce the amount of idiosyncratic risk. In the following section, I discuss the effect of share repurchases by deepening the mechanisms that cause this effect by assessing repurchase activity in up and down markets. The following theory backs the difference in effectivity of share repurchases on the efficiency in up and down markets. Managers can trade on positive public information, which is not yet incorporated into the stock price. Their belief is that the stock price should be worth more and therefore repurchase shares until the fundamental value is reached. If the firm incorporates positive public information into the stock price, an increase in price efficiency and hence a decrease in *Delay* should be observed when the market goes up.

Managers can also trade on negative public information to prevent stock prices from falling from the fundamental value. If firms trade on negative public information, they create a lower bound price at fundamental value, which leads to more accurately price stock prices and hence repurchases should increase the price efficiency when markets go down. For the definition of up and down markets, I use the market return over the current quarter. If the sum of the market returns is positive, it is defined as an up market, and vice versa. The repurchase measures are interacted with up and down to determine the effect on price efficiency when positive or negative public information is incorporated. For the analysis in Table 9, the same specification as in Table 5 and 7 is used, however, for simplicity, the variables other than repurchase variables are suppressed and *Repurchase intensity* (not interacted) is left out because of collinearity issues with *Repurchase intensity x Up market* and *Repurchase intensity x Down market.* Panel A of Table 9 represents the regressions of the efficiency measures on the

Table 9: The Impact of Repurchases on Delay in Up and Down Markets

Panel A

Dependent variable:	Delay			Coefficient-based delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$\widehat{\text{Repurchase intensity}}_t$	-1.4278**			-3.2841**		
x Up market$_t$	(-2.33)			(-2.20)		
$\widehat{\text{Repurchase intensity}}_t$	-3.8866***			-7.3524***		
x Down market$_t$	(-3.65)			(-3.10)		
Repurchase intensity$_{t-1}$		-0.0735			-0.2483**	
x Up market$_t$		(-1.17)			(-2.19)	
Repurchase intensity$_{t-1}$		-0.2523***			-0.7828***	
x Down market$_t$		(-3.00)			(-3.68)	
Remaining Volume$_t$			-0.0300**			-0.0724**
x Up market$_t$			(-2.13)			(-2.37)
Remaining Volume$_t$			-0.0636***			-0.1093**
x Down market$_t$			(-2.83)			(-2.14)
R^2 (within firm)	-0.015	0.039	0.040	-0.031	0.013	0.013
Observations	31.787	31.787	31.787	31.787	31.787	31.787
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Hansen's J (test)	1.16			1.58		
Hansen's J (*p*-value)	56.08%			43.34%		
Kleibergen-Paap (test)	61.93			61.90		
Kleibergen-Paap (*p*-value)	0.00%			0.00%		
Wald (up - down) (test)	6.66	2.42	2.07	4.27	4.26	0.61
Wald (up - down) (*p*-value)	1.00%	12.01%	15.04%	3.90%	3.92%	43.43%

(continued)

repurchase measures and Panel B on *R-squared* and |*Market correlation*| respectively, where each of the repurchase measures is interacted with up or down market. I observe that the repurchase measures are unequivocally higher, and hence increasing the price efficiency less, in up markets than in down markets in all specifications. The mean of *Repurchase intensity* in down markets is approximately 10% bigger than *Repurchase intensity* in up markets, where the efficiency measures are approximately 25% larger in up markets than in down markets. This means that firms repurchase 10% more shares when the market returns are negative over the current quarter. Furthermore, the distribution of observations between higher with respect to *Repurchase intensity x Up market* and *Repurchase intensity x Down market* is highly skewed,

with a ratio of 4 to 1 respectively. *Repurchase intensity* is statistical significant when estimated using GMM method, while Repurchase intensity x Down market lacks statistical significance when estimated using OLS method for *Repurchase intensity x Up market* in column (2) of Table 9. Remarkable is the fact that the coefficients of the repurchase measures in up markets are higher with respect to the analysis in Table 5. An increase in *Repurchase intensity* of one within-firm standard deviation in an up market reduces price delay by 2.36% (=0.0165 * 1.4278, where 1.4278 is the coefficient of *Repurchase intensity x Up market* in Panel A column (1) of Table 9), which corresponds to 5.56% of median *Delay* (=0.0236 / 0.4240, where 0.4240 is the median of *Delay*). In a down market an increase of one within-firm standard deviation reduces price delay by 6.41% (=0.0165 * 3.8866, where 3.2401 is the coefficient of *Repurchase intensity x Down market* in panel A column (1) of Table 9), which corresponds to 15.12% of median *Delay* (=0.0641 / 0.4240). This mean that share repurchases as a mechanism to increase the price efficiency in down markets are more efficient that share repurchases in up markets. However, individually, share repurchases are still effective. The results for specification (4) are equivalent.

Specifications (2) – (3) and (5) – (6) both show that *Repurchase intensity* and *Remaining volume* are significant, whereas share repurchases in down markets are more effective than in up markets. Consequently, I perform a Wald test to test whether the coefficients between the repurchase measures in up and down markets are statistically significantly different from each other. For all specifications, except for specification (5), the coefficients are significantly indifferent from each other, which means that the effectiveness of share repurchases in up and down markets is equal.

Panel B of Table 9 presented below shows equivalent outcomes to the results presented earlier on *Idiosyncratic risk*. Share repurchases increase *R-squared* and |*Market correlation*| in both up and in down markets. I observe semi-strong significant results for down markets when estimated using the OLS method. The coefficients of lagged *Repurchase intensity* and *Remaining volume* in up markets lack significance. Furthermore, the results show strong significance for *Repurchase intensity* in up and down markets when GMM method is used. An increase in *Repurchase intensity* in an up market of one within-firm standard deviation decreases *R-squared* by 1.60% (=0.0165 * 0.9717 where 0.9717 is the coefficient of *Repurchase intensity x Up market* in Panel B column (1) of Table 9), which corresponds to 5.52% of median *R-squared* (0.0160 / 0.2902). An increase in *Repurchase intensity* of the median in a down market increases the *R-squared* by 5.07 % (=0.0165 * 3.0755 where 3.0755 is the coefficient of *Repurchase intensity x Down market* in Panel B column (1) of Table 9),

Table 9: **The Impact of Repurchases on R-squared and Absolute Market Correlation in Up and Down Markets**

Panel B

Dependent variable:	R-squared			|Market correlation|		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$\widehat{\text{Repurchase intensity}}_t$	0.9717**			1.5731***		
x Up market$_t$	(2.01)			(2.88)		
$\widehat{\text{Repurchase intensity}}_t$	2.9579***			3.0755***		
x Down market$_t$	(3.72)			(3.49)		
Repurchase intensity$_{t-1}$		-0.0036			0.0412	
x Up market$_t$		(-0.10)			(0.86)	
Repurchase intensity$_{t-1}$		0.1937**			0.1638**	
x Down market$_t$		(2.53)			(2.11)	
Remaining Volume$_t$			0.0204*			0.0301**
x Up market$_t$			(1.94)			(2.43)
Remaining Volume$_t$			0.0495***			0.0497**
x Down market$_t$			(2.79)			(2.49)
R^2 (within firm)	0.006	0.059	0.060	-0.001	0.062	0.062
Observations	31.787	31.787	31.787	31.787	31.787	31.787
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Hansen's J (test)	2.32			2.58		
Hansen's J (*p*-value)	31.39%			27.59%		
Kleibergen-Paap (test)	61.79			61.03		
Kleibergen-Paap (*p*-value)	0.00%			0.00%		
Wald (up - down) (test)	8.73	3.44	2.83	3.81	1.05	0.90
Wald (up - down) (*p*-value)	0.32%	6.37%	9.29%	5.13%	30.50%	34.43%

This table presents GMM and OLS regressions of the efficiency measures (*Delay* or *Delay coefficient-based*) in panel A and *R-squared* and |*Market correlation*| in panel B on the repurchase activity measures (*Repurchase intensity* and *Remaining volume*. The repurchase activity measures are interacted with dummy variables up or down, indicating whether the market went up or down in terms of returns. The controls are the same as regressed in Table 5. In specification (1) and (4) *Repurchase intensity* is instrumented using *Program quarter* and *Program size*. Specification (2) and (5) use lagged *Repurchase intensity* as repurchase measure, specification (3) and (6) use *Remaining volume* as repurchase measure. Standard errors are clustered at the firm level. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

which corresponds to 17.49% of median *R-squared* (=0.0507 / 0.2902, where 0.2902 is the median of R-squared). Moreover, these results are both significant. This indicates that the amount of *Idiosyncratic risk* is reduced when firms perform share repurchases to provide price support in down markets and the amount of idiosyncratic risk is reduced when firms trade on positive public information. Furthermore, I observe that the coefficients of specification (1) and (2) are statistically significantly different from each other. This means that up or down markets drive the effectivity of *Repurchase intensity*. However, this notion is not supported by specifications (3) – (6). As mentioned by Busch and Obernberger (2016), if a firm provides price support during a specific time of the period in which the market went down, and where the market went up overall in the quarter, then share repurchases will have a positive effect on price efficiency in up markets. The results for specifications (4) – (6) are comparable to the results of specifications (1) – (3). The use of quarterly data in this analysis may cause a minor misfit of the data in a way that share repurchases can be performed in up markets while they are marked as share repurchases in down markets and vice versa. The number of observations with respect to up and down markets is highly skewed to up markets. This mean that there are far more observations in up markets than down markets. This is a result of an overall up going market in the sample period. Nonetheless, this results in a quarters marked as up market, while the actual share repurchase might be used to provide price support in a down market.

Concluding, the results in this section show that share repurchases increase price efficiency in up and down markets. This indicates that share repurchases increase the speed and accuracy by which both positive and negative public information is incorporated into stock prices. This provides evidence towards the price support hypothesis and attempts to prevent stock prices from diverging from its' fundamental value. Moreover, it also provides evidence towards the notion that managers use share repurchases to incorporate positive information into the stock price. I cannot fully reject the null hypothesis of Hypothesis 4b, which states that the reduction in *Idiosyncratic risk* is more pronounced in down markets than in up markets since the Wald tests are not significant for all specifications. Nonetheless, share repurchases reduce the amount of *Idiosyncratic risk* in both up and down markets.

5.9 Analysis of Repurchases in Low and High Attention Levels

The analysis presented below in Table 10 shows the results of the analysis on share repurchases specified by low and high states of the individual investors' attention level. The individual investors' attention level is defined as low if the level is below the average of the sample period and marked as high attention level if the attention level is above average. This analysis gives

Table 10: The Impact of Repurchases on Delay in Low and High Attention Levels

Panel A

Dependent variable:	Delay			Coefficient-based delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$\widehat{\text{Repurchase intensity}}_t$	-2.8265***			-5.5099***		
x Low attention$_t$	(-4.49)			(-3.69)		
$\widehat{\text{Repurchase intensity}}_t$	-1.3213**			-3.2415**		
x High attention$_t$	(-2.00)			(-2.03)		
Repurchase intensity$_{t-1}$		-0.1423**			-0.3712***	
x Low attention$_t$		(-2.04)			(-2.60)	
Repurchase intensity$_{t-1}$		-0.0856			-0.2611	
x High attention$_t$		(-0.82)			(-1.55)	
Remaining Volume$_t$			-0.0385**			-0.0746**
x Low attention$_t$			(-2.50)			(-2.21)
Remaining Volume$_t$			-0.0273			-0.0689*
x High attention$_t$			(-1.56)			(-1.90)
R^2 (within firm)	-0.019	0.039	0.039	-0.034	0.013	0.013
Observations	31.787	31.787	31.787	31.787	31.787	31.787
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Hansen's J (test)	3.55			2.51		
Hansen's J (*p*-value)	16.04%			28.51%		
Kleibergen-Paap (test)	13.98			8.50		
Kleibergen-Paap (*p*-value)	0.29%			3.67%		
Wald (up - down) (test)	15.96	0.23	0.33	8.45	0.28	0.02
Wald (up - down) (*p*-value)	0.01%	63.46%	56.46%	0.04%	59.44%	87.67%

(continued)

insight in the state of the firm when they perform share repurchases. In a fully efficient capital market where investors are rational and information is complete, stock prices should reflect the true fundamental value. The neglection of certain stocks by investors might cause price delay (Hou and Moskowitz, 2005). The results presented below in Table 10 show that firms use share repurchases to increase the price efficiency when investors are unwilling or not capable to do so.

Table 10 shows that share repurchases increase the price efficiency unambiguously more when investors' attention finds itself in a low level state. For the analysis in Table 10, the

same specification as in Table 5 is used, however, for simplicity, the variables other than repurchase variables are suppressed and *Repurchase intensity* (not interacted) is left out because of collinearity issues with *Repurchase intensity X Low attention* and *Repurchase intensity X Low attention.* Panel A of Table 10 represents the regressions of the efficiency measures on the repurchase measures and Panel B on *R-squared* and |*Market correlation*| respectively, where each of the repurchase measures is interacted with low and high levels of attention.

The most important part of this analysis is the fact that the effectiveness of share repurchases is more pronounced when investors neglect the firm's stock. The statistical significance is unambiguously higher in the low attention state than in the high attention state. An increase in *Repurchase intensity* in a low attention level of one within-firm standard deviation decreases *Delay* by 4.66% (=0.0165 * 2.8265 where 2.8265 is the coefficient of *Repurchase intensity x Low attention in* Panel A column (1) of Table 10), which corresponds to 11.00% of median *Delay* (0.0166 / 0.4240). When a firm experiences high attention an increase of one within-firm standard deviation reduces price delay by 2.18% (=0.0165 * 1.3213, where 1.3213 is the coefficient of *Repurchase intensity x High attention* in panel A column (1) of Table 10), which corresponds to 5.14% of median *Delay* (=0.0218 / 0.4240). The results for specification (4) are comparable to these results. The results of the Wald test partially indicate a difference between share repurchases during low and high attention levels. Column (1) and (4) show that share repurchases are more effective to diverge the price back to the true fundamental value when the firm is in a low attention level. This indicates that firms use share repurchases as a last resort to converge the stock price to the true fundamental value and reduce price delay. In line with the previous analysis, the coefficients of specifications (2) – (3) and (5) – (6) are approximately a factor of 20 smaller than specifications (1) and (4) respectively.

Panel B of Table 10 presents the results of the effect of share repurchase activity on the amount of *Idiosyncratic risk.* Remarkably again is the difference in statistical significance. I observe a higher level of statistical significance, unequivocally, for all measures in low attention levels with respect to high attention level. Furthermore, the amount of *Idiosyncratic risk* is reduced in all specifications except for specification (2), moreover, the amount of *Idiosyncratic risk* is reduced the most when the firm is in a low attention state.

An increase in *Repurchase intensity* in a low attention state of one within-firm standard deviation decreases *R-squared* by 3.30% (=0.0165 * 2.0017 where 2.0017 is the coefficient of *Repurchase intensity x Low attention* in Panel B column (1) of Table 10), which corresponds

Table 10: **The Impact of Repurchases on R-squared and Absolute Market Correlation in Low and High Attention Levels**

Panel B

Dependent variable:	R-squared			|Market correlation|		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$\widehat{\text{Repurchase intensity}}_t$	2.0017***			2.7657***		
x Low attention$_t$	(4.15)			(5.03)		
$\widehat{\text{Repurchase intensity}}_t$	0.7271			1.3419**		
x High attention$_t$	(1.41)			(2.24)		
Repurchase intensity$_{t-1}$		0.0666			0.1005*	
x Low attention$_t$		(1.26)			(1.72)	
Repurchase intensity$_{t-1}$		-0.0317			0.0176	
x High attention$_t$		(-0.53)			(0.22)	
Remaining Volume$_t$			0.0292**			0.0359***
x Low attention$_t$			(2.53)			(2.77)
Remaining Volume$_t$			0.0198			0.0300**
x High attention$_t$			(1.58)			(1.98)
R^2 (within firm)	0.008	0.0591	0.0594	-0.019	0.0620	0.0623
Observations	31.787	31.787	31.787	31.787	31.787	31.787
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Hansen's J (test)	11.94			11.45		
Hansen's J (*p*-value)	0.26%			0.33%		
Kleibergen-Paap (test)	65.45			64.63		
Kleibergen-Paap (*p*-value)	0.00%			0.00%		
Wald (up - down) (test)	22.53	0.35	0.22	19.91	0.35	0.27
Wald (up - down) (*p*-value)	0.00%	55.52%	64.09%	0.00%	55.69%	60.66%

This table presents GMM and OLS regressions of the efficiency measures (*Delay* or *Delay coefficient-based*) in panel A and *R-squared* and |*Market correlation*| in panel B on the repurchase activity measures (*Repurchase intensity* and *Remaining volume*. The repurchase activity measures are interacted with dummy variables low and high, indicating whether the individual investors' attention level was relatively low or high. The controls are the same as regressed in Table 5. In specification (1) and (4) *Repurchase intensity* is instrumented using *Program quarter* and *Program size*. Specification (2) and (5) use lagged *Repurchase intensity* as repurchase measure, specification (3) and (6) use *Remaining volume* as repurchase measure. Standard errors are clustered at the firm level. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

to 11.38% of median *R-squared* (0.0330 / 0.2902). An increase in *Repurchase intensity* of the median when the firm is in a high attention state increases the *R-squared* by 1.20% (=0.0165 * 0.7271 where 0.7271 is the coefficient of *Repurchase intensity x High attention* in Panel B column (1) of Table 10), which corresponds to 4.13% of median *R-squared* (=0.0120 / 0.2902, where 0.2902 is the median of R-squared). The effectiveness of share repurchases with respect to the reduction of *Idiosyncratic risk* is a factor three higher in a low attention state than in a high attention state. Furthermore, I observe that the Wald test is significant at the 1% level in specification (1) and (4), indicating that the coefficients between low attention state and high attention state are statistically significantly different from each other. Equivalent to the analysis presented in Panel A, this provides evidence that firms use share repurchases when investors lack to keep the prices efficient.

5.10 Analysis of Contemporaneous Repurchase Intensity

Table A4 in the Appendix presents the results of contemporaneous repurchase activity and a dummy for repurchase activity on either the efficiency measures or the Idiosyncratic risk measures. As mentioned by Busch and Obernberger (2016), contemporaneous *Repurchase intensity* might have a positive bias if share repurchases are used to prevent the stock price from diverging from its' fundamental value. A dummy variable is included into the model to assign the quarter as a quarter in which a firm repurchases shares. Busch and Obernberger (2016) use this methodology to detect any reverse causality. The results are partially in line with their findings. I observe that contemporaneous *Repurchase intensity* comes in with the right sign and is not significant for the efficiency measures. For R-squared, contemporaneous *Repurchase intensity* is only weakly significant. I do not find evidence that Idiosyncratic risk or price delay is higher in months where share repurchases took place, as presented in Panel B of Table A3. In Panel C, I split the repurchase dummies again in up and down markets. I statically significant results for contemporaneous repurchases in down markets. This indicates that price delay and *Idiosyncratic* risk is lower in down markets. However, I do not find the opposite result for up markets.

5.11 Robustness tests

To determine the feasibility and strength of the statistical models I perform several robustness tests and observe if the relationship between share repurchases and price efficiency and the

relationship between share repurchases and *Idiosyncratic risk* still hold. by using other proxies for accounting standards.

5.11.1 Accounting Standards

To examine the validity of *Accrual quality* as a proxy for accounting standards of the firm, I replace *Accrual quality* by either *Special items* or *Earnings surprise*. The results of Table A2 in the Appendix show that *Repurchase intensity* is merely influenced. This is in line with the previous analysis of *Repurchase intensity* interacted with accounting standards on Delay, presented in Table 5. However, Table 5 shows that all three proxies come in with the right sign, however the coefficients are not statically different from each other as presented by the Wald statistics. I do not find any evidence that *Repurchase intensity* is affected by the accounting standards of the firm, even though the proxies used for accounting standards are proven to be valid.

5.11.2 Effect of Share Repurchases by Frequency

In the means of *Repurchase intensity*, I find that the means of *Repurchase intensity* is ascending as frequency increases. Figure A3 in the Appendix presents a visual representation of the repurchase intensity plotted against the frequency level. The interpretation hereof is that the more share repurchases programs a firm has performed in the five years prior to the sample, the higher the average *Repurchase intensity* per quarter is. The higher means of repurchase activity in the higher frequency level may cause a bias in the effect of share repurchases on price efficiency or idiosyncratic risk. While there are slight differences in coefficients of lagged *Repurchase intensity* on the price efficiency measures and the *Idiosyncratic risk* measures, I do not find an ascending or descending trend in the coefficients. Therefore, the number of share repurchase programs prior to the sample does not affect the effectivity of share repurchases.

6. Conclusion

The purpose of this thesis is to examine the effect of share repurchases on the price efficiency and the amount of idiosyncratic risk of stock prices listed in the United States from a quarterly view in the period between 2011 and 2017. Thereafter the relationship between the attention towards a firm and the accounting environment of the firm is linked to share repurchases.

The results show that firms front-load execute share repurchase programs to reduce risk of uncertain market prices. Moreover, firms seem to actually repurchase shares when investors' attention is low. Additionally, the statistical evidence shows that share repurchases unambiguously increase the price efficiency of the stock price. This effect seems to be even more present when the market is down. This suggests that firms use share repurchases to provide price support.

The results concerning the differences in accounting quality shows mixed results. There is only partial evidence towards the notion that a higher accounting quality can be linked to a higher level of price efficiency. Moreover, there is little, but any, evidence that share repurchases are more effective when the accounting standards of the firm are lower.

Concerning the notion that share repurchases reduce the amount of idiosyncratic risk, the bigger part of the results show statistical evidence that share repurchases do reduce the amount of idiosyncratic risk. However, this notion is not completely observed. This similar findings are observed in the up and down market. Share repurchases are more effective to reduce the amount of idiosyncratic risk incorporated into the stock price in down markets than up markets.

Furthermore, the analysis on the effect of share repurchases on price efficiency and idiosyncratic risk in a framework of individual investors' attention shows that share repurchases are more effective when the firm is in a low attention level in contrast to a high attention level. This indicates that firms might use share repurchases as a last resort to converge the stock price back to its fundamental value.

7. Limitations and Further Research

This section elaborates on the limitations and shortcomings of the empirical research performed. I will briefly discuss what factors might cause problems for the interpretation of the results. Thereafter, I will give any suggestions to overcome or bypass these limitations and provide recommendations for further research.

7.1 Limitations

First of all, this thesis uses a wide variety of databases with different periodicities which must be matched to each other. For instance, the use of daily data with respect to delay, idiosyncratic risk, returns and volatility must be transformed into quarterly data, which raises some concerns. This might cause some effects, like delay, to be smoothened. It must be noticed that the effect of share repurchases is biased downwards since delay follows a mean reversion cycle. To capture this effect precisely, the share repurchases and price efficiency should both be measured on a daily basis. Furthermore, Compustat measures the number of shares repurchased on a quarterly basis, while a firm repurchases shares on a specific day or on a specific number of days. This creates a certain mismatch of the data. Hence, the most effective impact caused by share repurchases presented in this analysis is therefore less than in reality. In other words, the effect of share repurchases on price efficiency and idiosyncratic risk is therefore downward biased.

The results of the effect of share repurchases on price efficiency and idiosyncratic risk are slightly unreliable. The reason for this inaccuracy is that the distribution between up and down markets is highly skewed. The daily returns are summed on a quarterly return, which results in far more up market observations than down market observations. As discussed above, this is a result of converting daily data into quarterly data, which leads to some extent to imprecision.

Another limitation in this thesis is the inaccuracy of the calculation of *Remaining volume*, which acts as repurchase measure. The SDC database reports only the effective date of merely a handful of repurchase programs. Therefore I am unable to determine the end of a repurchase program. This problem is partially oppressed by setting the maximum length of a repurchase program as four quarters. However, this may reduce the reliability of *Remaining volume* as repurchase measure.

7.2 Further research

To overcome the problems presented in the previous section, the analysis on a quarterly basis provides novel insights at a more distant level, however, it also smooths out some of the effects. Therefore, share repurchase would ideally be analysed on a daily level. However, firms only disclose their share repurchase in the 8-K, 10-Q, 10-K and 20-F filings, which means that, at the best, share repurchases can be examined on a monthly level. However, this would still provide a better insight than on a quarterly basis and return a more accurate analysis. Exceptionally with respect to the results of the individual investors' attention. Further research on this aspect is necessary to draw any hard conclusions.

Furthermore, individual investors' attention is one way to measure the amount of attention a firm has, another way is to measure the institutional investors' attention. Novel research of Ben-Raphael, Da and Israelsen (2017), shows that one can measure institutional investors' attention by analysing the new reading activity and news searching in Bloomberg teminals. Combining the measure of individual investors' attention and the institutional investors' attention might give better insights in the level of attention towards a firm.

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Appendix

Table A1: Description of Variables

Name	Definition	Source	Unit
Assets (current)	Current assets (Compustat item: act)	Compustat	Million
Assets (total)	Total assets (Compustat item: at)	Compustat	Million
Accrual quality	Accounting quality measure constructed as the uncertainty in the accrual-cash-flow mapping, winsorized at 1%	Compustat	Ratio
Analysts	Number of analysts (ln)	I/B/E/S	Unit
Book to market	Book value equity / market cap, winsorized at 1%	Compustat	Ratio
Book value equity	Common equity (Compustat item: ceqq)	Compustat	Million
Cash	Cash and short-term investments (Compustat item: cheq)	Compustat	Million
CFO	Income before extraordinary items scaled by total assets (Compustat item: ib)	Compustat	Million
Coefficient-based delay	Price efficiency measure constructed as the ratio of the R^2 estimates of the extended market model and the base model	CRSP	Million
Debt	Debt in current liabilities Compustat item: dlc)	Compustat	Million
Delay	Price efficiency measure constructed as the ratio of the lag-weighted sum of the coefficients of the lagged market returns relative to the sum of all coefficients	CRSP	Million
Depreciation	Depreciation and amortization Compustat item: dp)	Compustat	Million
Deviation from $30	Absolute difference between the stock price and $30 (ln)	CRSP	Unit
Dividends	Total dividends (Compustat item: dvt)	Compustat	Million
EBITDA	Operating income before depreciation (Compustat item:oibdpq)	Compustat	Million
Earnings surprise	The absolute value of earnings surprise scaled by the standard deviation of annual earnings surprise in the last five years	I/B/E/S	Ratio
Frequency	The number of share repurchases made by the firm in the five years prior to the sample	SDC	Unit
Insider ownership	Shares held by insiders scaled by shares outstanding	Exec.	Ratio
Institutional ownership	Shares held by institutions scaled by shares outstanding	TR. Inst. Holdings	Ratio
Investors' attention level	The increase in absolute value of the Google Search Volume Index	Google Trends	Ratio
Leverage	(Total assets – book value equity) / total assets – book value equity market	Compustat / CRSP	Ratio

	cap)		
Liabilities	Current liabilities (Compustat: lct)	Compustat	Million
Market capitalization	Quarterly average of daily market capitalization (ln)	CRSP	Million
Market correlation	Correlation between daily stock return and contemporaneous market return	CRSP	Unit
Options exercised	Number of shares obtained by option exercises of corporate insiders in the respective quarter scaled by shares outstanding, winsorized at 1%	TR Insider Data	Ratio
Options outstanding	Outstanding options scaled by shares outstanding	Compustat	Ratio
Program quarter	Difference between current quarter and quarter before the start of the repurchase program plus 1 (ln) outstanding	Compustat	Ratio
Program size	Percentage of shares sought as of the date of announcement	SDC	Ratio
PPE	Power plant and equipment scaled by total assets (Compustat item: ppegt)	Compustat	Million
Relative spread	Quarterly average of the daily spread between the closing bid and the closing ask price divided by the mean (ln)	CRSP	Ratio
Remaining volume	Remaining number of the shares sought as of the beginning of the date of announcement scaled by the number of shares outstanding	CRSP / SDC	Ratio Ratio
Repurchase volume	Number of shares repurchased during one quarter (Compustat item: cshopq)	Compustat	Million
Repurchase intensity	Number of shares repurchased during one quarter divided by the number of shares outstanding at the last trading day of the previous quarter	Compustat / CRSP	Ratio
Repurchase intensity (TV)	Number of shares repurchased during one quarter divided by the number of shares traded over the quarter	Compustat / CRSP	Ratio
Return	Quarterly stock return	CRSP	Unit
Return > 0	Quarterly stock return if positive, else zero	CRSP	Unit
Return < 0	Quarterly stock return if negative, else zero	CRSP	Unit
R-squared	R-squared estimate of the market model	CRSP	Ratio
Rev	Revenue scaled by total assets (Compustat item: sale)	Compustat	Million
Shares outstanding	Number of shares outstanding at last trading day of the month	CRSP	Million
Special items	Special Items divided by the lagged total assets (Compustat item: spi)	Compustat	Million
Total assets	Total assets (Compustat item: atq) (ln)	Compustat	Million
Trading volume	Quarterly total trading volume excluding repurchases scaled by shares	CRSP	Ratio
Turnover	Trading volume scaled by market cap	CRSP	Ratio
Volatility	Standard deviation of daily returns over one quarter (ln)	CRSP	Unit

This table gives an overview of all variables used in the analysis. The table includes the name, the description, the source of the database and the unit in which the variable is measured.

Table A2: Analysis of Accountings Standards on Repurchase Intensity

Dependent variable:	Repurchase intensity		
	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Repurchase intensity$_{t-1}$	0.0668***	0.0618***	0.1156***
	(3.44)	(3.21)	(3.62)
Accrual quality$_{t-1}$	0.0260***		
	(2.61)		
Special items$_{t-1}$		0.0022	
		(1.30)	
Earnings surprise$_{t-1}$			0.0000
			(0.28)
R^2 (within firm)	0.030	0.029	0.035
Observations	30.850	30.625	14.095
Firm fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes

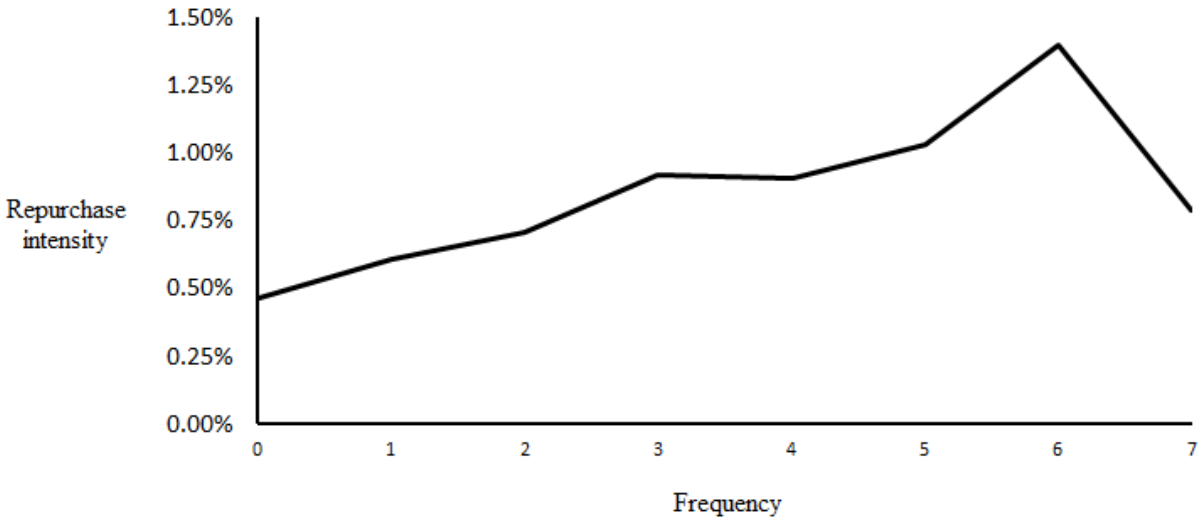
This table presents the results of the OLS regressions of *Repurchase intensity* on lagged *Repurchase intensity* , accounting standards (*Accrual quality, Special items* or *Earnings surprise*), the instrumental variables (*Program quarter* and *Program size*), *Investors' attention level*, the returns and the control variables. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

Table A3: Analysis Accounting Proxy Validity

Dependent variable:	Delay			Delay coefficient-based		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	OLS	OLS	OLS	OLS	OLS	OLS
Repurchase intensity$_{t-1}$	-0.2236***			-0.4051***		
X Accrual quality high$_t$	(-2.74)			(-2.60)		
Repurchase intensity$_{t-1}$	-0.0434			-0.3582***		
X Accrual quality low$_t$	(-0.67)			(-2.74)		
Repurchase intensity$_{t-1}$		-0.1625**			-0.4471***	
X Special items high$_t$		(-2.39)			(-3.83)	
Repurchase intensity$_{t-1}$		-0.0679			-0.2778	
X Special items low$_t$		(-0.83)			(-1.56)	
Repurchase intensity$_{t-1}$			-0.1428**			-0.3479***
X Earnings surprise high$_t$			(-2.05)			(-2.99)
Repurchase intensity$_{t-1}$			-0.0927			-0.4346**
X Earnings surprise low$_t$			(-1.08)			(-2.36)
R^2 (within firm)	0.044	0.044	0.044	0.014	0.014	0.014
Observations	31.787	31.787	31.787	31.787	31.787	31.787
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Wald (up - down) (test)	3.03	0.79	0.21	0.05	0.63	0.16
Wald (up - down) (*p*-value)	8.18%	37.46%	65.03%	81.74%	42.63%	69.08%

This table presents OLS regressions of the efficiency measures (*Delay* and *Delay coefficient-based*) on *Repurchase intensity*. The controls are similar to the variables used in Table 4. The proxies for accounting standards are replaced for either *Accrual quality*, *Special items* or *Earnings surprise*. Specification (1) – (3) use *Delay* and specification (4) – (6) use *Delay coefficient-based* as dependant variable. All specifications use lagged *Repurchase intensity* as repurchase measure. Standard errors are clustered at the firm level. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.

Figure A1: Repurchase Intensity Specified by Frequency



This figure plots the average *Repurchase intensity* of the firms against the frequency. Frequency is denoted as the number of share repurchase programs the firm has performed in the five year prior to the sample.

Table A4: The effect of Contemporaneous Repurchase Intensity

A. Contemporaneous repurchase intensity		Delay		
Dependent variable:	Delay	coefficient-based	R-squared	|Market correlation|
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
Repurchase intensity$_t$	0.0599	0.1609	-0.0706	-0.0705
	(1.03)	(1.14)	(-1.59)	(-1.43)
R^2 (within firm)	0.049	0.017	0.065	0.069
Observations	31.787	31.787	31.787	31.729
Firm fixed effects	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
B. Contemporaenous repurchase dummy				
Repurchase intensity$_t$	-0.0023	-0.0041	0.0009	0.0019
	(-1.00)	(-0.80)	(0.52)	(0.99)
R^2 (within firm)	0.049	0.017	0.065	0.069
Observations	31.787	31.787	31.787	31.729
Firm fixed effects	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
C. Contemporaenous repurchase dummy in up and down markets				
Repurchase dummy$_t$	0.0014	0.0043	-0.0037**	-0.0014
x Up market$_t$	(0.56)	(0.80)	(-2.04)	(-0.67)
Repurchase dummy$_t$	-0.0204***	-0.0452***	0.0233***	0.0180***
x Down market$_t$	(-4.96)	(-4.65)	(6.79)	(5.10)
R^2 (within firm)	0.050	0.018	0.067	0.070
Observations	31.787	31.787	31.787	31.729
Firm fixed effects	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

This table presents OLS regressions of the efficiency measures (*Delay* and *Delay coefficient-based*) and the *Idiosyncratic risk* measures (*R-squared* and |*Market correlation*|) on contemporaneous *Repurchase intensity* and controls. The dependent variables are for column (1) – (4) *Delay*, *Delay coefficient-based*, *R-squared* and |*Market correlation*| respectively. This table is divided in three panels, where Panel A includes Repurchase intensity, Panel B includes a dummy for Repurchase intensity and Panel C interacts the repurchase dummy with a dummy for up and down markets. Standard errors are clustered at the firm level. The t-statistics are provided in parentheses. The significance is indicated by asterisks *, **, ***, respectively at the 10%, 5% and 1% level.