The effect of actual share repurchases on price efficiency in the United Kingdom

Max Niemöller
Student ID: 372317

9th of November 2017

Abstract

My thesis examines the effect of actual share repurchases on share price efficiency in the United Kingdom during the period 2006 until 2016. To conduct this research, I hand collect data on actual share repurchases in the UK and use several measures of price efficiency. I document that share repurchase activity of UK firms remains relatively stable over the length of the repurchase program, which is in contradiction with the findings of the literature in the US. I attribute the difference in execution to the required shareholder approval in the UK. Furthermore, when I compare the results to the findings of the literature in the US, I report that share repurchases in the UK improve share price efficiency and reduce the firm's idiosyncratic risk even more than in the US. The larger effect could be related to the stricter disclosure requirements and regulation in the UK. Moreover, the results do not differ between market situations, which indicates that both the price support argument and the information incorporation argument explain the results. The negative effect of share repurchases on idiosyncratic risk shows that share repurchases in the UK do not manipulate share prices.

Keywords: Share repurchases, price efficiency, idiosyncratic risk, regulation

Supervisor: Dr. Stefan Obernberger

Co-reader: Dr. Xington Zhan

Erasmus University

Erasmus School of Economics

Master Economics & Business

Specialization in Financial Economics

Contents

1 Introduction

Share repurchases have become more popular over time. It was estimated that in the United States share repurchases account for approximately 58% of the total corporate payout (Busch & Obernberger, 2016). But not only in the US have share repurchases become an important form of payout, European firms follow this trend. Last years the volume and value of share repurchases have increased rapidly in the United Kingdom (ICSA The governance institute, 2015). Since share repurchases are becoming more popular, the academic literature examines extensively the motives for and the information content of share repurchases. The literature presents different motives for firms to repurchase shares such as, the signaling of undervaluation (Vermaelen , 1981), the reduction of agency costs (Jensen, 1986), tax advantages (Rau & Vermaelen, 2002), takeover defense (Billett & Xue, 2007; Dittmar, 2000), the distribution of excessive cash (A. K. Dittmar, 2000), the compensation of managers (Kahle, 2002), and the firms leverage ratio (Hovakimian, Opler, & Titman, 2001). The literature in the US also proposes that managers have incentives to manipulate stock prices with share repurchases (Bonaime & Ryngaert, 2013; Chan, Ikenberry, Lee, & Wang, 2010; Babenko, 2009; Fenn & Liang, 2001). However, all these researches focus on the period before the SEC implemented the 'safe harbor' rules and the quarterly discolure requirements to avoid price manipulation.

A recent published paper by Busch & Obernberger (2016) focuses on the information content of share repurchases after the implementation of the new rules by examining the effect of repurchases on price efficiency and idiosyncratic risk. The authors find that share repurchases increase price efficiency and reduce idiosyncratic risk, especially in times of negative market news. Their results do not support the idea that managers manipulate stock prices for their own compensation (Bonaime & Ryngaert, 2013; Fenn & Liang, 2001) or incorporate private information, as then a decrease in price efficiency and an increase in idiosyncratic risk is expected. Based on their findings, they conclude that share repurchase increase price efficiency by providing price support at the fundamental values. These results could indicate that the new regulation helps to avoid price manipulation and makes stock prices more efficient.

This makes it interesting to examine whether share repurchases in countries with stricter regulation make stock prices even more efficient. The academic literature suggest that strict disclosure requirements could result in more informative stock prices (e.g. Bonaime , 2015; Ben-Rephael, Oded, & Wohl, 2013; Simkovic, 2009; Healy & Palepu, 1993). Furthermore, the stricter regulation could also have an effect on the signaling power of share repurchases (Bonaime , 2015; Hacekthal & Zdantchouk, 2006). This could change the motives managers have to repurchase shares. Although the regulation with respect to share

repurchases differs a lot around the world, the research on the effect of share repurchases on price efficiency outside the US is relatively limited. I try to fill this gap by examining the effect of share repurchases on price efficiency in a country with more regulation with respect to share repurchases, the United Kingdom.

This analysis is helpful for regulators in other strictly regulated countries, who can observe whether this stricter regulation is capable of reaching its goals. The UK is an interesting country for this analysis, as it has the highest repurchase activity of Europe (Von Eije & Megginson, 2008) and the law of the US and the UK have a lot in common. For instance, both countries are so called 'common law' countries. In this system corporations try to maximize the wealth of shareholders instead of stakeholders, the latter applies to most of the other European countries. However, the regulation with respect to open market share repurchases differs on some significant issues between the US and the UK. When firms repurchase shares in the UK, they are required to disclose details of the transactions on the next business day to the Regulatory News Service (RNS), whereas firms in the US are only required to disclose their monthly repurchase activity in their quarterly reports. Moreover, in the UK firms require, similar to most countries, the approval of the shareholders in order to launch a share repurchase program, whereas US firms only require approval the board. This makes it harder for UK managers to launch a share repurchase program at the moment they desire. Besides, the regulation in order to prevent price manipulation is stricter in the UK than it is in the US. All these differences can lead to (i) different executions of share repurchase programs (ii) different motives for share repurchase programs (iii) different effects of actual share repurchases on stock prices. Despite the high repurchase activity in the UK, research with respect to share repurchases in the country is limited and mostly focuses on the announcement effects of share repurchase program. The results of my research provide an insight in the effect of actual share repurchases in more regulated countries outside the US. For this research, I use the following research question:

Do open market share repurchases in the UK, which has strict regulation with respect to share repurchases, make share prices more efficient?

In order to answer the above research question, I construct a hand-collected dataset. This dataset contains 112 UK listed firms that started 167 repurchase programs in the period 2006-2016. I have hand-collected the actual share repurchase activity per firm per month, by adding up the daily amount of shares repurchased using news articles and Bloomberg. The unique dataset has a total of 13,171 firm-months of which in 1,367 months shares were repurchased. For the analysis, I construct a monthly panel dataset

and regress measures of price efficiency and idiosyncratic risk on repurchase variables and relevant control variables.

I create different variables to measure the repurchase activity of firms per month. The first measure *Repurchase intensity* scales the shares repurchased by the number of outstanding shares. When I plot *Repurchase intensity* over *Program month,* I report that *Repurchase intensity* does not decrease over time, but remains relatively stable. This result is in contrast with the results in the US, which report that firms front-load the execution of their share repurchase program (Busch & Obernberger, 2016; Hillert, Maug, & Obernberger, 2016). I attribute this outcome to the difference in the required approval for share repurchase programs in the countries. The required shareholder approval in the UK gives managers less flexibility to start a share repurchase program, therefore they have to more evenly spread out their repurchases over the length of the program.

To analyze the effect share repurchases have on price efficiency, I regress price efficiency on different repurchase variables and some control variables. The measure of price efficiency estimates the delay with which new market information is incorporated in the stock price (Hou & Moskowitz, 2005). The larger the delay, the less efficiently a stock is priced. I use three different repurchase variables instead of a contemporaneous repurchase variable to overcome problems with reverse causality and endogeneity. The first repurchase variable uses the size of the repurchase program and the months with repurchase activity as predictors of contemporaneous *Repurchase intensity*. The second model lags *Repurchase intensity* with one month to also exclude possible reverse causality. The last repurchase variable is *Remaining volume*, based on the research of Busch & Obernberger (2016), which allows me to predict the ability of firms to intervene in their stock price.

The results show that share repurchases in the UK improve price efficiency even more than in the US. A possible explanation is that firms in the UK disclose their repurchase activity on daily basis, whereas firms in the US only report their monthly repurchase activity every quarter. As UK investors are informed with information every day they are better able to monitor the share repurchase behavior of the firms. When firms want to either provide price support at fundamental values or increase the speed with which positive information is incorporated, they can signal this directly to the market. In the US this information is only revealed every quarter. Moreover, as barriers to start a repurchase program in the UK are higher, the signal of actual share repurchases to the market is stronger (Bonaime, 2015; Hacekthal & Zdantchouk, 2006). A stronger signal results in a stronger effect, which enables UK firms to make their share prices

even more efficient than their US counterparts. The stricter regulation in the UK with respect to share repurchases could thus be the explanation for the larger effect of share repurchases on price efficiency.

Furthermore, I regress measures of idiosyncratic risk, which are similar to the measures used in Busch & Obernberger (2016), on the repurchase variables. When share repurchases manipulate share prices, as suggested by some academic articles (e.g. Bonaime & Ryngaert, 2013; Chan, Ikenberry, Lee, & Wang, 2010) or reveal inside information, idiosyncratic risk should increase. On the other hand when share repurchases increase the comovement of a stock with the market, as found by Busch & Obernberger (2016), idiosyncratic risk should decrease. I report that share repurchases in the UK reduce idiosyncratic risk even more than they do in the US. Again, I attribute these different outcomes to the regulatory systems in the countries. The UK has stricter regulation with respect to price manipulation than the US, which should make UK firms less able to manipulate prices. Moreover, UK firms have to disclose their repurchase activity on a daily basis, as this activity is already expected, probably no inside information is signaled to the market. By disclosing the repurchase activity on a daily basis, UK investors are informed almost immediately. As the information flows directly to the investors, UK firms could be better able to provide price support in down markets or increase the speed with which positive market information is incorporated in up markets. Besides, the stricter regulation gives more signaling power to the share repurchases, which improve the effect share repurchases have. Overall, the stricter regulation in the UK seems to help to reduce idiosyncratic risk even more than in the US.

After I confirm, that share repurchases in the UK make stock prices even more efficient than in the US, I examine whether this effect is mainly driven by firms providing price support at fundamental values or by firms actively incorporating positive market information. When the effect that share repurchases have on price efficiency is mainly found in down markets, the results are in line with the price support argument. On the other hand, when the effect is mainly found in up markets the results are consistent with the information incorporation argument. The results show that the effect is present in both market situations and that the effect does not differ significantly between the market situations. Moreover, when I examine the effect share repurchases have on a stock's volatility, I report that share repurchases reduce volatility in down markets, but do not reduce volatility in up markets. Together these results support the presence of both the 'price support argument' and the 'information incorporation argument', which is not consistent with Busch & Obernberger (2016), who report that providing price support at the fundamental values is the main driver behind the effect. I attribute the different results to the different regulation with respect to the approval for the start a repurchase program. UK firms need shareholder approval to launch

a share repurchase program, which give them less flexibility to start ad hoc a repurchase program to provide price support in case of a negative exogenous shock. Manconi, Peyer & Vermaelen (2014) report that managers in board approval countries are better able to time the market than managers in shareholder approval countries, which could explain the difference in results. Share repurchase programs in the UK are more long term minded, as they only get approval at the annual general meeting. This leads, as explained above, to more evenly spread out repurchase activity over the length of a program. During this period both positive and negative news come to market, which explains why both mechanisms are present as drivers of the positive effect share repurchases have on price efficiency in the UK.

The academic literature on share repurchases focuses mainly on the US market, since the US has the highest repurchase intensity. However, the popularity of share repurchases as a form of corporate payout is rising in countries outside the US as well. The UK is one of the largest economies in the world and is after the US one of the leading countries when it comes to share repurchases (Von Eije & Megginson, 2008). My thesis gives insight in the effect of share repurchases on price efficiency in a more regulated country than the US. This information is valuable, since most of the countries have stricter regulation with respect to share repurchases than the US. The evidence that share repurchases make stock prices even more efficient in a country that has more regulation with respect to share repurchases, is valuable to regulators all over the world. It is an indication that share repurchases benefit the market and that this benefit could potentially be larger with the right regulation. Furthermore, it shows academics that stricter regulation on share repurchases has implication on the results found in the US. Therefore, findings in the US cannot be generalized over the whole world. Since most of the countries in the world have stricter regulations and share repurchases are becoming more popular outside the US, it would be interesting to look further into this topic.

The rest of the thesis is structured as follows; Chapter 2 reports the theoretical framework with regards to share repurchases, this includes an overview of the academic literature, the applicable regulation and the hypothesis development. Chapter 3 documents the construction of the sample and describes the process of the data collection. Moreover, the chapter presents the methodology used for the analyses. Chapter 4 describes the empirical analysis of the results regarding the effect of share repurchases on price efficiency and idiosyncratic risk. Chapter 5 presents an overview of the thesis and provides the limitations and recommendations for further research.

2. Theoretical framework

This chapter sets out the relevant theoretical considerations for my thesis. The first sections describe the findings in the academic literature on the motives for and the effects of share repurchases. After the literature review, the chapter presents the applicable regulation in the UK and the US. I highlight the main differences and their possible effect on the results. These sections together eventually lead to the development of the hypotheses in the last section of this chapter.

2.1 Overview of motives for repurchases

There are several possible motives for managements to repurchase shares. This section set outs the different motives over time and the academic literature related to the motives.

2.1.1 Tax advantages

The original proposed motives for share repurchases were tax advantages and protection of the firm against hostile takeovers. These tax advantages exist, as there is no additional tax on share repurchases, only the capital gains rate has to be paid. While on the other hand the dividends are subject to the normal income tax rate, which is usually higher than the capital gains rate (Grullon & Michaely, 2002). Furthermore, the capital gain tax only has to be paid when the stock is sold, whereas the income tax rate on dividends has to be paid immediately (Dittmar , 2000). However, the literature in the US does not find support the view that open market share repurchases are tax driven (Grullon & Michaely, 2002; Dittmar, 2000). In the UK the evidence on tax as a driver of open market share repurchases is mixed. Rau & Vermaelen (2002) find that share repurchase activity is primarily tax driven, as the activity is significant larger in periods with tax favorable legislation for share repurchases compared to dividends. Whereas in a later research of Oswald & Young (2004) no similar pattern was found. As over time the legislation concerning share repurchases in the UK has changed[1] and firms could have developed other motives the results in my research period could differ from the older existing literature.

2.1.2 Distribution of excessive cash

Repurchasing stock can send mixed signals to the market. A possible explanation for share repurchases is, that the company just has no profitable use for the excessive cash due to the lack of growth opportunities (Nohel & Tarhan, 1998). This is interesting for current shareholders, but also signals that the company in the future might struggle, because of little growth. Naturally, you would expect a negative reaction if firms signal that they do not have any growth opportunities. But according to (Jensen, 1986) this news is perceived as positive by the market, because the market already knows there is a lack of valuable

[1] Section 2.3 describes the current UK regulation on share repurchases

investments and this distribution of cash prevents managers from overinvesting. The academic literature suggests that distributing excessive cash trough share repurchases lessens both agency costs and risks (Oswald & Young, 2004; Grullon, Michaely, & Swaminathan, 2002; Nohel & Tarhan, 1998; Jensen, 1986). In line with these suggestions Dittmar (2000) finds that the distribution of excessive cash to shareholders is one of the main drivers of share repurchases. Later research of Busch & Obernberger (2016) confirms that cash holdings have a positive effect on repurchase activity. Also in the UK evidence is consistent with the notion that firms use share repurchases to distribute cash. Wang, Strong, Tung, & Lin (2009) report that the abnormal returns after share repurchases in the UK are related to firms with overinvestment problems. Moreover, Oswald & Young (2008) reason that share repurchase reduce the agency costs related to free cash flows.

2.1.4 Capital Structure

A firm's capital structure could also have an influence on the decision whether to repurchase shares. Bagwell & Shoven (1988) present the impact share repurchases have on the leverage ratio. By repurchasing shares the amount of equity is reduced, which leads to a higher leverage-ratio. As the existence of an optimal leverage ratio has been addressed a lot in the literature, firms could use share repurchases to reach their optimal leverage ratio (Bagwell & Shoven, 1988). Firms with a leverage ratio below their target are therefore more likely to repurchase shares. These propositions are confirmed by the literature. Dittmar (2000) finds that firms indeed repurchase shares in order to increase their leverage ratio. A similar result is found by Hovakimian, Opler, & Titman (2001), who show that capital structure is an important consideration when firms repurchase shares, especially compared to the raise of capital. More recent literature is consistent with the findings of older literature, as firms with higher leverage ratios are less likely to repurchase shares (Busch & Obernberger, 2016). In the UK a survey about the motivations for share repurchases reported that achieving an optimal capital structure is a primary reason for share repurchases (Dixon R. , Palmer, Stradling, & Woodhead, 2008).

2.1.5 Price manipulation

The incentives for managers to start a repurchase program do not necessarily have to be in the best interest of the firm. Many academic articles report that managers could potentially manipulate their share price with share repurchases for their own benefit. Over the years management compensation has shifted to granting stock options instead of salary (Strege, 1999). This creates incentives for managers to boost their stock price up to the exercise price with for example share repurchases. The literature provides some evidence for this notion, as it reports a that management options have a positive influence on the likeliness of a share repurchase program (Kahle, 2002; Fenn & Liang, 2001). Not only the option to receive

shares in the future influences the decision to repurchase shares, also the actual possesion of shares by employees seems to increase the likelihood of a share repurchases program. Babenko (2009) documents that firms, in which employees hold a large proportion of shares, announce more share repurchase programs than firms with a lower employee stake. Moreover, the likelihood of share repurchases seems to be the highest in net insider selling quarters (Bonaime & Ryngaert, 2013). All these findings could support the view that managers manipulate share prices for their own benefit by using share repurchases. However, the recent results after the implementation of the 'safe harbor' rules in the US are not consistent with the idea that managers manipulate stock prices. Busch & Obernberger (2016) document that share repurchases make stock prices more efficient and reduce idiosyncratic risk. These results are in contradiction with the idea that managers manipulate stock prices. The UK has strict regulation with respect to share repurchases and price manipulation. However, to the best of my knowledge no paper has looked into the possible price manipulation with share repurchases in the UK

2.1.6 Signaling of positive inside information

Another explanation for repurchasing shares is that the managers want to signal inside information to the market, this is called the 'signaling hypothesis' developed by Vermaelen (1981). This hypothesis reflects the idea that managers believe their firm's stock is undervalued in the current market conditions. According to their inside knowledge the stock should be worth more and they want to reveal this information to the market. Therefore, they repurchase stock to increase the stock price to the desired level. The academic literature, that researches the relation between repurchases and undervaluation, almost all find positive abnormal returns after share repurchases or announcements (Bargeron, Bonaime, & Thomas, 2017; Dittmar & Field, 2015; Jagannathan & Stephens, 2003; Stephens & Weisbach, 1998; Ikenberry, Lakonishok, & Vermaelen, 1995; Vermaelen, 1981). The positive abnormal returns obtained by firms that repurchase shares, support the view that managers indeed signal undervaluation to the market. In many papers undervaluation is thus mentioned as a motive for share repurchases (Babenko, Tserlukevich, & Vedrashko, 2012; Brav, Graham, Harvey, & Michaely, 2005; Grullon & Michaely, 2002; Ikenberry, Lakonishok, & Vermaelen, 1995).

When undervaluation is indeed a motive for managers to repurchase shares and if they are able to correctly identify this undervaluation, the price for the repurchased shares should be lower than the average market prices. The results in the literature are in line with this expectation. Ben-Rephael, Oded, & Wohl (2013) find that small S&P 500 firms indeed repurchase shares at a significantly lower price than the average market price. They report only significant positive abnormal returns for share repurchases of

small firms. The authors interpret these results as an indication that small firms repurchase shares strategically and that large firms use repurchases as a method to distribute excessive cash. Dittmar & Field (2015) also report that firms repurchase shares at a significantly lower price than the average market price. But, they do not find a difference in relative repurchase price related to size. The authors only report a price discount for firms that repurchase shares with a low frequency. So, the price discount is not equal for all firms, but varies due to size or repurchase frequency.

The above findings have been partly contradicted by Obernberger (2013). His paper does not report positive abnormal returns after share repurchases in the US. However, he does find similar to Ben-Rephael, Oded, & Wohl (2013) and Stephens & Weisbach (1998) that repurchases are mainly driven by past negative returns, which enables firms to repurchases below average market level. According to Obernberger (2013) these findings do not support the concept of managerial timing ability, but the idea of contrarian-trading. The negative past returns drive the stock price down and the firms intervene by repurchasing shares, this results in a lower repurchase price than average market prices.

Other academic articles related to the information content of actual share repurchases also cannot find hard evidence that actual share repurchases reveal private information. Ben-Rephael, Oded, & Wohl (2013) state that private information is not incorporated immediately after a repurchase, but only when the repurchase activity is published in the quarterly filings. According to them, this could explain the delay in the price response to the actual buyback. Therefore, they conclude that share repurchases do not reveal private information in the US. Dittmar & Field (2015) do report positive abnormal returns in the 3 months after a repurchase, but cannot explain whether the stock price incorporates private information during the share repurchase. The recent published paper by Busch & Obernberger (2016) gave a little more insight in this question. Their research focuses on the impact of share repurchases on stock price efficiency. Price efficiency stands for the extent to which all available information is incorporated in a firm's stock prices (Busch & Obernberger, 2016). If share repurchases reveal new information to the market private firm information is incorporated in the stock price. Revealing private information to the market should lead to higher idiosyncratic risk of the stock, as the release of private information is firm specific. By researching the effect of repurchases on price efficiency, one can determine if repurchases improve or distort the market stock prices. The findings of Busch & Obernberger (2016) are exactly opposite to the findings associated with revealing private information. Instead of an increase in idiosyncratic risk, they found that share repurchases decrease the idiosyncratic risk of a firm's stock. This

could indicate that no private information is revealed by share repurchases, but does not give a decisive answer.

2.1.7 The price support argument

The findings that firms intervene in their stock price after a decline is the basis for the price support argument, which has been proposed in the literature as another motive for share repurchases over the last years (Busch & Obernberger, 2016; Hong, Wang, & Yu, 2008; Keswani, Yang, & Young, 2007). The argument resembles the idea that firms intervene in their stock price if it tends to move away significantly from its fundamental value, in other words firms intervene when their stock price significantly drops (Hong, Wang, & Yu, 2008). Besides anecdotal evidence of firms repurchasing shares in turbulent times, such as the market crash in 1987 and the attack on 11 September 2011, the findings in the academic literature do also align well with the argument. Brav, Graham, Harvey, & Michaely (2005) report that managers give weak stock performance as main reason for the initiation of repurchases, which is in line with the claims of institutional brokers that most firms order share repurchases after weak stock returns (McNally, Smith, & Barnes, 2006). The observed increase of repurchase intensity by many papers after poor past returns (e.g., Busch & Obernberger, 2016; Ben-Rephael, Oded, & Wohl, 2013; Stephens & Weisbach, 1998) fits with the idea of firms intervening in order to prevent a price drop. Results in the US (Cook, Krigman, & Leach, 2003) and France (Ginglinger & Hamon, 2007) present that managers repurchase stock after a decline and that stock prices stabilize after these repurchases, which is also in line with the price support hypothesis. The research in the UK relating to the price support argument is limited. Keswani, Yang, & Young (2007) have looked into this topic and report average share price declines in periods where trading is prohibited (around earnings announcements). The authors argue that this finding is consistent with the price support argument, as it becomes clear that stock prices fall, when firms cannot interfere. To the best of my knowledge this is the only paper that looks into this topic in the UK.

To further examine the price support argument, Hong, Wang, and Yu (2008) extend the model of Grossman & Miller (1988) and make firms able to repurchase shares if their share price drops below its fundamental value due to an exogenous demand shock. They argue that firms with more ability to repurchase shares can prevent a drop down of their stock price, resulting in a lower variance in the short-horizon. The price reaction to unexpected negative market information will be more stable, as this interference provides a boundary at the fundamental value of the stock. Therefore, repurchasing shares in times of negative market news, should result in a more efficiently priced stock with lower idiosyncratic risk.

Busch & Obernberger (2016) provide a more in depth analysis on this topic. Their research focuses on the effect of actual share repurchases on price efficiency and idiosyncratic risk. When share repurchases increase price efficiency rises and reduce idiosyncratic risk, it indicates that firms indeed provide price support when the stock price drops below its fundamental value. On the other hand, managers could also unintentionally provide price support above fundamental values to reach their payout targets. This leads to a decrease in price efficiency and a raise in idiosyncratic risk. The price support above fundamental values is more an indication of price manipulation than providing a lower bound (Busch & Obernberger, 2016). Their findings are in line with the results found by Hong, Wang, & Yu (2008). In their panel regression of 125.769 US firm months, which consists of 38.155 repurchase months, they find that firms repurchase stock at a lower price than the average market price. Furthermore, the research reveals that share buybacks reduce the idiosyncratic risk of a firm and increase the price efficiency of its stock, particularly in down markets. Moreover, share repurchases lower volatility, which is consistent with the notion that firms provide a lower bound for their stock price. Therefore, they conclude that the share repurchases provide price support at fundamental levels in order to make prices more efficient.

2.1.8 The incorporation of positive information into the stock price

Besides providing price support at the lower bound, there could be other ways in which share repurchases increase the price efficiency of a stock. Hou & Moskowitz (2005) constructed a measure to examine the delay with which a stock price reacts to new available market information. This delay measure compares the R-squared of two market models, the simple market model and the extended market model. The extended market model adds 5 lags of market returns as independent variables to the model. The higher the explanatory power of the extended market model and thus of the lagged market returns the larger is the delay with which the stock price incorporates information. A large delay in incorporating new information in the stock price, is an indicator of a less efficiently priced stock. Hou & Moskowitz (2005) argue that stocks can be price less efficiently due to inattention of investors. Their reasoning is based on the results that firms with the largest price delay obtain significant premium returns.

Based on this research, Busch & Obernberger (2016) construct the hypothesis that share repurchases improve the speed with which stock prices incorporate new positive information, when firms intensify the repurchasing of shares due to positive information that is not reflected in the stock price yet. The hypothesis reflects the idea that managers believe that their shares should be worth more because of the new positive market information. Consequentially, managers will repurchase shares until their stock prices reaches its fundamental value. Busch & Obernberger (2016) further reason that the repurchase of

shares can attract the attention of investors that neglected the stock. The extra attention can improve the price efficiency of the stock. By the placement of a market order a firm is capable of directly incorporating the positive market information. In the UK the strict regulation makes it harder to launch a share repurchase program, so when firms start a repurchase program it could raise even more attention. Bonaime (2015) and Hacekthal & Zdantchouk (2006) report that share repurchase in stricter regulated countries, send stronger signals to the market. Therefore, share repurchases could potentially raise more awareness in the UK than in the US.

The results Busch & Obernberger (2016) present do not report a decisive answer whether firms use share repurchases to increase the speed of the incorporation of positive information. In periods with positive market returns, they do not find that share repurchases have a positive impact on price efficiency, whereas they do find a significant increase in price efficiency due to share repurchases in periods with negative returns. These results are not consistent with the positive market information incorporation argument, as this effect should be found in positive markets. Furthermore, the volatility of the stock prices decreases due to share repurchases, while for the incorporation of positive information we would expect the volatility to rise. However, while these results are not in line with the positive information incorporation argument, the argument is not fully rejected.

In the UK the research with respect to the effect of actual share repurchases is limited. Rees (1996) documents that in the 5 days around an actual share repurchase, UK firms generate an abnormal return of 0.25%. This confirms that the market follows actual share repurchase behavior and values it positively. It could be an indication that firms in the UK can use actual share repurchases to boost their share prices, for instance to make their share price more allign with the market. However, until my thesis no academic article has look into this topic in the UK. So, the literature does not provide an answer yet.

2.2 Regulatory framework

This section describes the key takeaways of the regulation in the UK and the US with respect to share repurchases. First, I discuss the relevant regulation in the UK, thereafter the regulation in the US. At the end of the section I compare these regulations and reason how these differences in regulation could affect the results.

2.2.1 UK regulation

Whereas in other European countries share repurchases have been illegal for a long time, it has been legal in the UK since 1981 (Andriasopoulos & Lasfer, 2015). The shares repurchased had to be cancelled, until 2003 when the legislation changed and the repurchased shares could be kept as treasury stocks. This

change in law allowed firms to have more flexibility in the way they managed their capital. From then on, they could use the shares repurchased in possible acquisitions and reissue them at relatively low cost in the future. Holding shares as treasury shares could lead to an increase in stock liquidity and a reduction in price instability for the short-term (De Cesari, Espenlaub, Kurshed, & Simkovic, 2012)

In the UK, companies need the approval of the shareholders by a resolution in the general meeting (Kim, Schremper, & Varaiya, 2005). In this approval the company has to mention (i) the maximum number of shares that it is allowed to repurchase under the program (with a maximum of 15% of the total shares outstanding); (ii) the minimum and maximum price range for the repurchased shares (with a maximum of 105% of the average market price in the week); (iii) the date on which the repurchase program expires (which can be no later than 18 months after the start of the program (Andriosopoulos & Hoque, 2013; Companies Act, 2006, 18). The company does not have the obligation to publicly announce that it intends launch a share repurchase program.

The disclosure requirements in the UK are one of the strictest requirements in the world. Companies have to report to the regulatory authorities on the business day following a repurchase transaction (i) the date of the share repurchase; (ii) the number of shares it has bought; (iii) the average price paid per share; (iv) the number of shares repurchased to be held as treasury shares; (v) the number of shares repurchased for cancellation.

Moreover, the UK has regulation that intends to prevent price manipulation by managers. The law in the UK prohibits firms to trade in their own shares during periods in which chances of informational advantage over normal investors are high, for example around earnings announcements (Keswani, Yang, & Young, 2007). These periods are called the “close periods”. However, under some circumstances UK firms are allowed to repurchase shares in the close periods. In order to repurchase shares in a closed period the shares have to be repurchased by a third party in name of the company and the company has to make sure that the managers, who have inside information, do not provide this information to the persons involved in the repurchase transaction (Andriosopoulos & Hoque, 2017). Furthermore, the management of a firm is not allowed to trade in its own stock when a repurchase is planned (Dhanani & Roberts, 2016). Therefore possible insider trading is less of a concern in the UK.

2.2.2. US Regulation

Regulation with respect to share repurchases in the US is mostly absent. For the authorization of a share repurchase program, firms only require the approval of the board, instead of the approval of shareholders as in the UK (Dhanani & Roberts, 2016; Kim, Schremper, & Varaiya, 2005). Furthermore, firms do not have

restrictions on the timing of share repurchases, the price of share repurchases and the size of the program (Kim, Schremper, & Varaiya, 2005). However, over the last couple years the regulator in the US has provided the so called 'safe harbor' rules, these rules are non-mandatory, but if firms do not apply to the rules they can be liable for market manipulation (Andriosopoulos & Hoque, 2017). The safe harbor rules mention that firms (i) have to purchase all shares from a single broker or deal during a single day; (ii) the repurchase price cannot exceed the highest independent bid or the last transaction price quoted; (iii) the firm cannot purchase more than the 25% of the average daily volume (Kim, Schremper, & Varaiya, 2005).

Since 17 December 2003 US firms are required to disclose information with respect to their share repurchase activity, before this date no disclosure was required at all. In their quarterly filings firms have to state (i) the monthly average repurchase price; (ii) the monthly quantity of repurchased shares; (iii) the total number of repurchased shares under the share repurchase program; (iv) the maximum number of shares that the company is still allowed to repurchase under the program (Andriosopoulos & Hoque, 2017).

2.2.3. Differences in regulation

The regulation with respect to share repurchases differs between the UK and the US on some significant issues (Kim, Schremper, & Varaiya, 2005). The regulation is stricter in the UK than it is in the US, which explains why share repurchases in the UK are less popular than in the US (Rau & Vermaelen, 2002). The first main difference in regulation is that the authorization for a share repurchase program is more complicated in the UK than in the US. Firms in the US only require board approval to launch a repurchase program, whereas UK firms need approval of the shareholders at the general meeting. Most of the countries outside the US require shareholder approval in order to protect shareholders from value-destroying motives of managers. However, this intended protection comes at a price. Resulting in less flexibility and a higher bar for managers in the UK to start a share repurchase program relative to their US colleagues. As UK managers are not able to launch a share repurchase immediately, they are less able to signal undervaluation to the market than managers in the US (Rau & Vermaelen, 2002). Manconi, Peyer, & Vermaelen (2014) confirm this notion, as they report lower short and long term announcement returns for shareholder approval countries relative to board approval countries. The authors reason that announcement effects for shareholder approval countries are lower, as with the announcement they only ask for permission, whereas the announcement in board approval countries indicates the start of the repurchase program. On the other hand, when it is harder for firms to start a repurchase program, the

actual share repurchase program will send a stronger signal to the market (Bonaime A. , 2015; Hacekthal & Zdantchouk, 2006). This stronger signal could attract more attention of investors.

Besides, the disclosure requirements in the UK are much stricter than in the US. UK firms have the obligation to report a repurchase transaction to the regulatory authority no later than the following work day. The Regulatory News Service (RNS) make this information public immediately, therefore investors and the market are informed well about the actual share repurchase behavior of the firms. This should lead to more informed decisions of investors (Bonaime, 2015; Healy & Palepu, 1993). In the US, firms do not have to report their share repurchase activity on a daily basis. Instead the regulator in the US requires firms to report their overall monthly share repurchase activity every quarter. So, the information with respect to share repurchase activity is provided with a large delay to US investors relative to investors in the UK. Ben-Rephael, Oded & Wohl (2013) report that disclosing actual repurchase data leads to more informative stock prices, therefore they advise the SEC to come up with even stricter disclosure requirements. Besides, research shows that the more information of a firm makes pubic the more efficient its stock price is priced (Dutta, 1996). Due to the difference in regulation, US investors could make less informed investment decisions than their colleagues in the UK, which could lower the effect of share repurchases on the price efficiency of the stock. Moreover, the stricter disclosure requirements are useful in the prevention of price manipulation, as investors can closely follow repurchase behavior (Simkovic, 2009). Bonaime (2015) also reports that share repurchases in countries with strict disclosure requirements generate higher returns than in countries with less strict requirements. The author reasons that as investors in strict disclosure countries can closely follow the repurchase activity, the share repurchases send a stronger signal to the market.

Overall, the regulation in the UK is similar to the US when it comes to shareholder protection and the possibility for firms to keep treasury shares. However, the different regulation regarding the approval of share repurchase programs and the 'closed periods' gives managers in the UK less flexibility than in the US. Consequentially, UK managers could possibly react slower to changing market conditions and thus have less ability to make their stock price more efficient. On the other hand, UK investors are informed every day about the share repurchase activity in the UK market, whereas investors in the US have to wait for the quarterly filings to get this information. Moreover, as the regulation is stricter actual share repurchases can send stronger signals to the market, which raises investors' awareness. These differences in information supply to investors could increase the effect share repurchases have on price efficiency.

2.3 Hypothesis development

In this section, I describe how the findings in the academic literature lead to the development of my hypotheses. I use these hypotheses to answer the main research question.

The execution of share repurchase programs in the US is skewed to the beginning of the program (Hillert, Maug, & Obernberger, 2016; Busch & Obernberger, 2016). This indicates that firms in the US purchase most of their shares at the beginning of the program. In the UK, the execution of the repurchase programs could differ from the US, as UK firms do not have the same flexibility to start new repurchase programs as their US counterparts. The shareholder approval for the start of a repurchase program is mostly given at the annual general meeting. The barrier to ask for the start of a new repurchase program is high, since the board has to set up a new shareholder meeting (Kim, Schremper, & Varaiya, 2005). Therefore, UK firms will probably not use their total ability to repurchase shares in the early months, as then they will have to wait for the next shareholder approval to be able to repurchase shares again. Moreover, research shows that firms with strict disclosure requirements are more likely to complete the repurchase program (Andriosopoulos & Hoque, 2013). This could also lead to a higher repurchase activity later in the program. Hence, I expect that firms in the UK do not front-load the execution of their share repurchase programs, but spread it more evenly over the months. I construct the following hypothesis to test this prediction:

Hypothesis 1 (H1): *UK firms do not front-load the execution of their share repurchase programs*

Recent results show that actual share repurchases in the US make stock prices more efficient (Busch & Obernberger, 2016). This result is surprising, since a long list of academic literature proposes that managers purposely manipulate stock prices with share repurchases, which should not make stock prices more efficient (e.g. Bonaime & Ryngaert, 2013; Fenn & Liang, 2001). The regulation in the US concercing the prevention of price manipulation and the disclosure of repurchase activity is not as strict as in other countries around the world. Therefore, in countries with stricter regulation the effect of share repurchases on price efficiency could be even larger. The UK has similar to the US a common law system in which corporations try to maximize the wealth of shareholders instead of stakeholders (Manconi, Peyer, & Vermaelen, 2014). However, the regulation with respect to share repurchases is much stricter than in the US. For instance, firms are not allowed to repurchases shares in the ‘ closed periods’ and need the approval of shareholders to start a repurchase program. Due to these extra barriers share repurchase give a stronger signal to market, which raises investors attention (Bonaime, 2015; Hacekthal & Zdantchouk, 2006). Moreover, firms have to disclose their repurchase activity on a daily basis instead of the quarterly reporting in the US. Investors in the UK are thus better provided with information than US

investors who have to wait for a quarterly report. According to Ben-Rephael, Oded and Wohl (2013) frequenter disclosure should lead to more informative stock prices. Furthermore, research shows that the more public information a firm provides the more efficient its stock price will be (Dutta, 1996). As the information about the repurchase activity of UK firms directly flows to the market, I expect that share repurchases in the UK make prices more efficient than in the US. Hence, I develop the following hypothesis:

Hypothesis 2 (H2): *Share repurchases increase the speed with which new market information is incorporated in the stock price.*

The academic literature on share repurchases and possible price manipulation mainly focuses on the US market prior the implementing of the 'safe harbor' rules. Most of the articles do report that price manipulation for the benefit of the management is a possible motive for share repurchases (Bonaime & Ryngaert, 2013; Chan, Ikenberry, Lee, & Wang, 2010; Babenko, 2009; Fenn & Liang, 2001). However, all these articles conduct a research in the period before the implementation of the 'safe harbor' rules and the disclosure requirements. The research of Busch & Obernberger (2016) focuses on a research period after the regulatory changes by the SEC. They report that share repurchases decrease the idiosyncratic risk of a stock, which is not in line with the idea that managers manipulate stock prices or reveal private information, as then an increase in idiosyncratic risk is expected. So, share repurchases in the US increase the comovement of stocks with the market. The regulation to prevent that share repurchases are used in order to manipulate stock prices is stricter in the UK than in the US, as explained in section 2.3. Consequentially, I expect that stock price manipulation is less of a concern in the UK and thus that share repurchases do not increase idiosyncratic risk. Furthermore, the request for approval signals inside information to the market, but I predict that actual share repurchases do not reveal inside information to the market as they are already expected. Since the barriers to launch are share repurchase program are higher in the UK than in the US, I expect that share repurchases attract more attention of investors, as proposed by Bonaime (2015) and Hacekthal & Zdantchouk, 2006. According to Hou & Moskowitz (2005) this extra attention can improve the speed with which positive market information is incorporated in the stock price and thus consequentially increases the comovement of a stock with the market. Based on these findings, I expect that share repurchases in the UK reduce idiosyncratic risk. I use the following hypothesis to test this prediction:

Hypothesis 3 (H3): *Share repurchases reduce idiosyncratic risk.*

The first two hypotheses examine the effect of share repurchases on price efficiency and idiosyncratic risk regardless of the market performance. However, as described earlier in the theoretical framework share repurchases can improve price efficiency in two ways. Firms can either increase the speed with which positive market information is incorporated in the stock price (Hou & Moskowitz, 2005; Busch & Obernberger, 2016). Or firms increase the accuracy with which the stock price incorporates negative market information by using share repurchases to provide a lower bound for their stock price (Hong, Wang, & Yu, 2008).

The academic literature presents a lot of evidence in favor of this price support argument. In surveys managers declare that negative stock returns are an important motive to repurchase shares (Brav, Graham, Harvey, & Michaely, 2005). Other research confirm this notion and report an increase in repurchase intensity after poor past returns (e.g., Busch & Obernberger, 2016; Ben-Rephael, Oded, & Wohl, 2013; Stephens & Weisbach, 1998). Also the evidence in the UK is consistent with the argument, since stock prices drop in periods when repurchasing is prohibited (Keswani, Yang, & Young, 2007). Hong, Wang & Yu (2008) report that firms with higher ability to repurchase shares in negative market times have lower short-term variance. According to the authors, this implies that firms provide price support by providing a lower bound for the stock price. Busch & Obernberger (2016) report that actual share repurchases reduce idiosyncratic risk, and therefore conclude their results are in line with the price support argument of Hong, Wang & Yu (2008). For the positive information incorporation argument no support is found in the US (Busch & Obernberger, 2016). As firms in the UK need shareholder approval in order to start a repurchase program, their flexibility to start a repurchase program ad hoc in order to provide price support in the short term is lower (Manconi, Peyer, & Vermaelen, 2014). Instead, they are likely to repurchase a stable amount of shares over the length of the program. On the other hand the signaling power of share repurchases is larger in regulated countries (Bonaime, 2015; Hacekthal & Zdantchouk, 2016). This could raise more awareness of investors and thus increase the speed with which positive information is incorporated in the stock price. Therefore, I expect that both mechanisms explain the improvement in price efficiency in the UK and that the effect of share repurchase in down markets is smaller than in the US. To test this notion, I use the following hypothesis:

Hypothesis 4 (H4) *The effect of share repurchases on price efficiency and idiosyncratic risk does not differ between Up and Down markets*

Lastly, to examine whether both mechanisms indeed explain how share repurchase improve price efficiency in the UK, I analyze the effect of repurchase activity on the volatility of a stock. If firms intervene

in their stock price to prevent it from dropping below its fundamental value, you would expect the volatility of a stock to be lower, as the firm prevents the stock from having extreme negative values (Hong, Yang & Wu, 2008). When firms incorporate positive information you would expect volatility to rise. Busch & Obernberger (2016) show that share repurchases decrease volatility in times of positive and negative markets in the US. This is consistent with the view that share repurchases provide price support at the fundamental value. However, as mentioned above firms in the UK do not have the same flexibility to start a repurchase program as their US counterparts. Besides, UK firms could raise more attention with share repurchases, because of the stronger signal. This could enable the 'information incorporation argument' to drive the results. Therefore, I expect that both mechanisms explain the improvement in price efficiency. If this is true, volatility should decrease in *Down markets* and rise in *Up markets*. Hence, I construct the following hypotheses:

Hypothesis 5a (H5a): *Actual share repurchases reduce the volatility of a stock in Down markets*.

Hypothesis 5b (H5b): *Actual share repurchases increase the volatility of a stock in Up markets*.

3 Data & Methodology

In this chapter, I describe the process of the data collection and the setup of the regressions for the analyses performed.

3.1 Sample of repurchasing firms

The dataset contains firms, which are publicly listed on the London Stock Exchange and launched a share repurchase program in the research period starting on January 2006 and ending on December 2016. Furthermore, the repurchase program has to be an open-market program, which consequentially excludes privately negotiated transactions or tender offers. Firstly, I use the SDC database to obtain the announcements and characteristics of the program, such as the size. This database gives access to financial data of corporations all over the world. Via the 'deals analysis tool' I obtain data on share repurchase announcements. This results in 96 announcements of open-market repurchase programs by 70 UK firms. However, the data of SDC contains a lot of investment trusts. I exclude these from the sample because of their different nature and regulation that applies to them (Oswald & Young, 2008). The total amount of useful announcements drops thereby to 62 of 45 firms.

The data of SDC seems incomplete, as the number of repurchase program announcements is rather low. Therefore, I extend the dataset by searching through news articles in the Factiva database. This database contains news articles from media all over the world. The most relevant media for collecting data on

repurchase announcements in the UK are the Regulatory News Serivce (RNS) and the Financial Times. By searching on the terms 'repurchase' 'buy-back and 'buyback', for all firms included in the FTSE 350, I obtain the announcements and characteristics of share repurchase programs. The announcements have to mention the total number of shares allowed to be repurchased and the buyback has to be executed in the open-market. In order to make the dataset as complete as possible, I obtain announcement data of FTSE 350 firms via the Bloomberg terminal or manually via annual reports, this results in 212 announcements of 139 UK firms.

As I examine the effect of actual repurchases on the price efficiency, data of these actual repurchases is necessary. In the UK, firms have to publicly provide their daily repurchase data, but are not required to give a monthly overview. This makes the data collection process time consuming. In the UK, firms report the number of shares repurchased, the average price paid per share and the shares outstanding to the Regulatory News Service on every day that open market repurchases are executed. All the data of share repurchases is hand-collected, which makes it a unique dataset. Via Factiva and Bloomberg, I obtain the daily data of the repurchases. The actual repurchase data of some firms is not reported in the database, therefore I drop 36 announcements. Resulting in a total of 176 announcements of 119 UK firms. The daily data of shares repurchased (volume and value) are summed over a month in order to get the same time variable as (Busch & Obernberger, 2016). This results in 1,424 repurchase months of 119 firms. The data for these firms is manually checked on irregularities. Firms with a negative book value of equity or leverage are deleted due to their unstable characteristic. Firms with missing information on any of the variables are also deleted. Therefore, I drop 7 firms and consequentially 57 repurchase months. Eventually, the dataset contains 167 repurchase programs of 112 UK firms. The total of firm-months is 13,171 of which 1,708 were Program months, where in 1,367 months shares were repurchased. Table A1 in the appendix reports a description of the repurchase variables, price efficiency measures, idiosyncratic risk measures and the control variables.

3.2.1. Repurchase activity analysis

The research method in this thesis is similar to the research of Busch & Obernberger (2016), as I examine if the effect of share repurchases on price efficiency differs between the UK and the US. First, I perform an analysis on the repurchase variables, *Repurchase intensity and Remaining volume. Repurchase intensity* is defined as the number of shares repurchased during a month divided by the number of shares outstanding at the last trading day of the month. Remaining volume is defined as the number of shares that can still be bought under the program at the beginning of the month scaled by the shares outstanding.

$$\textit{Repurchase variable}_{i,t} = \alpha + \beta \textit{Instruments}_t + \text{controls} + \text{firm and time fixed effects} \quad (1)$$

Regression (1) determines the drivers of repurchases. As the databases on UK firm are not as extensive as the databases of US firms, I cannot include variables related to management compensation and insider trading. The quarterly balance sheet data variables are obtained via Compustat Global. These variables are *Total Assets (ln), Cash and short term investments to assets*, *EBITDA to assets* and *Dividends to assets*. *Market capitalization* is downloaded from Datastream, herewith I can construct the variables *Book-to-market* and *Leverage*. As all these variables are predictors and the data is documented quarterly, I lag the variables 3 months in the regression. The monthly return variables are calculated by summing the daily returns of the firm's stock prices. I calculate these daily returns by taking the natural logarithm of the stock prices, which are downloaded from Datastream.

Furthermore, the analysis of repurchase activity gives insight if *Program* and *Program size* are relevant instruments in my dataset for the regressions on efficiency to isolate exogenous variation. These variables should be suitable as both are fixed beforehand and do not change endogenously. Lastly, the analysis shows if the lag of repurchase intensity is a suitable proxy for contemporaneous intensity.

3.2.2 Measure of price delay

The measure of price efficiency is similar to the measure of Busch & Obernberger (2016). The authors use the model developed by Hou & Moskowitz (2005), which measures the delay with which new information is incorporated in the stock price. Long delay indicates that the stock price is not efficient, since not all the new information is incorporated immediately. The original model determined the delay by comparing the R-squares of a base market model to an extended market model with lagged weekly returns.

$$Delay = 1 - \frac{R^2_{base}}{R^2_{extended}} \quad (2)$$

The more the extended model explains the daily return relative to the base model, the more influence have past market returns on the firms stocks return, which implies that the stock incorporates new information slowly. So, if the delay measure increases this indicates a stock is less efficiently priced. Instead of weekly returns as Hou & Moskowitz (2005) used, I follow Boehmer & Wu (2013) and Busch & Obernberger (2016) in using daily stock and market returns[2] for the market model regressions per firm per month. The regressions are as follows:

[2] Returns are calculated by taking the ln of (P_t/P_{t-1}). I use the stock price of the FTSE 350 Index and download from Datastream

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

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

In the regressions $r_{i,t}$ reflects the return of firm i on day t, while $r_{m,t}$ stands for the market return of day t. In regression (3) $r_{m,t-n}$ reflects the market return n days in front of day t. β_i^0 is the coefficient for the market return on day t, whereas β_i^n is the coefficient for the lagged market returns. I use five lags, which resemble all the trading days in a week. When the market is fully efficient, which means that all the available market information is incorporated in the stock price, β_i^n should be zero and β_i^0 should reflect the impact of today's market return. When the stock price is not fully efficient the coefficients of the lagged returns will differ from zero. This indicates that the stock price incorporates market information with a delay.

The second measure of price delay, *Coefficient-based delay*, is also proposed by Hou and Moskowitz (2005). Instead of comparing the explanatory power of the models, this measure uses the absolute coefficients of the regressions scaled by their standard deviations, which results in the absolute t-values. I construct the measure in the following way:

$$Coefficient - based\ delay = \frac{\sum_{n=1}^{5} n \cdot \frac{abs(\beta_i^n)}{se(\beta_i^n)}}{\frac{abs(\beta_i^0)}{se(\beta_i^0)} + \sum_{n=1}^{5} \frac{abs(\beta_i^n)}{se(\beta_i^n)}} \quad (5)$$

The absolute t-values of the lagged market returns in the numerator are multiplied by their lag and summed. In the enumerator, I sum the absolute t-values of all the coefficients. The same interpretation to this measure applies, the smaller the value of the delay, the more efficient is the stock price.

3.2.3. Measure of idiosyncratic risk

To examine the information content of the stock price, I determine the firm specific (idiosyncratic) information that is incorporated in the stock price. The idiosyncratic risk of a stock can be determined by measuring the correlation of the market with the individual stock, as suggested by Bris, Goetzmann & Zhu (2007) and performed by Busch & Obernberger (2016). A high correlation indicates that the stock reacts similar to the market, which implies a lower amount of idiosyncratic risk. Furthermore, the R-squared of the base model is used as an indicator of idiosyncratic risk. The more the market return explains the stock return, the less idiosyncratic risk is incorporated. I determine both variables by using daily returns over a month.

3.2.4. Method to examine effect of repurchases on stock price efficiency

After determining all the necessary variables, I set up the regressions to examine the effect of share repurchases on price efficiency. In order to compare the UK results with the US results I use the same setup as Busch & Obernberger (2016):

$$Efficiency_{i,t} = \alpha + \delta Efficiency_{i,t-1} + \beta Rep_{i,t} + \sum_{l=1}^{l=K} \gamma l Control_{i,l,t} + \mu_i + \eta_t + u_{i,t} \quad (6)$$

$$IdiosyncraticRisk = \alpha + \delta IdiosyncraticRisk_{i,t-1} + \beta Rep_{i,t} + \sum_{l=1}^{l=K} \gamma l Control_{i,l,t} + \mu_i + \eta_t + u_{i,t} \quad (7)$$

In regression (6) the dependent variable efficiency reflects either *Delay* or *Coefficient-based delay*. I regress price delay on the one month lagged delay measure, a repurchase variable (either *Repurchase intensity* or *Remaining volume*) and control variables. *Repurchase intensity* resembles the effect of actual share repurchases on the stock prices. *Remaining volume* relates to the ability of a firm to repurchase shares. If *Remaining volume* decreases, the firm is restricted in the amount of shares it is allowed to repurchases. Therefore, it can become harder to interfere in the stock price and prices could become less efficient. To account for heterogeneity, I include firm and time fixed effects. The coefficients resulting from these regressions will show the actual effect of the variables on price efficiency in the UK. To examine the effect of the repurchase variables on the idiosyncratic risk of a stock, I use the same regressions as for efficiency, only changing the dependent variable to either absolute market correlation or the R-squared of the base model.

The paper of Busch & Obernberger (2016) shows that there are some concerns with these regressions if firms prevent the mispricing of their stock by providing price support. The most important problems are the possible endogeneity or reverse causality in the regressions. These problems arise as the level of price efficiency in previous months can influence the level of repurchase intensity. As firms probably determine their level of repurchase intensity to meet the level of price efficiency in previous months. This causes *Repurchase intensity* to be endogenously determined by the amount of mispricing when firms do not repurchase shares. Furthermore, when firms are not able to prevent the mispricing of their stock by share repurchases, contemporaneous *Repurchase intensity* will be negatively or not correlated to price efficiency. As the effect of share repurchases reflects the difference between the actual outcome and the amount of mispricing if no shares are repurchased.

To overcome these problems, Busch & Obernberger (2016) propose three methods which I follow. The first method uses the above mentioned variables *Program and Program Size*, which both are

predetermined, as instruments in a Generalized Methods of Moments (GMM) regression. Including these variables makes it possible to forecast the exogenous *Repurchase Intensity.* The reason for using predetermined variables instead of realized variables, is that the realized variables depend on actual repurchases, which could cause endogeneity. The second proposed method solves the reverse causality problem. To overcome reverse causality I lag the *Repurchase intensity* variable by one month in the regression, as lagged *Repurchase intensity* is not related to the level of price efficiency in the contemporaneous month .The third method uses *Remaining volume,* instead of *Repurchase intensity,* in explaining the effect on price efficiency. As mentioned above, remaining volume reflects the ability of a firm to intervene in their stock price. As this variable is also predetermined it can overcome the reverse causality problem related to repurchase intensity. The problem is overcome, because the price efficiency during a month does not have any influence on the remaining volume at the beginning of a month. This gives some advantages over the use of repurchase intensity as predictor of price efficiency.

The possible problems of heterogeneity and other factors are solved by the mentioned firm and time fixed effects and by lagging the dependent variable by one month. Possible announcement effects are taken into account by including a dummy for program initiation in the regressions.

4 Results

In this chapter, I analyze the outcome of the regressions on the effect of repurchases on price efficiency. To get a good understanding of the results a description of the dataset is necessary, therefore I describe the used dataset first. Thereafter, the analysis focuses on the effect of repurchases on price delay, whereas later in the section the effect on idiosyncratic risk is analyzed.

4.1 Descriptive statistics

Table 1 shows the characteristics of the used variables in the dataset. The dataset includes all the repurchasing firms in the UK over the period 2006-2016, which have the necessary data available. This results in a total of 13,171 firm months, of which in 1,367 months shares are repurchased. The measures of price delay and idiosyncratic risk show similar values and distribution as the US dataset of Busch & Obernberger (2016), which makes it suitable for a comparison with this paper. The means and median of these dependent variables are quite similar, indicating that the distribution tends to be normal.

The table shows under ‘repurchase measures’, the statistics over the whole sample period, including months in which firms did not repurchase shares. Therefore, these values are lower than in repurchase months and less relevant to discuss, since the value of repurchases measures are mostly 0.

Over the 1,367 repurchase months the average *Repurchase volume* was £52.6 million, with a median of £17.9 million. The repurchase volume represents an average buyback of 0.44% (median = 0.28%) of the shares outstanding in a month. Compared to the total of shares traded over a month, it reflects on average 5.99% (median = 3.74%) of the trading volume in a month. The average (median) length of a repurchase program is 10 months (median = 7 months). In these months average (median) percentage of shares that could be bought back was 4.36% (3.04%).

Table 1
Descriptive statistics

	Mean	Median	SD	SD (within)	1st Perc.	99th Perc.	N
Dependent variables							
Delay	0.469	0.419	0.296	0.255	0.030	0.999	13171
Coefficient-based delay	1.914	1.876	0.618	0.564	0.674	3.431	13171
R-squared	0.284	0.250	0.220	0.190	0.000	0.810	13171
Market correlation	0.479	0.499	0.235	0.223	0.012	0.900	13171
Repurchase measures							
Repurchase volume	5.5	0.0	35.8	32.8	0.0	139.0	13171
(mill.)	0.05%	0.00%	0.22%	0.22%	0.00%	0.98%	13171
Repurchase intensity	0.64%	0.00%	3.22%	3.12%	0.00%	13.77%	13171
Repurchase intensity (TV)	0.54%	0.00%	2.11%	1.87%	0.00%	11.45%	13171
Remaining volume							
Repurchase measures in repurchase months							
Repurchase volume	52.6	17.9	99.5	69.7	0.0	463.0	1367
(mill.)	0.44%	0.28%	0.56%	0.43%	0.00%	2.72%	1367
Repurchase intensity	5.99%	3.74%	8.12%	6.08%	0.00%	38.27%	1367
Repurchase intensity (TV)	4.36%	3.04%	3.90%	2.37%	0.03%	15.00%	1367
Remaining volume							
Program descriptives							
Program month	10	8	9.45	6.41	1	18	167
Program size (scaled)	6.16%	4.12%	6.97%	3.20%	0.10%	15.00%	167
Control variables							
Analysts	8.179	5	9.069	3.605	0	31	13171
Book to market	0.776	0.485	1.031	0.691	0.046	5.53	13171
Cash to assets	11.10%	7.02%	12.06%	6.72%	0.09%	62.73%	13171
Dividends to assets	0.71%	0.28%	1.11%	0.90%	0.00%	5.39%	13171
EBITDA to assets	3.07%	2.81%	2.52%	1.60%	-0.819%	11.07%	13171
Leverage	0.435	0.422	0.229	0.102	0.005	0.976	13171
Market cap (mill.)	8031.55	1888.25	16421.48	4239.69	11.11	85451.94	13171
Return	0.75%	0.66%	10.18%	10.15%	-27.21%	29.34%	13171
Total assets (mill.)	18895.64	2496.9	53239.05	6593.54	9.454	310708	13171
Trading volume (scaled)	0.079	0.058	0.075	0.063	0.001	0.350	13171
Volatility	2.00%	1.60%	2.06%	1.97%	0.45%	7.50%	13171

Table 1 reports the descriptive statistics of the price efficiency measures, repurchase measures and the control variables. Table A2 in the appendix reports the description of the variables. For all the variables the table reports the mean, the median, the standard deviation (SD), the standard deviation within-firms (SD within), the 1st percentile the 99th percentile and the number of observations. None of the reported values is in natural logarithms.

Compared to the Busch & Obernberger (2016) paper, I find some differences in the statistics of the repurchase measures. The median of the *Repurchase Volume* is 3 times larger than in the US dataset, whereas the median of the intensity is lower. This difference could be explained by several factors. For

instance, the length of the share repurchase programs in the UK is smaller than in the US, while the Program size is similar. Therefore logically UK firms buy more in a shorter period of time and thus the *Repurchase volume* rises. On the other hand, for *Repurchase intensity* both the average and median are smaller than in the US. So, the amount of shares repurchased in a month relative to shares outstanding is lower in the UK. The reason for this can be twofold, the average price per share paid in the UK dataset is larger than in the US or the amount of shares outstanding of the UK firms is larger than in the US dataset

The set of control variables included in the regressions give a good overview of the characteristics of the firms used in the dataset. The median of the *Book-to-market* ratio is 0.485, meaning that the market values the companies twice the assets in place. Growth is therefore expected, indicating that the sample tends to consist more of growth than of value stocks.[3] *Cash to assets*, *EBITDA to assets* and *Leverage* show expected means and medians. An interesting figure is the median of 0.28% of *Dividends to assets*, which shows that UK firms tend to pay dividends quarterly. This means that in the UK dividends is still an important way of corporate pay-out, whereas in the US a median of 0.00% was found. The difference in corporate payout policies between the two countries could lead to different effects of share repurchases.

The average (median) values of *Market capitalization* and *Total Assets* are quite high indicating this dataset contains mostly large companies. This is probably caused by the availability of data in the UK and because larger firms could have fewer growth options, which makes them decide to distribute the excessive cash to shareholders (Jensen, 1986). The values for trading volume are also smaller than in the US, which marks that stocks in the UK are less often traded than in the US. The smaller trading volume could imply that investors pay less attention to a stock, which could affect the delay with which information is incorporated in the stock price (Hou & Moskowitz, 2005). Therefore, share repurchases could have a larger impact on the visibility of a stock, resulting in a more efficient stock price. The *Volatility* of the UK stock market shows a normal pattern, with a highest monthly value of 7.5% during the financial crisis. The average (median) monthly return over the sample period is a positive 0.75% (0.66%) which shows that the sample period has mostly positive returns. This is an interesting figure to keep in mind, as the paper of Busch & Obernberger (2016) found different effects of repurchases on price efficiency in Up- and Down markets.

[3] For an explanation of growth and value stocks see Fama, E. F., & French, K. R. (1998). Value versus growth: The international evidence. *The journal of finance*, *53*(6), 1975-1999.

4.2 The execution of the share repurchase programs

Due to the different regulation with respect to the approval of share repurchase programs, US and UK firms could execute their share repurchase programs differently. US firms can start share repurchase programs, whenever the board agrees to start one. This gives them a lot of flexibility and even the opportunity to launch more share repurchase programs within one year. On the other hand, firms in the UK need the approval of the shareholders, which they can usually only receive at the annual general meeting. Therefore, these firms are less likely to repurchase all the allowed shares at the beginning, since then they are not allowed to repurchase any shares till the next approval of the shareholders.

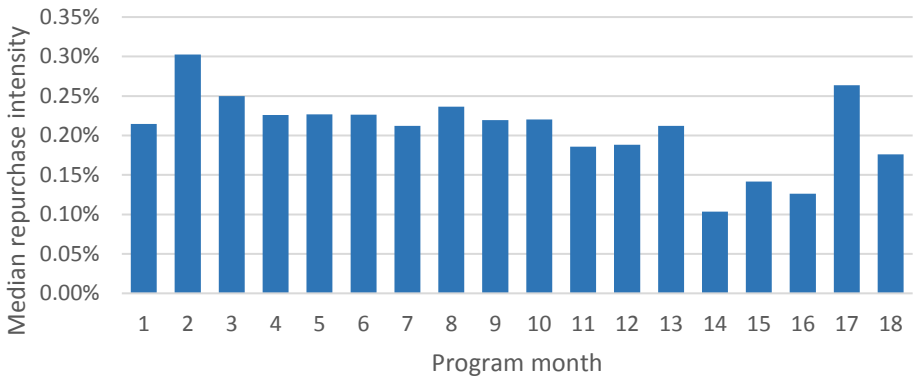
Figure 1 plots the median of *Repurchase intensity* over *Program month* to examine the development of repurchase activity over time in the UK. It does not show that firms front-load the execution of the program, as found by Hillert, Maug & Obernberger (2016). The peak of *Repurchase intensity* is in the second repurchase month, which is similar to the results found in the US. However, after the peak *Repurchase intensity* remains relatively stable. This implies that *Repurchase intensity* remains relatively constant over time. Therefore, it seems that the execution of share repurchase programs in the UK differs from the execution of repurchase programs in the US. As mentioned above, the different execution of share repurchases programs could be attributed to the different regulation with respect to approval.

Moreover, when I regress *Repurchase intensity* on *Program Size, Program month* and a set of control variables, the coefficient for *Program month* is significantly positive[4]. This results is the opposite of the US results of Busch & Obernberger (2016) and is also not in line with the notion that firms front-load the execution of their share repurchase programs. Consequentially, I accept *Hypothesis 1* that UK firms do not front-load the execution of their share repurchase programs.

The result that *Repurchase intensity* does not decrease over *Program month* has implications for my further analysis. As *Repurchase intensity* does not decrease over time, but remains relatively stable I do not use, like Busch & Obernberger (2016), *Program month* as an instrument for *Repurchase intensity* in the GMM-regressions. Using *Program month* would lead to wrong estimations. Instead I use *Program,* which is a dummy that equals 1 if a firm repurchases shares in a month, as an instrument, since the *Repurchase intensity* in repurchase months is relatively stable. This allows me to predict contemporaneous *Repurchase intensity*.

[4] The results of these regressions can be found in table A4 in the Appendix

Figure 1: Repurchase Intensity over Program month. Figure 1 plots the median of *Repurchase intensity* against the *Program month*.



4.2 Empirical analysis of the repurchase variables

In this section, I analyze the effect of several variables on the repurchase measures. To examine what drives *Repurchase intensity* and *Remaining volume,* I use OLS regressions and regress the measures on the predetermined program characteristics and the control variables. Table A2 in the appendix shows the correlation matrix of the variables and does not report a high correlation between the independent variables, therefore concerns about possible multicollinearity are low. Table 2 reports the outcome of the regressions. These OLS regressions are valuable in several ways. First, I have to determine whether Program and Program size have a significant effect on the repurchase. These program characteristics need to be significant, as I use them as instruments in the following Generalized Methods of Moments (GMM) regressions of price efficiency in section 4.3. The second regression analyzes whether lagging the *Repurchase intensity* with one month is a good proxy for contemporaneous *Repurchase intensity*. Lastly, these regressions help in the determination of the drivers of actual share repurchases.

4.2.1 Instrumental variables

The proposed instruments for *Repurchase intensity* are *Program size* and *Program*. To use both program characteristics as instruments, I have to determine their validity. A valid instrument has to correlate with *Repurchase intensity* and has no direct effect on the dependent variables of price efficiency or idiosyncratic risk. The variable *Program size* is fixed at the beginning of the program, this ensures that the variable is exogenous with regards to the future variations in price efficiency and idiosyncratic risk. The variable *Program size* has to be fixed upfront, otherwise it would be endogenously determined by the level of repurchase activity, which would make it an unsuitable instrument.

Table 2
Analysis of the repurchase variables

Dependent variable:	Repurchase intensity	Repurchase intensity	Remaining volume
	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Repurchase intensity$_{t-1}$		0.248***	
		(3.473)	
Program	0.00192***	0.00155***	0.00220
	(6.025)	(4.853)	(0.957)
Program size$_t$	0.0306***	0.0234***	0.659***
	(4.191)	(4.237)	(11.28)
Return$_{t-1}$ > 0	-8.15e-05	-0.000195	-6.87e-05
	(-0.391)	(-0.927)	(-0.0600)
Return$_{t-1}$ < 0	-0.00131***	-0.00123***	0.000947
	(-2.825)	(-2.711)	(0.680)
Total assets$_{t-3}$ (ln)	6.51e-05	7.67e-05	0.000934
	(0.766)	(1.120)	(1.292)
Book to market$_{t-3}$	-6.48e-05*	-4.69e-05*	0.000394**
	(-1.811)	(-1.856)	(2.020)
Cash to assets$_{t-3}$	0.000171	0.000189	-0.00225
	(0.506)	(0.690)	(-1.021)
EBITDA to assets$_{t-3}$	-0.00129	-0.00169	0.000524
	(-0.978)	(-1.507)	(0.0588)
Dividends to assets$_{t-3}$	-0.000415	0.000317	0.0144
	(-0.185)	(0.156)	(0.834)
Leverage$_{t-3}$	0.000306	0.000247	-0.00337
	(0.811)	(0.837)	(-1.620)
Constant	-0.000751	-0.000814	-0.00635
	(-1.190)	(-1.553)	(-1.148)
Observations	13,171	13,171	13,171
R^2 (within firm)	0.325	0.386	0.776
Number of firms	112	112	112
Firm FE	YES	YES	YES
Time FE	YES	YES	YES

Table 2 reports the OLS of *Repurchase intensity* and *Remaining volume* on the instruments, lagged *Repurchase intensity* and the control variables. Table A1 in the appendix shows the definition of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***.

The other proposed instrument *Program* also has to be exogenous with respect to the following variation in the dependent variables. Busch & Obernberger (2016) report that in their US dataset this is the case for *Program month*. In line with Hillert, Maug & Obernberger (2016), they find that repurchase activity is the highest at the beginning of the program and decreases afterwards. They argue that the length of a

repurchase program is also determined upfront and is not influenced by the dependent variable, which would make it exogenous. Using these two instruments allows them to determine the repurchase activity over the program. Figure 1 shows that *Repurchase activity* remains stable over the program months in the UK, which is an indicator that repurchase months are also determined upfront and thus exogenous with respect to the dependent variables.

I test, whether for my dataset, *Program size* and *Program* are suitable instruments for *Repurchase intensity*. Column (1) and (2) show the results of the analysis of *Repurchase intensity*. The coefficients for *Program* are positive and highly significant in both columns (1) and (2). This is in line with the expectation, since *Repurchase intensity* is naturally higher in months where firms repurchase shares relative to non-repurchase months. As *Program* has a significant influence on *Repurchase intensity* and is not related to future levels of price efficiency or idiosyncratic risk, I conclude it is a valid instrument for my analysis.

The other proposed instrument, *Program size,* has a significant positive coefficient in all the models, which is in line with the expectations, since more ability to buy shares induces more buying. As *Program size* is fixed upfront, it is not affected by future variations in price efficiency or idiosyncratic risk. Having a significant positive effect on *Repurchase intensity* and being exogenous with respect to the levels of price efficiency and idiosyncratic risk, *Program size* seems a reliable instrument for the GMM-regressions.

4.2.2 Lagged repurchase intensity as proxy for Repurchase intensity

After the confirmation of the relevance of the instruments, I proceed to analyze the fitness of lagged *Repurchase intensity* as a proxy for contemporaneous repurchases. The quality check of the proxy is necessary, as weak proxy would underestimate the correlation between two different variables caused by a measurement error. The underestimation naturally decreases the chance of retrieving the right significant results. The results in column (2) show that lagged repurchase intensity has a highly significant positive coefficient of 0.25. Therefore, it seems that lagged repurchase intensity has a positive impact on current repurchase intensity. The R-squared of the model, which reflects the explanatory power of the model, increases almost 6% from 32.5% to 38.6%. These results are similar to the results obtained by Busch & Obernberger (2016), therefore lagged repurchase intensity seems a good proxy for contemporaneous repurchase intensity in my thesis as well.

4.2.3 Drivers of repurchase activity

The control variables in the *Repurchase intensity* regressions almost show no significant effects. Only negative prior returns seem to have an impact the amount of shares repurchased in a month. The variable *Negative prior returns* has a negative significant coefficient. This indicates that firms lower the amount of

shares repurchased after a month with negative stock returns. Positive prior stock returns do not have an effect on *Repurchase intensity*, in line with the literature. These findings do not support the view that managers repurchase shares in order to prevent the stock price from dropping down. The insignificance of all the other control variables only reveals that incentives for actual repurchases are not similar to the incentives in the US. It seems that firms in the UK have other drivers of *Repurchase intensity* than firms in the US.

In column (3) *Remaining volume* is regressed on the same variables as in column (1). The outcomes of this regression differ from the ones in column (1) and (2). *Program* does not have a significant effect on *Remaining volume*, which is expected, since the ability to repurchase shares is different every month and does not depend on whether shares are repurchased. The variable *Program size* is highly significant with the expected positive sign. The larger the size of the program the more shares a firm can repurchase in month. Like in the Busch & Obernberger (2016) paper, *Program size* almost accounts for 50% of the explanation of the model.

Almost none of the control variables have a significant effect on either *Repurchase activity* or *Remaining volume*. This indicates that the size of a firm in the UK does not affect the intensity with which it repurchases shares. Furthermore, the quarterly holdings of cash, earnings and dividends do also not seem to have an effect on the share repurchase activity. The results for earnings and dividends are consistent with the findings of Busch & Obernberger (2016). The lack of a significance for the effect of *Cash* on *Repurchase intensity* is remarkable, since the distribution of excessive cash is an often mentioned motive in the literature (Dittmar, 2000). A higher *Book to market ratio* seems to have a negative influence on *Repurchase intensity*, but a positive influence on *Remaining volume*. This result could seem rather odd, but might be explained by the undervaluation theory of Vermaelen (1981). Firms that have a high *Book to market ratio* are valuated low by the market, the announcement of a large repurchase program, signals to the market that the managers believe their shares are undervalued. However, when it comes to the repurchase of actual shares these firms may not have the ability to repurchase all the shares, which lowers their *Repurchase activity* and leaves *Remaining volume* relatively high. Leverage also does not seem to have an influence on the repurchase measures, which is not in line with the notion that firms use share repurchases to achieve their optimal levarge ratio (Hovakimian, Opler, & Titman, 2001).

Two other important results from column (3) are the insignificance of the coefficients from the prior returns. This means that the number of shares that still can be bought under the current program are not affected by the performance of a firms stock in the month before. This relationship does not exist, as the

execution of share repurchases in the UK is relatively stable over time. The non-existence of this relationship favors *Remaining volume* over *Repurchase intensity* in two ways. First, because the amount that may be repurchased during a month is fixed at the beginning, the problem of reverse causality is eliminated in the following regressions. Second, as no relationship between prior returns and *Remaining volume* exists, chances of correlation between *Remaining volume* and the efficiency measures are lower.

4.3 Share repurchases and price delay

This section describes the results of the regressions of price delay on the repurchase measures and the control variables. As mentioned above, I construct two measures of price delay *Delay* and *Coefficient-based delay*. Columns (1) to (3) analyze *Delay* and columns (4) to (6) analyze *Coefficient-based delay*. The columns (1) and (4) show the results for the GMM regressions. In these regressions the variables *Program* and *Program size* are used as instruments for *Repurchase intensity*. In column (2) and (5) lagged *Repurchase intensity* is used as a proxy for *Repurchase intensity*. Column (3) and (6) use *Remaining volume* as repurchase measure instead of *Repurchase* intensity. Columns (2), (3), (5) and (6) show the results of the OLS regressions of price efficiency on the repurchase measures. Table A3 in the Appendix shows the correlation matrix of the used variables in the regressions, it reports no high correlation between independent variables. Therefore, I have no reason to believe that multicollinearity affects the results. I first discuss the relevance of the chosen instruments. Thereafter, the next part discusses the effect of share repurchases on price delay. The last part of this section reports the effect of the control variables on price delay.

4.3.1 Validity of the instruments

To test whether the instruments are suitable for the analysis, I perform some additional tests to the analysis shown in table 3. The first test performed, is the test for over identifying restrictions with the Hansen J-statistic. Model 1 has a statistic of 1.141 (p=28.55%) and model 4 has statistic of 1.409 (p=23.52%). Thus for both models the null hypothesis cannot be rejected, this indicates that the model is correctly specified.[5] After the test for overidentification, I check whether the models are underidentified. The Kleibergen-Paap test is a robust test for models with several variables that are endogenous, therefore it is the most suitable test for under identification in my models. The null hypothesis for this test is that the model is underidentified, which means that the instruments are irrelevant. Both models (1) and (4) reject this null hypothesis with high t-statistics of 64.657 and 64.670. This implies that the model is not underidentified, which is an indication that the instruments are relevant and thus suitable for the

[5] The GMM models for R-squared and market correlation do not reject the null of correct specification as well

identification of endogenous variables. Lastly, I can reject the null hypothesis of the Stock-Yogo test that the instruments are weak. Altogether, the results indicate that the chosen instruments are valid.

4.3.2 The effect of share repurchases on price delay

The results show a negative effect of *Repurchase intensity* on price delay in all the models. Only in column (5) the effect is not statistically significant different from zero. These results indicate that share repurchases make stock prices more efficient. The coefficient for *Repurchase intensity* in column (1) is largely negative (-9.206) and significant. This indicates that a small increase in *Repurchase intensity* has a positive impact on the speed with which market information is incorporated in the stock price. By increasing *Repurchase intensity* with one within-firm standard deviation the economic effect of a higher *Repurchase intensity* becomes clearer. Table 1 shows a within-firm standard deviation of 0.43% for *Repurchase intensity* in repurchase months. Multiplying this with the coefficient, results in (0.0043 * -9.206) a decrease in *Delay* of 0.0396 percentage points. Relative to the median of *Delay* (shown in table 1) this increase in *Repurchase intensity* results in a decrease in *Delay* of 9.45% (= 0.0396/0.419). The effect of repurchases in this regression is almost twice the effect Busch & Obernberger (2016) found in their US sample, who report a decrease of 4.88%. This could indicate the effect of share repurchases in the UK is double the effect of repurchases in the US. The result is in line with my expectation that the effect of share repurchases on price efficiency in the UK is larger than in the US. However, I have to address some remarks to the results. As can be found in table 2 model (1), the R-squared is only 2.6%, which is quite low. Although a low R-squared is not necessarily a bad thing (for some relationships explaining only a small part of the relationship can already be valuable), the R-squared of the model of Busch & Obernberger (2016) is around 5 times larger (=13.1%). Therefore, the large effect of share repurchases in the UK relative to the US should be interpreted with care, since the model only explains a small part of the variation.

The OLS regression in column (2) shows a smaller (around 4 times) and less significant relationship between (coefficient = -2.176) lagged *Repurchase intensity* and *Delay* compared to contemporaneous share repurchases. The smaller coefficient could indicate that the correlation between the variables is underestimated. As explained above, this is a possible sign that despite the run tests lagged *Repurchase intensity* is a weak proxy for contemporaneous share repurchases. On the other hand, the explanation of the variation in the model has risen almost 8 times compared to model (1).

Table 3
The effect of share repurchase on delay

Dependent variable:	Delay			Coefficient-based delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
Repurchase intensity$_t$	-9.206***			-15.89***		
	(-4.485)			(-3.503)		
Repurchase intensity$_{t-1}$		-2.176**			-2.474	
		(-2.344)			(-1.292)	
Remaining volume$_t$			-0.301**			-0.690**
			(-2.203)			(-2.254)
Delay$_{t-1}$	0.0849***	0.0545***	0.0548***			
	(9.424)	(5.525)	(5.558)			
Coefficient-based delay$_{t-1}$				0.0449***	0.0265**	0.0264**
				(4.478)	(2.561)	(2.558)
Return$_{t-1}$ > 0	0.0758**	0.0411	0.0403	0.185***	0.157**	0.157**
	(2.411)	(1.271)	(1.252)	(2.661)	(2.029)	(2.025)
Return$_{t-1}$ < 0	0.000769	0.00783	0.00805	-0.100	-0.0107	-0.0115
	(0.0180)	(0.174)	(0.179)	(-1.145)	(-0.114)	(-0.122)
Program initiation$_t$	-0.0180	-0.0197	-0.00425	-0.0161	-0.0195	0.0143
	(-1.170)	(-1.235)	(-0.265)	(-0.451)	(-0.570)	(0.392)
Market cap$_{t-1}$ (ln)	-0.0492***	-0.0573***	-0.0569***	-0.0712***	-0.0891***	-0.0879***
	(-6.460)	(-6.385)	(-6.327)	(-4.310)	(-4.571)	(-4.502)
Book to market$_{t-3}$	0.00230	-0.00240	-0.00218	0.00257	-0.00793	-0.00765
	(0.538)	(-0.529)	(-0.478)	(0.253)	(-0.746)	(-0.722)
Volatility$_{t-1}$ (ln)	-0.0385***	-0.0296***	-0.0293***	-0.0758***	-0.0601***	-0.0598***
	(-6.317)	(-5.175)	(-5.128)	(-5.818)	(-5.302)	(-5.301)
Analysts$_{t-1}$ (ln)	-0.0111*	-0.00814	-0.00795	-0.0112	-0.00746	-0.00674
	(-1.845)	(-1.319)	(-1.292)	(-0.793)	(-0.532)	(-0.483)
Trading volume$_{t-1}$	-0.0114***	-0.0128**	-0.0128**	-0.0253***	-0.0264***	-0.0258***
(scaled)	(-2.699)	(-2.212)	(-2.193)	(-3.397)	(-2.907)	(-2.823)
Constant		0.908***	0.906***		2.505***	2.499***
		(12.10)	(12.02)		(17.13)	(17.02)
Observations	13,171	13,171	13,171	13,171	13,171	13,171
R^2 (within firm)	0.025	0.198	0.198	0.011	0.148	0.148
Firm FE	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y
Hansen's J (test)	1.141			1.409		
Hansen's J (p-value)	28.55%			23.52%		
Kleibergen-Paap (test)	64.657			64.670		
K-Paap (p-value)	0.00%			0.00%		

Table 3 reports the results of the GMM and OLS regressions of *Delay* and *Coefficient-based delay* on *Repurchase intensity* or Table 3 reports the results of the GMM and OLS regressions of *Delay* and *Coefficient-based delay* on *Repurchase intensity* or *Remaining volume* and the control variables. Models (1) to (3) have *Delay* as dependent variable and models (4) to (6) have *Coefficient-based delay*. The repurchase measures are instrumented by *Program* and *Program size* in models (1) and (4). Models (2) and (5) use the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. For both tests table 3 reports the test-statistics and the p-values.

Column (3) also shows a statistically significant negative relationship between *Remaining volume* and *Delay*. The coefficient of *Remaining volume* has a value of -0.301. I apply the same method of calculating the economic effect of *Remaining volume* on *Delay,* as I do for the effect of *Repurchase intensity*. Increasing *Remaining volume* with one within-firm standard deviation (=2.37%, found in table 1) results in a decrease in *Delay* of 0.0072 percentage points (= 0.0237 * -0.301). Relative to the median of *Delay* this results in a decrease in *Delay* of 1.70% (=0.0071/0.419). This effect is over 3 times larger than the effect reported in the US (= decrease of 0.50%) by Busch & Obernberger (2016). Indicating that, in the UK, the ability to repurchase shares has a larger influence on the speed with which new market information is incorporated in the stock price than in the US.

The results on the other price efficiency measure, *Coefficient-based Delay*, are consistent with the results on *Delay*. Column (4) shows a similar significant relationship between *Repurchase intensity* and price, with a more negative coefficient (=-15.89) than in column (1). This seems logical since the scale for *Coefficient-based Delay* (0-5) is larger than for *Delay* (0-1). Column (5) does report a negative relationship between *Repurchase intensity* and *Coefficient-based delay*, however this relationship lacks statistical significance. *Remaining volume* in column (6) also has a significant negative coefficient (= -0.690), which is twice the size of the coefficient in column (3) due to the larger scale of *Coefficient-based delay*.

Overall, the results show that *Repurchase intensity* has a negative effect on price delay, which is line with the findings of Busch & Obernberger (2016). This implies that firms are able to increase the speed with which market information is incorporated in the stock price by repurchasing shares. The magnitude of the effect is almost twice as large as the effect found in the US by Busch & Obernberger (2016). This indicates that share repurchases in the UK are even more capable of making stock prices efficient than in the US. The greater effect could be explained by the daily disclosure requirement in the UK relative to the quarterly disclosure requirement in the US. Due to this stricter disclosure requirement, information about repurchase activity flows directly to investors, which they can incorporate in the valuation of the stock. Whereas investors in the US, only receive this information every quarter. Furthermore, as the barriers to start a repurchase program are higher, the share repurchases could send a stronger signal to the market. Altogether, I can accept *Hypothesis 2* that share repurchases increase the speed with which market information is incorporated in the stock price.

4.3.3 Effect of control variables on price delay

The results for the control variables are mixed, some do show a significant relationship with the price efficiency measures, others do not. Over the different models significance and signs of the control variables are broadly the same. The lagged price efficiency measures have in all the models a positive significant effect on the contemporaneous price efficiency measure similar to Busch & Obernberger (2016). This implies that higher *Delay* induces more *Delay* in the next period. The relationship could exist, because if people start neglecting a stock, the next month maybe even more people neglect the stock. The under attention for a stock lowers the speed with which information is incorporated in the stock price and therefore increases delay (Hou & Moskowitz, 2005).

Prior positive returns seem to have a positive impact on price delay. The effect is significant for *Delay* in the GMM model and for *Coefficient-based delay* in all the models. No such relation is found for prior negative returns, where all coefficients are not statistically different from zero. These results imply that positive past returns lower the speed with which information is incorporated in the stock price. This finding is exactly opposite to the findings of Busch & Obernberger (2016). I do not have a solid explanation for these contradicting results, as this is not really discussed in the academic literature. But, it could be that negative returns raise more investors' awareness than positive returns, as most people are risk averse

The start of a repurchase program does not have an effect on price delay in the UK. Whereas, Busch & Obernberger (2016) do find a significantly positive relation between program initiation and delay, the UK results do not show a similar pattern. This could be an indicator that the announcement effects, as reported by Peyer & Vermaelen (2008), do not really play a role in the UK. Manconi, Peyer, & Vermaelen (2014) state that announcement effects are smaller in countries, which require shareholder approval, relative to countries, which require only board approval. The authors reason that in shareholder approval countries the announcement is only a request for approval, whereas in board approval countries the announcement, is actually the announcement of the start of the program.

Market capitalization has a significant negative coefficient over all models. As market capitalization is an indicator for size, I can conclude that larger firms incorporate information faster than smaller firms. This observation is in line with the academic literature (e.g., Busch & Obernberger, 2016; Saffi & Sigurdsson, 2010; Hou & Moskowitz, 2005) and expectations, since larger firms naturally receive more attention from investors. With more attention being paid to a stock, the delay of information incorporation naturally decreases (Hou & Moskowitz, 2005).

Book-to-market ratio does not show any significant coefficients. The signs of the coefficients also differ over the models. The valuations of a company relative to the assets in place, thus have no significant relationship with price delay in the UK. In contrast to the paper of Busch & Obernberger (2016), who do find a significant positive relationship between *Book-to-market ratio* and *Delay*.

Volatility has a significant negative coefficient over all the models. This is in line with expectations, as stocks that fluctuate raise attention. So, if the fluctuations of a stock rise then the attention will go up and delay will decrease. The literature reports also a negative relationship between volatility and price delay (Busch & Obernberger, 2016; Phillips, 2011).

Analysts has a negative coefficient in all the models, but is only statistically significant at the 10%-level in model (1). The academic literature shows similar results (Busch & Obernberger 2016; Hou & Moskowitz 2005). The negative coefficient is in line with expectations, since analysts cover a stock and provide information. So, the more analysts a firm has, the more attention investors pay to the stock, which should lead to a more efficient stock price.

Trading volume also has a significant negative coefficient in all the models. Indicating that the more a stock is traded the lower the price delay is. This observation does also align well with the expectations, since more trading induces more attention and more attention induces lower price delay. These findings are in line with the results of Boehmer & Wu (2013), but in contrast with the results of Busch & Obernberger (2016). However Busch & Obernberger (2016) call their results surprising themselves and driven by other liquidity results, implying that the results found in this thesis and by Boehmer & Wu (2013) are more appropriate.

4.4 Share repurchases and idiosyncratic risk

To further test the effect share repurchases have in the UK, I regress measures of idiosyncratic risk on the same variables. A decrease in idiosyncratic risk due to share repurchases could imply that firms provide price support according to Hong, Wang and Yu (2008). On the other hand, if share repurchases increase idiosyncratic risk, it could be an indication for stock price manipulation, as manipulating stock prices causes idiosyncratic risk to rise (Busch & Obernberger, 2016). This section presents the results of the regressions of idiosyncratic risk on repurchase measures and the controls. The first part describes the effect of share repurchases on idiosyncratic risk. The second part shows the effect of the control variables on idiosyncratic risk.

4.4.1 The effect of share repurchases on idiosyncratic risk

Columns (1) to (3) show the results for the *R-squared* regressions and columns (4) to (6) for the *Absolute market correlation*. The higher the values of these independent variables, the lower the idiosyncratic risk of the stock. The tests for the validity of the instruments *Program size* and *Program* in the GMM-models (1) and (4) again show that the models are correctly specified[6].

The results imply that share repurchases decrease idiosyncratic risk. Model (1) shows a significant positive coefficient for *Repurchase intensity* (=6.622). To give more economic interpretation to this coefficient, again I multiply it with the one within-firm standard deviation of *Repurchase intensity*, which is 0.43% and is reported in table 1. This gives an increase in R-squared of 0.028 percentage points (=0.0043*6.622). Relative to the median R-squared of 0.25, it leads to an increase of the R-squared of 11.39% (= 0.028/0.25). Compared to the US sample of Busch & Obernberger (2016), who report an increase of 6.34% the effect of repurchases is almost twice as large in the UK. Implying that share repurchases reduce idiosyncratic risk even more in the UK than they do in the US. However, the R-squared of model (1) is still relatively low (4.4%), therefore we should interpret these results with care.

The second column (2) shows the same significant effect for lagged *Repurchase intensity* only with a smaller coefficient (=1.609). The smaller coefficient for lagged *Repurchase intensity* could indicate, as described before, that it is a weaker proxy for contemporaneous *Repurchase intensity* than assumed. The explanation of the variation in the models (2) and (3) with OLS regressions is again much higher than in the GMM models.

The results in column (3) show that *Remaining volume* also has significant a positive effect on the R-squared. Though the coefficient (=0.266) is a lot smaller than the coefficients found for *Repurchase intensity*. To put this coefficient in a better perspective, I examine the effect of the increase in one within-firm standard deviation of *Remaining volume*. Multiplying the within-firm standard deviation of 2.53% (shown in table 1) with the coefficient results in an increase in *R-squared* of 0.006 (=0.0253*0.266) points. Relative to the median of R-squared (=0.250, also shown in table 1) this increase is 2.69% (=0.006/0.25). Compared to the effect of actual repurchases the effect of the ability to repurchase shares is smaller on the R-squared in the UK. This indicates that market is more sensitive to actual share repurchases than to

[6] See the statistics of Hansen's J test, Kleibergen-Paap in table 4

Table 4

The effect of share repurchases on R-squared and absolute market correlation

Dependent variable	R-squared			|Market correlation|		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
Repurchase intensity$_t$	6.622***			8.037***		
	(4.033)			(4.744)		
Repurchase intensity$_{t-1}$		1.609**			1.661**	
		(2.265)			(2.255)	
Remaining volume$_t$			0.266**			0.318***
			(2.344)			(2.848)
R-squared$_{t-1}$	0.168***	0.118***	0.118***			
	(13.32)	(8.670)	(8.700)			
|Market correlation|$_{t-1}$				0.132***	0.0860***	0.0858***
				(12.48)	(7.882)	(7.906)
Program initiation$_t$	-0.00899	-0.0122	-0.0257**	-0.000825	-0.00252	-0.0134
	(-0.667)	(-1.019)	(-2.100)	(-0.0643)	(-0.211)	(-1.119)
Market cap$_{t-1}$ (ln)	0.0313***	0.0442***	0.0438***	0.0330***	0.0466***	0.0461***
	(5.485)	(5.606)	(5.551)	(5.499)	(5.996)	(5.924)
Book to market$_{t-3}$	-0.00196	0.00326	0.00310	-0.00266	0.00229	0.00212
	(-0.607)	(0.866)	(0.824)	(-0.916)	(0.656)	(0.608)
Analysts$_{t-1}$	0.00637	0.00442	0.00422	0.00886*	0.00677	0.00650
	(1.437)	(0.955)	(0.913)	(1.893)	(1.408)	(1.357)
Trading volume$_{t-1}$	0.0105***	0.00675*	0.00663*	0.0128***	0.0105**	0.0103**
(scaled)	(3.922)	(1.949)	(1.909)	(3.871)	(2.248)	(2.197)
Constant		-0.189***	-0.187***		-0.0361	-0.0329
		(-3.096)	(-3.049)		(-0.587)	(-0.535)
Observations	13,171	13,171	13,171	13,171	13,171	13,171
R^2 (within firm)	0.043	0.289	0.289	0.032	0.253	0.253
Firm FE	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y
Hansen's J (test)	0.568			0.685		
Hansen's J (p-value)	45.12%			40.79%		
Kleibergen-Paap (test)	64.438			64.441		
Kleibergen-Paap (p-value)	0.00%			0.00%		

Table 4 reports the results of the GMM and OLS regressions of *R-squared* and *Absolute market correlation* on *Repurchase intensity* or *Remaining volume* and the control variables. Models (1) to (3) have *R-squared* as dependent variable and models (4) to (6) have *Absolute market correlation.* The repurchase measures are instrumented by *Program* and *Program size* in models (1) and (4). Models (2) and (5) use the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. Table A1 in the appendix reports the description of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. For both tests table 4 reports the test-statistics and the p-values.

the ability of firms to repurchase shares. So, the ability to repurchase shares is not as effective in reducing idiosyncratic risk as the actual repurchase of shares.

The results for the effect of the repurchase measures on R-squared are in line with the results obtained fin the US by Busch & Obernberger (2016), only the magnitude of the coefficients is larger in the UK. This implies that share repurchases in the UK reduce more idiosyncratic risk than they do in the US. The outcome is in line with expectations, since the number of share repurchase programs in the UK is a lot smaller than in US. As share repurchases in the UK are not as common, stock price reaction to share repurchases could be more positive than in the US, resulting in a more stable stock price and thus lower idiosyncratic risk. Moreover, the information of share repurchase activity flows directly to the investors due to the strict disclosure requirements.

The results for absolute *Market correlation* are in line with the results for *R-squared*. Column (4) shows a large significantly positive effect of *Repurchase intensity* (coefficient= 8.037) on *Market correlation*. Multiplying this coefficient with the increase of one within-firm standard deviation of *Repurchase intensity* gives an increase in correlation of 0.031 (=0.0043*8.037) points. Relative to the median of 0.499 (found in table 1) this is an increase in correlation of 6.93% (=0.031/0.499). The magnitude of this effect weakens in column (5) for lagged *Repurchase intensity*. Lastly, column (6) shows a slightly larger coefficient for *Remaining volume*. Putting this in an economic perspective the one within-firm increase of *Remaining volume* leads to an increase of 0.0075 (=0.318*0.0237) points in absolute *Market correlation*. Relative to the median this is an increase of 1.51% (0.0078/0.499). The results in Column (4) to (6) show that the repurchases measures also have a large positive effect on market correlation. Meaning that an increase in one of the repurchases measures increases the co-movement of an individual stock. The effect on actual share repurchases is again larger than the effect of the ability to repurchases shares. These results imply again that the market reacts more to actual share repurchases than it does to the ability to repurchase shares.

Overall, the results are in line with *Hypothesis 3* which states that share repurchase reduce idiosyncratic risk, I therefore also accept the third hypothesis. The results do not support the idea that managers manipulate stock prices or signal inside information with share repurchases, as then idiosyncratic risk is expected to rise. Again the magnitude of the effect is larger than the effect found in the US by Busch & Obernberger (2016). The greater magnitude has several potential explanations. First the regulation to prevent price manipulation is stricter in the UK than in the US, so chances that repurchases increase idiosyncratic risk are lower. Second, as UK investors can closely monitor the repurchase behavior of firms,

firms are expected to normally execute their repurchase program. Consequentially, the actual share repurchases do not reveal private information and thus do not increase idiosyncratic risk. Third, as the information of share repurchase activity directly flows to the investors in the UK, managers better able to signal information to their investors. So, if managers want to provide price support in times of negative market news or increase the speed with which positive information is incorporated, they can immediately inform investors using share repurchases. Lastly, the signaling power of share repurchases is stronger due to the strict regulation. This could enable them to make their stocks more align with the market than their US counterparts.

4.4.2. Control variables

The control variables do not always show the same significance and coefficients as the prior literature on idiosyncratic risk. *Program initiation* has a negative coefficient in all the models (1) to (6). This in line with expectations, since the initiation of a share repurchase program is firm-specific and announcement effects are found (Stephens & Weisbach, 1998). Therefore, the initiation of the program could lower the alignment between a stock and the market. However, only in model (3) the effect for *Program initiation* is significant, whereas Busch & Obernberger (2016) find the effect to be significant in all the models. Announcement effects, therefore, do not seem to play a big role in the UK, as explained earlier. *Market capitalization* does show a significantly positive coefficient is all models. Implying that larger firms have a higher *R-squared* and are more correlated with the market. This observation is in line with prior literature (e.g. Busch & Obernberger, 2016; Hutton, Marcus, & Tehranian, 2009; Piotroski & Roulstone, 2004). The larger the firm the more attention it receives and the more impact it has on the market, so this observation seems to make sense. *Book to market* does not show any significant or consistent results. In model (1) and (4) the coefficient is negative, whereas in the other models the coefficients is positive. The prior literature (e.g. Busch & Obernberger 2016; Ferreira & Laux, 2007) also reports mixed results for *book to market*. So, it seems there is no clear relationship between book to market and idiosyncratic risk. *Analysts* has a positive coefficient in all the models, but lacks statistical significance. Therefore, I cannot conclude that the number of analysts reduces the amount of idiosyncratic risk. Lastly, *Trading volume* has significant positive effect on the idiosyncratic risk measures. In model (2) and (3) the effect is only significant at the 10%-level, all the other models show higher significance levels. Higher trading volume thus leads to less noise in the stock price, which makes sense as the stocks receives more attention. Busch & Obernberger (2016) find the same significant effect, when they remove other liquidity measures from their models.

4.5 The effect of share repurchases in Up- and down markets

Besides examining the effect that share repurchases improve price efficiency and reduce idiosyncratic risk, it is valuable to examine the drivers of this improvement in price efficiency. For example, the period in which firms repurchase shares could be an indication of this drive. When firms repurchase shares in good times (periods in which the stock prices go up) this can imply that firms believe the positive public information is not yet incorporated in the stock price and their stock is undervalued (Busch & Obernberger, 2016). By repurchasing their own shares, they try to raise the firm's stock price to the desired level. On the other hand, when firms repurchase shares in bad times (periods in which the stock prices go down), it could be an indication that they try to prevent a drop down of their stock price (Busch & Obernberger, 2016). By repurchasing shares, they could be able to raise the stock price and this way improve accuracy with which negative public information is incorporated in the stock price. These two given incentives for share repurchases are according to me the most sensible ones. To examine which of the two explanations is the main driver, I need a new setup for the regressions. In the new setup I make a distinction between Up and down market via a dummy variable. When the stock return over the current month is positive, *Up market* is 1 while *Down market* is 0 and vice versa. These dummy variables interact with the repurchase measures, to examine whether there is a different effect in *Up* or in *Down markets*. When price efficiency increases in Up markets, it is an indication that firms repurchase share to increase the speed with which positive information is incorporated and when efficiency increases in Down markets it is an indication that firms repurchase shares in order to prevent their stock from falling down. The setup of the regressions is the same as in the tables 3 and 4. However, there are some slight differences. The repurchase measure is now in divided in two parts, one interaction with *Up market* and one interaction with *Down market.* Despite the interaction terms in the regressions no level variables are included, as they are collinear with some other variables. The dummies for Up and Down market are collinear with time fixed effects, whereas *Repurchase intensity* is collinear with the vector of both the interaction terms.

4.5.1 The effect of share repurchases on price efficiency in Up and Down markets

Table 5 shows the results for the effect of share repurchases in *Up* and *Down markets* on price efficiency. The coefficients for the controls are not tabulated, as I have already discussed these extensively. Column (1) and (4) show the results for the GMM-regressions, in which I use *Program* and *Program size* as instruments for the repurchase measures. Both models show a negative coefficient for the repurchase measures. But, only *Repurchase intensity* in *Down markets* has a large negative coefficient. This indicates that share repurchases mainly make stock prices more efficient in times of negative market news. The

Wald-test for difference in means, reports that the difference between repurchases in *Up* and *Down markets* is significant. The outcome is consistent with the notion that firms provide price support at the fundamental values, since the effect of share repurchases on price efficiency is mainly found in *Down markets*. However, the tests for the validity of the instruments raise concerns about the specification of the model. The models for weak and under identification do show the desired results. The Kleibergen-Paap tests reject the null hypothesis over underidentification, which indicates the models are not underidentified. The Stock-Yogo test for weak identification also rejects null hypothesis that the instruments are weak. Only the Hansen J test for over identification rejects the null hypothesis of correct identification, which implies that instruments are not distributed independently of the error process. The instruments in the models are thus not exogenous with respect to the future variations in price efficiency and therefore not valid. Consequentially, I cannot draw any conclusions from the GMM regressions.

The OLS results in columns (2), (3), (5) and (6) in table 5 present in all the models the similar negative signs for the coefficients of the repurchase measures. Column (2) presents that *Repurchase intensity* has a significant negative effect on price delay in *Up markets*, but the variable loses its significance for the effect on *Coefficient-based delay* Column (5). *Remaining volume* in *Up markets* has a negative coefficient in all the models. For *Down markets* no significant effect is found for any of the repurchase variables. The loss of significance for both *Up and Down markets* could be explained by the dividing of the repurchase measures. As the repurchases measures are now divided into two groups, the number of observations per variable drops. The calculation of the t-statistic depends on the number of observations. The standard deviation is divided by the square root of the number of observations. So, the larger the number of observations the lower the outcome will be and the higher the t-statistic. The higher level of significance in *Up markets* can therefore be explained by the higher number of shares repurchases in *Up markets* (=836) relative to *Down markets* (=593).

The coefficients for *Up* and *Down markets* are quite similar, indicating that there is not much of a difference of the effect between *Up* and *Down markets*. The Wald-test for a difference in means does not show that the results for *Up market* differ from *Down market.* These results imply that the effect of share repurchases on price delay do not depend on current market returns in the UK. As share repurchases mostly take place in *Up market* months and no difference in effect between *Up market* and *Down markets* is found, the results do not clearly support the view that the effect is mainly driven by firms providing price support at fundamental values. This finding does not correspond with the findings of Busch and Obernberger (2016) in the US, who do find that share repurchases mainly have an effect in down markets.

In the UK both the price support argument and the information incorporation seem to be the drivers of the results.

Table 5

The effect of share repurchase on Delay in Up and Down markets

Dependent variable:	Delay			Coefficient-based delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$Intensity_t$ x Up $market_t$	-2.795			-1.296		
	(-1.254)			(-0.243)		
$Intensity_t$ x Down $market_t$	-15.64***			-30.784***		
	(-7.016)			(-6.431)		
$Intensity_{t-1}$ x Up $market_t$		-2.637**			-1.697	
		(-2.323)			(-0.574)	
$Intensity_{t-1}$x Down $market_t$		-1.545			-3.255	
		(-1.186)			(-1.232)	
Rem. $vol._t$ x $Upmarket_t$			-0.304**			-0.721**
			(-2.161)			(-2.010)
Rem. $vol._t$ x $Downmarket_t$			-0.209			-0.482
			(-1.482)			(-1.603)
Observations	13,171	13,171	13,171	13,171	13,171	13,171
R-squared	0.025	0.198	0.198	0.0112	0.148	0.148
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
Hansen's J (test)	7.026			9.656		
Hansen's J (p-value)	2.98%			0.80%		
Kleibergen-Paap (test)	59.713			59.727		
Kleibergen-Paap (p-value)	0.00%			0.00%		
Wald (up – down) (test)	29.98	0.43	0.42	23.05	0.14	0.41
Wald (up – down) (*p*-value)	0.00%	51.22%	51.9%	0.00%	70.68%	52.2%

Table 5 reports the results of the GMM and OLS regressions of *Delay* and *Coefficient-based delay* on *Repurchase intensity* or *Remaining volume,* interactions terms of the repurchase measures with dummy variables that indicate *Up* and *Down markets* and the control variables (untabulated). Models (1) to (3) have *Delay* as dependent variable and models (4) to (6) have *Coefficient-based delay.* The repurchase measures are instrumented by *Program* and *Program size* in models (1) and (4). Models (2) and (5) use the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. Table A1 in the appendix reports the description of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. The Wald statistic examines whether the coefficients on *Up* and *Down market significantly* differ. For all the tests table 5 reports the test-statistics and the p-values.

4.5.2 The effect of share repurchases on idiosyncratic risk in Up and Down markets

Table 6 present the results of the effect of share repurchases on idiosyncratic risk The GMM regressions show that share repurchases mainly reduce idiosyncratic risk in *Down markets,* as the coefficient is largely

positive and significant. Furthermore, the Wald-test reports there is a significant difference in means. Again the Kleibergen-Paap and Stock-Yogo test show that the instruments are not under identified or weak. But, the Hansen-J statistic shows that the model is overidentified, so I am unable to draw any conclusions from these results.

In the OLS regressions the coefficients for the repurchase measures all have positive signs, indicating that in every market state share repurchases reduce idiosyncratic risk. For *Repurchase intensity* these coefficients are only significant in *Up markets. Remaining volume* has a significant positive coefficient in all the models. However, the Wald-test still cannot find a significant difference in means between *Up* and *Down markets*. This implies that the effect of share repurchases on the reduction of idiosyncratic risk does not depend on the market environment they take place in. Furthermore, the magnitude of the coefficients for *Repurchase intensity* in *Up markets* is larger than in *Down markets*. Therefore, the results show more support for the positive information argument than the price support argument. However, since there is not statistical difference in means, this evidence is weak. These results are not in line with the findings of Busch & Obernberger (2016), who do find that the reduction of idiosyncratic risk by share repurchases is mainly caused by repurchases in *Down markets*. So, in the UK the results do not provide evidence that only one mechanism is mainly driving the results. Altogether, the results do not show that the effect share repurchases have on price efficiency and idiosyncratic risk differs between Down *markets* and *Up markets*, consequentially I accept *Hypothesis 4* that the effect share repurchases have on price efficiency and idiosyncratic risk does not differ between *Up and Down markets* in the UK.

The difference in approval for the start of a repurchase program could be the reason for the different outcomes in the US and the UK. As UK firms require the approval of the shareholders at the general meeting in order to start a repurchase program, they do not have the flexibility to start a repurchase program on a short term basis, in order to for example provide price support. So, when UK firms start a repurchase program their focus will be on a longer time horizon, since otherwise they have to wait to next year in order to start a new repurchase program. The results show that indeed in the UK firms more evenly spread out their repurchase activity over the length of the program. Since during this longer time horizon both positive and negative market news could come up, both arguments are able to explain the effect share repurchases have on price efficiency and idiosyncratic risk. Whereas, in the US the literature shows that firms primarily repurchase shares in the beginning months of the program (Hillert, Maug, & Obernberger, 2016). As firms in the US are able to start a repurchase program ad hoc, they will be better able to provide immediate price support in case of negative market news to avoid significant losses. This

difference could be an indication that, if managers can start a repurchase program without shareholder approval, they mainly do this to provide price support, whereas if they require shareholder approval both the price support and the information incorporation argument are drivers.

Table 6

The effect of share repurchase on R-squared and absolute Market correlation in Up and Down markets

Dependent variable:	R-squared				|Market correlation|	
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$Intensity_t$ x Up $market_t$	0.710			2.345		
	(0.412)			(1.333)		
$Intensity_t$ x Down $market_t$	13.841***			14.925***		
	(7.062)			(7.868)		
$Intensity_{t-1}$ x Up $market_t$		2.422***			2.503***	
		(2.621)			(2.859)	
$Intensity_{t-1}$x Down $market_t$		0.865			0.913	
		(0.944)			(0.891)	
Rem. $vol._t$ x $Upmarket_t$			0.229**			0.305***
			(2.109)			(2.775)
Rem. $vol._t$ x $Downmarket_t$			0.247**			0.278**
			(2.098)			(2.424)
Observations	13,171	13,171	13,171	13,171	13,171	13,171
R-squared	0.046	0.292	0.292	0.037	0.256	0.256
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Hansen's J (test)	9.241			7.746		
Hansen's J (p-value)	0.98%			2.08%		
Kleibergen-Paap (test)	59.699			59.716		
Kleibergen-Paap (p-value)	0.00%			0.00%		
Wald (up – down) (test)	44.09	1.58	0.03	42.59	1.52	0.06
Wald (up – down) (*p*-value)	0.00%	21.1%	86.8%	0.00%	22.0%	81.1%

Table 6 reports the results of the GMM and OLS regressions of *R-squared* and *Absolute market correlation* on *Repurchase intensity* or *Remaining volume,* interactions terms of the repurchase measures with dummy variables that indicate *Up* and *Down markets* and the control variables (untabulated). Models (1) to (3) have *R-squared* as dependent variable and models (4) to (6) have *Absolute market correlation.* The repurchase measures are instrumented by *Program* and *Program size* in models (1) and (4). Models (2) and (5) use the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. Table A1 in the appendix reports the description of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. The Wald statistic examines whether the coefficients on *Up* and *Down market significantly* differ. For all the tests table 6 reports the test-statistics and the p-values.

4.6 Share repurchases and volatility

As the analysis on the effect of share repurchases in *Up* and *Down markets* on price efficiency and idiosyncratic risk does not provide a main driver of the results, I perform another analysis to examine whether both mechanisms can drive the results. Table 7 shows the effect of share repurchases on the volatility of a stock. This analysis can help in the further interpretation of the drivers of effect on price efficiency of share repurchases. If the volatility of a stock becomes lower due to share repurchases, it implies the price movement becomes less extreme. A less extreme price movement could support the view that firms repurchase shares to set a lower bound for their stock price (Busch & Obernberger, 2016). By providing price support they prevent the stock price from falling down, which consequentially lowers the volatility of a stock. When volatility of a stock goes up, so the price movement becomes more extreme, this could be an indication that firms increase the speed with which positive information is incorporated in the stock price. As increasing the incorporation of positive news leads to higher stock prices and thus to more extreme outcomes.

4.6.1 The effect of share repurchases on volatility

Column (1) in table 7 shows that *Repurchase intensity* has a significant large negative coefficient (= -13.04), which implies that share repurchases decrease the volatility of a stock. However, again the instruments in this regression seem not valid, as the Hansen J test rejects the null hypothesis that the model is correctly specified. Therefore I focus on the OLS regressions. Column (2) also shows a negative coefficient (-3.078) for *Repurchase intensity* which is significant at the 5%-level. Moreover, column (3) also presents a negative coefficient for *Remaining volume*. So in all the models a negative relationship between repurchase measures and volatility is found, which is in line with Busch & Obernberger (2016).

The decrease in volatility due to share repurchases is more in line with the price support argument than the positive information incorporation argument. When firms actively incorporate positive market information in their stock price, the stock price should go up and consequentially volatility should increase. Whereas, if firms provide price support in case of negative market news or a negative idiosyncratic shock, volatility should decrease. Note that in this scenario volatility could also decrease in *Up markets*, as firms can provide price support due to negative idiosyncratic shocks. Based on the results, I can conclude that share repurchases reduce volatility.

Table 7
The effect of share repurchases on volatility

Dependent variable	Volatility (ln)		
	(1)	(2)	(3)
Method:	GMM	OLS	OLS
Repurchase intensity$_t$	-13.04***		
	(-3.319)		
Repurchase intensity$_{t-1}$		-3.078**	
		(-2.313)	
Remaining volume$_t$			-0.361**
			(-2.027)
Volatility$_{t-1}$ (ln)	0.386***	0.270***	0.271***
	(23.29)	(31.62)	(31.68)
Return$_{t-1}$ > 0	0.206***	0.141***	0.139**
	(2.975)	(2.594)	(2.571)
Return$_{t-1}$ < 0	-0.902***	-0.659***	-0.658***
	(-9.463)	(-9.796)	(-9.788)
Program initiation$_t$	0.0786***	0.0304	0.0492*
	(2.734)	(1.074)	(1.667)
Market cap$_{t-1}$ (ln)	-0.123***	-0.0688***	-0.0683***
	(-7.915)	(-8.430)	(-8.362)
Book to market$_{t-3}$	-0.000509	0.00814	0.00845
	(-0.0412)	(1.486)	(1.544)
Analysts$_{t-1}$	-0.000894	0.00107	0.00125
	(-0.0713)	(0.178)	(0.207)
Trading volume$_{t-1}$	0.0660***	0.0408***	0.0408***
(scaled)	(6.491)	(7.318)	(7.314)
Constant		-2.584***	-2.586***
		(-32.31)	(-32.32)
Observations	13,171	13,171	13,171
R-squared	0.268	0.446	0.446
Firm FE	YES	YES	YES
Time FE	YES	YES	YES
Hansen's J (test)	64.696		
Hansen's J (p-value)	0.00%		
Kleibergen-Paap (test)	8.296		
Kleibergen-Paap (p-value)	0.40%		

Table 7 reports the results of the GMM and OLS regressions of *Volatility* on *Repurchase intensity* or *Remaining volume* and the control variables. The repurchase measures are instrumented by *Program* and *Program size* in model (1). Models (2) uses the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. Table A1 in the appendix reports the description of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. For both tests table 7 reports the test-statistics and the p-values.

4.6.2. The effect of share repurchases on volatility in Up and Down markets

To get a better understanding of the results on volatility, I split up the variables in *Up market* and *Down market* in the same way as shown in section 4.5. By splitting the variables, I can examine what the effect of repurchases on volatility is during positive market news and negative market news. The split up helps in analyzing, which arguments drives the results on price efficiency. If the volatility increases due to share repurchases in *Up markets*, this an indication for the information incorporation argument. On the other hand, when volatility decreases due to share repurchases in *Up* and *Down markets* this could imply that firms provide support to their stocks in bad times, since firms provide a lower bound in case of a negative shock (systematic or idiosyncratic). Table 8 shows the results of the regressions. I do not discuss the GMM regression as these models are again overidentified.

The OLS results show the same sign for the coefficients of the repurchase measures in both models. Repurchasing shares thus lowers the volatility of stock both in *Up* and *Down markets*. However, there is only a significant coefficient for *Repurchase intensity* in *Down markets*. Besides the higher level of significance, the magnitude of this coefficient is also larger than the coefficient for *Repurchase intensity* in *Up markets*. These results imply that share repurchases mainly lower volatility in *Down markets*. The Wald-test for a difference in means is not significant, but is with a p-value of 12% close to significance. These observations are in line with the price support argument, since providing a lower bound for the stock price decreases volatility. As the effect is largest in *Down market*s, the results are mostly in line with providing price support in times of negative market news. The negative coefficient for *Repurchase intensity* in *Up markets* does not align well with argument of positive information incorporation, as for this argument volatility is expected to go up due to share repurchases. However, the coefficient lacks statistical significance. The small negative coefficient could also be caused by firms providing price support to some negative idiosyncratic shocks during an *Up market* month, which lowers the volatility of a stock. The coefficients for *Remaining volume* are negative in both market states, but also lack significance. Here the Wald-test does not report a significant difference in means. Overall, the results show that only significant lower volatility in *Down markets* and do not have a significant effect on volatility in *Up markets*. Consequentially, I accept *Hypothesis 5a* that share repurchases decrease volatility in *Down* markets and reject *Hypothesis 5b* that share repurchases increase a stocks volatility in *Up markets*. These results do support the view that share repurchases provide price support at the fundamental values in the UK. On the other hand, the results do not present a clear effect of share repurchases on volatility in *Up markets*. I do not report that share repurchases increase volatility in *Up markets*, so this weakens the evidence for the positive information incorporation argument.

Table 8
The effect of share repurchases on volatility in Up and Down markets

Dependent variable	Volatility (ln)		
	(1)	(2)	(3)
VARIABLES	GMM	OLS	OLS
$Intensity_t$ x $Upmarket_t$	-25.45***	-1.043	
	(-5.812)	(-0.613)	
$Intensity_t$ x $Downmarket_t$	2.528	-5.343**	
	(0.518)	(-2.193)	
$Rem.\ vol._t$ x $Upmarket_t$			-0.311
			(-1.220)
$Rem.\ vol._t$ x $Downmarket_t$			-0.359
			(-1.369)
Observations	13,171	13,171	13,171
R-squared	0.265	0.447	0.446
Number of firms		112	112
Firm FE		YES	YES
Time FE		YES	YES
Hansen's J (test)	9.662		
Hansen's J (p-value)	0.80%		
Kleibergen-Paap (test)	59.745		
Kleibergen-Paap (p-value)	0.00%		
Wald test	33.61	2.46	0.04
Wald p-value	0.00%	12.0%	84.7%

Table 8 reports the results of the GMM and OLS regressions of *Volatility* on *Repurchase intensity* or *Remaining volume,* interactions terms of the repurchase measures with dummy variables that indicate *Up* and *Down markets* and the control variables (untabulated). The repurchase measures are instrumented by *Program* and *Program size* in models (1). Models (2) uses the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. Table A1

in the appendix reports the description of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. The Wald statistic examines whether the coefficients on *Up* and *Down market significantly* differ. For all the tests table 8 reports the test-statistics and the p-values.

4.7 OLS results for contemporaneous repurchases

Table 9 presents the results for the OLS regressions of contemporaneous *Repurchase intensity* and the results for the use of a dummy variable that indicates repurchase months. As outlined in section 3.2.4, contemporaneous Repurchase *intensity* could be correlated positively with *Delay*, if firms provide price support in order to provide a lower bound for their stock. This can result in a positive bias for the coefficient on contemporaneous *Repurchase intensity*. If this correlation exists, I would expect a lower level of significance for contemporaneous *Repurchase intensity* relative to the more exogenous *Repurchase dummy*. *Repurchase dummy* is less affected by reverse causality, as it will rather effect the amount of share repurchases than the decision to repurchase shares (Busch & Obernberger, 2016).

Table 9
The effect of contemporaneous share repurchases

A. Contemporaneous repurchase intensity

Dependent variable:	Delay	Coeff.-based delay	R-squared	|Market correlation|
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
Rep. intensity$_t$	-1.892*	-2.371	1.072	1.463*
	(-1.814)	(-0.951)	(1.337)	(1.919)
Observations	13,171	13,171	13,171	13,171
R^2 (within firm)	0.198	0.148	0.291	0.256
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Controls	Y	Y	Y	Y
B. Contemporaneous repurchase dummy				
Rep. Dummy$_t$	-0.0157*	-0.0313	0.0154**	0.0188***
	(-1.948)	(-1.512)	(2.191)	(2.972)
Observations	13,171	13,171	13,171	13,171
R^2 (within firm)	0.198	0.148	0.292	0.256
Firm FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
C. Contemporaneous repurchase dummy in up and down markets				
Rep. Dummy$_t$ x Up market$_t$	-0.0132	-0.0230	0.0124*	0.0181***
	(-1.504)	(-0.931)	(1.687)	(2.664)
Rep. Dummy$_t$ x Down market$_t$	-0.0192*	-0.0428	0.0194**	0.0198**
	(-1.690)	(-1.648)	(2.054)	(2.283)
Observations	13,171	13,171	13,171	13,171
R-squared	0.198	0.148	0.292	0.256
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Controls	Y	Y	Y	Y
Wald (up – down) (test)	0.26	0.46	0.59	0.04
Wald (up – down) (*p*-value)	60.8%	49.77%	44.45%	84.1%

Table 9 reports the OLS of *Delay, Coefficient-based delay, R-squared* and *Absolute market correlation* on contemporaneous repurchase variables and control variables. In model (1) *Delay* is the dependent variable, in model (2) *Coefficient-based delay*, in model (3) *R-squared* and in model (4) *Absolute market correlation*. Panel has *Repurchase intensity* as repurchase measure, panel B has a *Repurchase dummy* and panel C has interaction term between *Repurchase dummy* and *Up* and *Down markets.* Table A1 in the appendix shows the definition of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***.

The results are in line with my expectations, the level of significance is higher for *Repurchase dummy* than for contemporaneous *Repurchase intensity* in all the models. However, the difference is not as large as

found in the Busch & Obernberger (2016) paper and mainly applies to the reduction of idiosyncratic risk. As there is a difference between significance of contemporaneous *Repurchase intensity* and *Repurchase dummy*, but this difference is rather low, the results provide weak evidence that firms provide price support. The results in table C again show that share repurchases increase price efficiency and reduce idiosyncratic risk regardless of the market situation.

4.8 Robustness checks

This section describes the robustness checks, I conduct on my data and regressions to prove the validity of both the data and analyses used in the thesis.

4.8.1 Different repurchase frequencies

Lagged *Repurchase intensity* is only a good predictor for exogenous *Repurchase intensity*, when months following repurchase months also have repurchase activity. So, firms have to repurchase shares frequently in a year and not random. Dittmar & Field (2015) report that in their dataset many firms only repurchase shares a few times a year. If this would be the case in my dataset, I cannot precisely predict the contemporaneous *Repurchase intensity.* Busch & Obernberger (2016) report that in their dataset 71% of the repurchase months are followed by months which have repurchase activity. Therefore they argue that lagged *Repurchase intensity* is still a good proxy for contemporaneous *Repurchase intensity.* In my dataset 84% of the repurchase months are followed by a month with repurchase activity, so I can conclude that lagged *Repurchase intensity* is a good predictor of contemporaneous *Repurchase intensity*.

4.8.2 Results driven by the financial crisis

During the research period of 2006 till 2016 one of the largest financial crises in history hit the world economy. To be certain that this crisis does not drive my results, I run the regressions again, while excluding the data from September 2008 till March 2009, similar to Busch & Obernberger (2016). I obtain similar results, therefore I can conclude that the financial crisis does not drive my results. The effect share repurchases have on price efficiency and idiosyncratic risk tends to be even larger, when I do not include the crisis period. This is another indication that price support at fundamental values is not the primary driver of the results, as then I would expect to find a larger effect in periods with more negative returns. Figure A2 in the appendix shows that *Delay* has normal pattern over time, therefore there are no concerns that extreme values of *Delay* in a specific year drive my results.

5 Conclusion

My thesis examines the effect of share repurchases on stock price efficiency and idiosyncratic risk in the UK. Share repurchases are becoming are more popular form of corporate payout all over the world. However, the research on the information content of share repurchases is limited outside the US. Examining the effect share repurchase have on price efficiency and idiosyncratic in more regulated countries gives an insight in the potential effect of different regulatory systems. My thesis contributes to literature, as the effect of share repurchases on price efficiency has not been researched outside the US. The outcomes could help regulators in their decisions how to regulate the repurchase of shares in their country.

I report that UK firms execute their share repurchase program in a different way than their US counterparts. Instead of front-loading the execution of share repurchase program, the share repurchase activity of UK firms remains relatively stable over the length of the repurchase program. As UK firms need shareholder approval in order to start a repurchase program, they are not as flexible as the US firms. Therefore, they are more likely to evenly spread out their repurchase activity until the next shareholder approval. Moreover, the results present that share repurchases have greater positive impact on price efficiency in the UK compared to the results in the literature in the US. The findings for the effect on idiosyncratic risk are similar, share repurchases reduce idiosyncratic risk more in the UK compared to the literature results in the US. I attribute the larger effects to the stricter disclosure requirements and share repurchase regulation in the UK. Due to the disclosure requirements, information flows directly to the investors. The stricter regulation makes it harder for UK firms to repurchase shares, consequentially share repurchases send a stronger signal to the market. The strict regulation to prevent price manipulation seems to work as well, since share repurchases do not increase idiosyncratic risk. Altogether, this explains why the effect of share repurchases on price efficiency and idiosyncratic risk is larger in the UK than in the US.

The effect share repurchases have on price efficiency and idiosyncratic risk does not differ between positive and negative market situations. This indicates that both providing price support at the fundamental values and increasing the speed with positive information is incorporated in the stock price, are the drivers of the effect of share repurchases on price efficiency and idiosyncratic risk. This is not in line with the results in the US, which report that the effect is primarily driven by providing price support. I attribute the difference in findings to the stricter regulation in the UK, which gives managers less flexibility. UK managers are not able to provide immediate price support as their US colleagues. Instead,

they have to wait for shareholder approval and thus spread their repurchase activity more evenly out over the length of the program. In this longer period both positive and negative market news could enter the market, therefore both mechanisms can be important drivers of the results.

For further research on this topic, I discuss the limitations of my research and possible recommendations. In comparison to the researches in the US, the necessary data for the UK is not easily accessible. Therefore the number of repurchase months and repurchasing firms is relatively low compared to the Busch & Obernberger (2016) paper. Because the number of repurchase months is relatively low, I am not able to conduct thorough analysis on the effect of share repurchases in *Up* and *Down markets*. For future research, I recommend to find a way to obtain more data of share repurchases to perform all the desired analyses. Also for many variables, such as *Net insider trading* and *Options outstanding* the UK has limited data available, which make it impossible to include the variables in the analysis. To get a better understanding of the drivers of share repurchase activity, it would helpful to include these variables in the analysis. Besides, the use of other price efficiency and idiosyncratic risk measure, could benefit the robustness of the results.To have a closer look on the potential effects of regulation with respect to share repurchases, I would recommend to perform an analysis on similar firms in similar countries that have some differences with respect to the share repurchase regulation. Moreover, the effect of regulation changes within a country could also be meaningful in this topic. Both analyses could give a better insight, which rules about share repurchases benefit the stock market and which do not.

Bibliography

Andriasopoulos, D., & Lasfer, M. (2015). The market valuation of share repurchases in Europe. *Journal of Banking & Finance, 55*, 327-339.

Andriosopoulos, D., & Hoque, H. (2013). The determinants of share repurchases in Europe. *Interntional Review of Financial Analysis, 27*, 65-76.

Andriosopoulos, D., & Hoque, H. (2017). Directors' Purchases Talk and Share Repurchases Whisper.

Arena, M., & Kutner, G. (2015). Territorial tax systems reform and corporate financial policies. *The Review of Financial Studies, 28*(8), 2250-2280.

Babenko, I. (2009). Share repurchases and Pay-Performance Sensitivity of Employee Compensation Contracts. *The Journal of Finance, 64*(1), 117-150.

Babenko, I., Tserlukevich, Y., & Vedrashko, A. (2012). The credibility of open market share repurchase signaling. *Journal of Financial and Quantitative Analysis, 47*(4), 1059-1088.

Bagwell, L. (1991). Share repurchase and takeover deterrence. *The Journal of Economics*, 72-88.

Bagwell, L., & Shoven, J. (1988). Share repurchases and acquisitions: An analysis of which firms participate. *Corporate takeovers: Causes and consequences*, 191-220.

Bargeron, L., Bonaime, A., & Thomas, S. (2017). The timing and source of long-run returns following repurchases. *Journal of Financial and Quantitative Analysis, 52*(2), 491-517.

Bebchuk, L. A. (2013). The myth that insulating boards serves long-term value. *Colum. L. Rev. 113*, 1637.

Ben-Rephael, A., Oded, J., & Wohl, A. (2013). Do firms buy their stock at bargain prices? Evidence from actual stock repurchases disclosures. *Review of Finance*, 1299-1340.

Billett, M., & Xue, H. (2007). The takeover deterrent effect of open market share repurchases. *The Journal of Finance, 62*(4), 1827-1850.

Boehmer, E., & Wu, J. (2013). Short selling and the price discovery process. *Review of Financial Studies*, 287-322.

Bonaime, A. (2015). Mandatory disclosure and firm behavior: Evidence from share repurchases. *The Accounting Review, 90*(4), 1333-1362.

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

Brav, A., Graham, J., Campbell, R., & Michaely, R. (2004). Payout policy in the 21st century. *Journal of Financial Economics, 77*, 483-527.

Brav, A., Graham, J., Harvey, C., & Michaely, R. (2005). Payout policy in the 21st century. *Journal of financial economics, 77*(3), 483-527.

Bris, A., Goetzmann, W., & Zhu, N. (2007). Efficiency and the beart: Short sales and markets around the world. *The Journal of Finance, 62*(3), 1029-1079.

Brounen, D., De Jong, A., & Koedijk, K. (2006). Capital structure policies in Europe: Survey evidence. *Journal of Banking & Finance, 30*(5), 1409-1442.

Busch, P., & Obernberger, S. (2016). Actual Share Repurchases, Price Efficiency, and the Information Content of Stock Prices. *The Review of Financial Studies*, 324-362.

Chan, K., Ikenberry, D., Lee, I., & Wang, Y. (2010). Share repurchases as potential tool to mislead investors. *Journal of Corporate Finance, 16*, 137-158.

Cook, D., Krigman, L., & Leach, J. (2003). On the timing and execution of open market repurchases. *The Review of Financial Studies, 17*(2), 463-498.

De Cesari, A., Espenlaub, S., Kurshed, A., & Simkovic, M. (2012). The effects of ownership and liquidity on the timing of repurchase transactions. *Journal of Corporate Finance 18 (5)*, 1023-1050.

Dhanani, A., & Roberts, R. (2016). Corporate share repurchases in the UK: Perceptions and practices of corporate managers and investors. *Journal of Applied Accounting Research, 17*(3), 331-355.

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

Dittmar, A., & Field, L. (2015). Can managers time the market? Evidence using repurchase price data. *Journal of Financial Economics*, 261-282.

Dixon, R., Palmer, G., Stradling, B., & Woodhead, A. (2008). An empirical survey of the motivation for share repurchases in the UK. *Managerial finance*, 886-906.

Dixon, R., Palmer, G., Stradling, B., & Woodhead, A. (2008). An empirical survey of the motivation for share repurchases in the UK. *Managerial Finance, 34*, 886-906.

Dutta, S. (1996). Private and public disclosures and the efficiency of stock prices. *Review of Accounting Studies, 1*(4), 285-307.

Fenn, G., & Liang, N. (2001). Corporate payout policy and managerial stock incentives. *Journal of Financial Economics, 60*(1), 45-72.

Ferreira, M., & Laux, P. (2007). Corporate governance, idiosyncratic risk and information flow. *The Journal of Finance, 62*(2), 951-989.

Ginglinger, E., & Hamon, J. (2007). Actual share repurchases, timing and liquidity. *Journal of Banking & Finance, 31*(3), 915-938.

Grossman, S., & Miller, M. (1988). Liquidity and market structure. *Journal of Finance*, 617-633.

Grullon, G., & Michaely, R. (2002). Dividends, share repurchases, and the substitution hypothesis. *The Journal of Finance, 57*(4), 1649-1684.

Grullon, G., Michaely, R., & Swaminathan, B. (2002). Are dividend changes a sign of firm maturity? *Journal of Business*, 387-424.

Hacekthal, A., & Zdantchouk, A. (2006). Signaling power of open market share repurchases in Germany. *Financial Markets and Portfolio Management, 20*(2), 123-151.

Healy, P., & Palepu, K. (1993). The effect of firm's financial disclosure strategies on stock prices. *Accounting Horizons, 7*(1), 1-11.

Hillert, A., Maug, E., & Obernberger, S. (2016). Stock repurchases and liquidity. *Journal of Financial Economics, 119*(1), 186-209.

Hong, H., Wang, J., & Yu, J. (2008). Firms as buyers of last resort. *Journal of Financial Economics*, 119-145.

Hou, K., & Moskowitz, T. (2005). Market frictions, price delay, and the cross-section of expected returns. *Review of Financial Studies 18*, 981-1020.

Hovakimian, A., Opler, T., & Titman, S. (2001). The debt-equity choice. *Journal of Financial and Quantitative analysis, 36*(1), 1-24.

Hutton, A., Marcus, A., & Tehranian, H. (2009). Opaque financial reports, R2 and crash risk. *Journal of Financial Economics, 94*(1), 67-86.

ICSA The governance institute. (2015, October 26). *The cost of buying back*. Retrieved from ICSA: https://www.icsa.org.uk/knowledge/governance-and-compliance/features/november-2015-the-cost-of-buying-back

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

Jagannathan, M., & Stephens, C. (2003). Motives for multiple open-market repurchase programs. *Financial Management*, 71-91.

Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review*, 323-329.

Kahle, K. (2002). When a buyback isn't a buyback: Open market repurchases and employee options. *Journal of Financial Economics*, 235-261.

Keswani, A., Yang, J., & Young, S. (2007). Do share buybacks provide price support? Evidence from mandatory non-trading periods. *Journal of Business Finance and Accounting*, 840-860.

Kim, J., Schremper, R., & Varaiya, N. P. (2005). Open market repurchase regulation: a croos-country examiantion. *Corporate Finance review*, 29-38.

Manconi, A., Peyer, U., & Vermaelen, T. (2014). *Buybacks around the world.*

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

Morck, R., Yeung, B., & Yu, W. (2000). The information content of stock markets: why do emerging markets have synchronous stock price movements>. *Journal of Financial Economics, 58*(1), 215-260.

Nohel, T., & Tarhan, V. (1998). Share repurchases and firm performance: new evidence on the agency cost of free cash flow. *The Journal of Financial Economics, 49*, 187-222.

Obernberger, S. (2013). The Timing of Share Repurchases. *European Financial management Association Conference.*

Oswald, D., & Young, S. (2004). What role taxes and regulation? A second look at open market share buyback activity in the UK. *Journal of Business Finance & Accounting, 31*(1), 257-292.

Oswald, D., & Young, S. (2008). Share reacquisitions, surplus cash and agency problems. *The Journal of Banking & Finance volume 32*, 795-806.

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

Phillips, B. (2011). Options, short-sale constraints and market efficiency: A new perspective. *Journal of Banking and Finance, 35*, 430-442.

Piotroski, J., & Roulstone, D. (2004). The influence of analysts institutional investors and insiders on the incorporation of market, industry, and firm-specific information into stock prices. *The accounting review, 79*(4), 1119-11551.

Rau, P., & Vermaelen, T. (2002). Regulation, taxes, and share repurchases in teh United Kingdom. *The Journal of Business, 75*(2), 245-282.

Rees, W. (1996). The impact of open market equity repurchases on UK equity prices. *European Journal of Finance, 2*, 353-370.

Saffi, P., & Sigurdsson, K. (2010). Price efficiency and short selling. *The Review of Financial Studies, 24*(3), 821-825.

Simkovic, M. (2009). The effect of Mandatory Disclosure on Open-Market Repurchases. *Berkeley Business Law Journal, 6*(1), 96-127.

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

Strege, D. (1999). Employee strategies for stock based compensation. *Compensaton and Benefits Review*, 41.

Vermaelen, T. (1981). Common stock repurchases and market signaling. *Journal of Financial Economics*, 139-183.

Von Eije, H., & Megginson, W. (2008). Dividends and share repurchases in the European Union. *Journal of Financial Economics, 89*, 347-374.

Wang, C., Strong, N., Tung, S., & Lin, S. (2009). Share repurchases, the clustering problem, and the free cash flow hypothesis. *Financial Management, 38*, 487-505.

Appendix

Table A1

Description of the variables

Name	Definition	Source	Unit
Analysts	Number of analysts (ln)	IBES	Unit
Book to market	Book value of equity/ market capitalization	Compustat.& Datastream	Ratio
Book value equity	Common equity (Comp.: ceqq)	Compustat	Millions
Cash	Cash and short-term investments (Comp: cheq)	Compustat	Millions
Delay	Measure of price efficiency which is 1 minus the ratio of the R^2 of the base model relative to the R^2 of the extended market model	Datastream	Ratio
Coefficient-based delay	Measure of price efficiency which compares the lag-weighted sum of the coefficients of the lagged market returns relative to the sum of all coefficients	Datastream	Ratio
Dividends	Total dividends (Comp. :dvt)	Compustat	Millions
Down market	Equals 1 if market return is negative, otherwise 0	Datastream	Unit
EBITDA	Operating income before depreciation (Comp.: oibdpq)	Compustat	Millions
Leverage	(Total asset – book value equity)/ (total asset – book value equity + market cap.)	Compustat & Datastream	Ratio
Market return	The return of the FTSE 350 over a month	Datastream	Percentage
Market capitalization	Monthly average of daily market capitalization (ln)	Datastream	Millions
Market correlation	Correlation between daily stock return and contemporaneous market return	Datastream	Unit
Program	Equals 1 if a firm repurchases shares during a month, otherwise 0	Factiva/Bloomberg/Annual reports	Binary
Program month	Difference between current month and month before start of the repurchase program plus 1 (ln)	Factiva/Bloomberg/Annual reports	Unit
Program size (scaled)	Size of the repurchase program scaled by the shares outstanding at the beginning of the program	SDC/Factiva/Bloomberg	Ratio

Remaining volume	Remaining number of shares that can be repurchased at the beginning of the month scaled by shares outstanding	SDC/Factiva/Bloomberg	Ratio
Repurchase volume	GBP volume of shares repurchased during a month	Factiva/ Bloomberg	Millions
Repurchase dummy	Equals 1 if a repurchase takes place during a month	Factiva/Bloomberg	Binary
Repurchase intensity	Number of shares repurchased during a month scaled by the shares outstanding at the last day of the previous month	Factiva/Bloomberg/Datastream	Ratio
Repurchase intensity (TV)	Number of shares repurchased during a month relative to the number of shares traded during a month	Factiva/Bloomberg/Datastream	Ratio
Return	Monthly stock return	Datastream	Unit
Return > 0	Monthly stock return if positive, 0 otherwise	Datastream	Unit
Return < 0	Monthly stock return if negative, 0 otherwise	Datastream	Unit
R-squared	R-squared of the base market model	Datastream	Ratio
Shares outstanding	Number of shares outstanding at the last trading day of the month	Datastream	Millions
Total assets	Total assets (Comp.: atq) (ln)	Compustat	Millions
Trading volume (scaled)	Monthly total trading volume without share repurchases relative to shares outstanding	Factiva/Bloomberg/Datastream	Ratio
Up market	Equals 1 if market return is positive, otherwise 0	Datastream	Unit
Volatility	Standard deviation of daily returns over one month (ln)	Datastream	Unit

Figure A1 Delay over time. Figure A1 plots the mean of *Delay* over time.

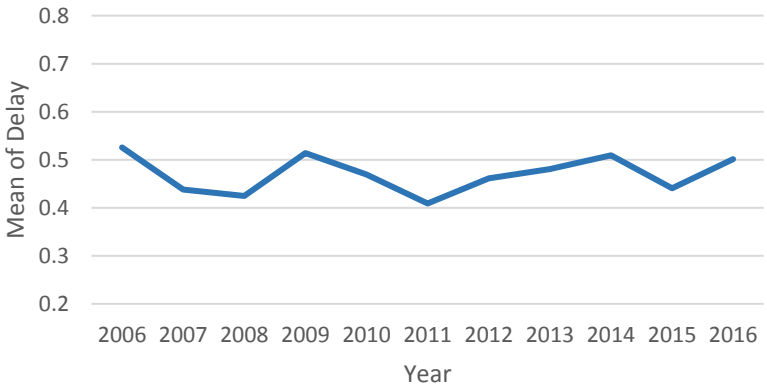


Table A2

Correlation matrix of the variables in the repurchase variable analysis

	Repurchase intensity$_t$	Remaining volume$_t$	Program$_t$	Programsize (scaled)	Return$_{t-1}$ > 0	Return$_{t-1}$ < 0	Total assets$_{t-3}$ (ln)	Book to market$_{t-3}$	Cash to assets$_{t-3}$	EBITDA to assets$_{t-3}$	Dividends to assets$_{t-3}$	Leverage$_{t-3}$
Repurchase intensity$_t$	1.0000											
Remaining volume$_t$	0.4932*	1.0000										
Program$_t$	0.5254*	0.6851*	1.0000									
Programsize (scaled)	0.5580*	0.8816*	0.7667*	1.0000								
Return$_{t-1}$ > 0	-0.0325*	-0.0273*	-0.0474*	-0.0300*	1.0000							
Return$_{t-1}$ < 0	-0.0291*	0.0086	0.0349*	0.0052	0.2890*	1.0000						
Total assets$_{t-3}$ (ln)	0.0457*	0.1177*	0.1515*	0.1046*	-0.0596*	0.0378*	1.0000					
Book to market$_{t-3}$	-0.0475*	-0.0405*	-0.1084*	-0.0579*	0.1693*	-0.0633*	0.0887*	1.0000				
Cash to assets$_{t-3}$	-0.0000	-0.0185*	-0.0157	-0.0040	0.0691*	-0.0476*	-0.2692*	-0.0481*	1.0000			
EBITDA to assets$_{t-3}$	0.0339*	0.0912*	0.1262*	0.0946*	0.0006	0.0580*	-0.0951*	-0.3068*	0.0318*	1.0000		
Dividends to assets$_{t-3}$	0.0068	0.0221*	0.0910*	0.0245*	-0.0186*	0.0503*	-0.0653*	-0.2097*	0.1434*	0.4308*	1.0000	
Leverage$_{t-3}$	-0.0222*	-0.0383*	-0.0770*	-0.0405*	0.0815*	-0.0422*	0.4972*	0.3639*	-0.2756*	-0.3070*	-0.2800*	1.0000

Table A2 shows the correlation coefficients between the variables. * indicates that the correlation is significant at the 5%-level

Table A3

Correlation matrix of the variables in the price efficiency analysis

	Delay	Coefficient-based Delay	Repurchase intensity$_t$	Remaining volume$_t$	Return$_{t-1}$ > 0	Return$_{t-1}$ < 0	Program initiation	Market Cap$_{t-3}$ (ln)	Book to market$_{t-3}$	Volatility$_{t-1}$ (ln)	Analysts$_{t-1}$ (ln)	Trading volume (scaled)$_{t-1}$
Delay	1.0000											
Coefficient-based Delay	0.7836*	1.0000										
Repurchase intensity$_t$	-0.0668*	-0.0557*	1.0000									
Remaining volume$_t$	-0.0917*	-0.0814*	0.4932*	1.0000								
Return$_{t-1}$ > 0	0.0401*	0.0298*	-0.0325*	-0.0273*	1.0000							
Return$_{t-1}$ < 0	0.0030*	0.0029	-0.0291*	0.0086	0.2890*	1.0000						
Program initiation	-0.0357*	-0.0276*	0.1468*	0.2855*	-0.0167	0.0032	1.0000					
Market Cap$_{t-3}$ (ln)	-0.4101*	-0.3214*	0.0656*	0.1517*	-0.0837*	0.1231*	0.0529*	1.0000				
Book to market$_{t-3}$	0.0849*	0.0534*	-0.0475*	-0.0405*	0.1693*	-0.0633*	-0.0238*	-0.2186*	1.0000			
Volatility$_{t-1}$ (ln)	-0.0546*	-0.0559*	-0.0063	-0.0356*	0.1308*	-0.3180*	-0.0254*	-0.1571*	0.2042*	1.0000		
Analysts$_{t-1}$ (ln)	-0.1539*	-0.1269*	0.0484*	0.1051*	-0.0077	-0.0150	0.0237*	0.2716*	-0.0129	0.0531*	1.0000	
Trading volume (scaled)$_{t-1}$	-0.1344*	-0.1141*	0.0774*	0.0602*	0.0771*	-0.1823*	0.0043	0.0728*	0.0338*	0.2771*	0.0839*	1.0000

Table A3 shows the correlation coefficients between the variables. * indicates that the correlation is significant at the 5%-level

Table A4

Analysis of the repurchase variables with Program size instead of Program

Dependent variable:	Repurchase intensity	Repurchase intensity	Remaining volume
	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Repurchase intensity$_{t-1}$		0.258***	
		(3.553)	
Program month$_t$ (ln)	0.000589***	0.000383*	-0.00503***
	(2.929)	(1.861)	(-4.031)
Program size$_t$	0.0384***	0.0309***	0.774***
	(4.703)	(4.953)	(14.28)
Return$_{t-1}$ > 0	-8.36e-05	-0.000201	-7.92e-05
	(-0.404)	(-0.958)	(-0.0709)
Return$_{t-1}$ < 0	-0.00127***	-0.00119**	0.00134
	(-2.731)	(-2.606)	(1.007)
Total assets$_{t-3}$ (ln)	9.60e-05	0.000102	0.00101
	(1.174)	(1.599)	(1.329)
Book to market$_{t-3}$	-5.87e-05	-4.13e-05	0.000402**
	(-1.569)	(-1.555)	(2.365)
Cash to assets$_{t-3}$	0.000241	0.000255	-0.00157
	(0.671)	(0.880)	(-0.712)
EBITDA to assets$_{t-3}$	-0.00127	-0.00166	0.00278
	(-1.014)	(-1.563)	(0.314)
Dividends to assets$_{t-3}$	0.000278	0.000802	0.00882
	(0.127)	(0.412)	(0.505)
Leverage$_{t-3}$	0.000123	8.19e-05	-0.00465**
	(0.314)	(0.267)	(-2.283)
Constant	-0.000890	-0.000927*	-0.00646
	(-1.469)	(-1.882)	(-1.106)
Observations	13,171	13,171	13,171
R^2 (within firm)	0.325	0.386	0.776
Number of firms	112	112	112
Firm FE	YES	YES	YES
Time FE	YES	YES	YES

Table A4 reports the OLS of *Repurchase intensity* and *Remaining volume* on the instruments, lagged *Repurchase intensity* and the control variables. Table A1 in the appendix shows the definition of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***.

Table A5
The effect of share repurchases on price efficiency without the crisis period

Dependent variable:	Delay			Coefficient-based delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
Repurchase intensity$_t$	-9.436***			-16.58***		
	(-4.438)			(-3.543)		
Repurchase intensity$_{t-1}$		-2.705***			-3.382*	
		(-2.920)			(-1.676)	
Remaining volume$_t$			-0.304**			-0.697**
			(-2.264)			(-2.452)
Delay$_{t-1}$	0.0847***	0.0545***	0.0546***			
	(9.212)	(5.532)	(5.550)			
Coefficient-based delay$_{t-1}$				0.0468***	0.0282***	0.0282***
				(4.507)	(2.704)	(2.698)
Return$_{t-1}$ > 0	0.0666*	0.0254	0.0240	0.205***	0.158*	0.157*
	(1.948)	(0.748)	(0.710)	(2.656)	(1.888)	(1.875)
Return$_{t-1}$ < 0	0.0517	0.0248	0.0275	0.00602	0.00417	0.00673
	(1.084)	(0.490)	(0.544)	(0.0578)	(0.0378)	(0.0609)
Program initiation$_t$	-0.0171	-0.0199	-0.00430	-0.0139	-0.0206	0.0134
	(-1.078)	(-1.191)	(-0.258)	(-0.379)	(-0.582)	(0.355)
Market cap$_{t-1}$ (ln)	-0.0487***	-0.0576***	-0.0573***	-0.0735***	-0.0939***	-0.0930***
	(-6.079)	(-6.128)	(-6.069)	(-4.217)	(-4.678)	(-4.615)
Book to market$_{t-3}$	0.00124	-0.00409	-0.00384	-0.00273	-0.0140	-0.0138
	(0.300)	(-0.917)	(-0.856)	(-0.283)	(-1.408)	(-1.384)
Volatility$_{t-1}$ (ln)	-0.0365***	-0.0296***	-0.0294***	-0.0757***	-0.0625***	-0.0623***
	(-5.744)	(-4.981)	(-4.952)	(-5.448)	(-5.181)	(-5.187)
Analysts$_{t-1}$ (ln)	-0.0118**	-0.00827	-0.00816	-0.0125	-0.00781	-0.00727
	(-2.023)	(-1.414)	(-1.402)	(-0.888)	(-0.563)	(-0.527)
Trading volume$_{t-1}$	-0.00949**	-0.0113*	-0.0113*	-0.0204**	-0.0203**	-0.0197**
(scaled)	(-2.195)	(-1.904)	(-1.887)	(-2.555)	(-2.083)	(-1.988)
Constant		0.915***	0.914***		2.545***	2.541***
		(11.58)	(11.48)		(16.78)	(16.64)
Observations	12,468	12,468	12,468	12,468	12,468	12,468
R^2 (within firm)	0.023	0.201	0.201	0.011	0.150	0.150
Firm FE	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y
Hansen's J (test)	1.174			1.106		
Hansen's J (p-value)	27.86%			29.30%		
Kleibergen-Paap (test)	63.342			63.352		
K-Paap (p-value)	0.00%			0.00%		

Remaining volume and the control variables. Models (1) to (3) have *Delay* as dependent variable and models (4) to (6) have *Coefficient-based delay.* The repurchase measures are instrumented by *Program* and *Program size* in models (1) and (4). Models (2) and (5) use the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. For both tests table 3 reports the test-statistics and the p-values.

Table A6
The effect of share repurchases on idiosyncratic risk without the crisis period

Dependent variable	R-squared			|Market correlation|		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
Repurchase intensity$_t$	7.276***			8.677***		
	(4.261)			(4.849)		
Repurchase intensity$_{t-1}$		1.984**			2.197***	
		(2.610)			(3.077)	
Remaining volume$_t$			0.288**			0.333***
			(2.528)			(2.950)
R-squared$_{t-1}$	0.165***	0.115***	0.115***			
	(13.04)	(8.403)	(8.427)			
|Market correlation|$_{t-1}$				0.128***	0.0826***	0.0825***
				(12.05)	(7.581)	(7.596)
Program initiation$_t$	-0.0106	-0.0123	-0.0267**	-0.00113	0.00222	-0.0144
	(-0.773)	(-0.976)	(-2.126)	(-0.0864)	(0.178)	(-1.162)
Market cap$_{t-1}$ (ln)	0.0332***	0.0440***	0.0437***	0.0359***	0.0472***	0.0468***
	(5.392)	(5.374)	(5.311)	(5.502)	(5.770)	(5.689)
Book to market$_{t-3}$	-0.000842	0.00453	0.00435	-0.000972	0.00420	0.00400
	(-0.264)	(1.268)	(1.221)	(-0.341)	(1.224)	(1.169)
Analysts$_{t-1}$	0.00669	0.00423	0.00407	0.00912*	0.00651	0.00632
	(1.489)	(0.916)	(0.884)	(1.951)	(1.381)	(1.345)
Trading volume$_{t-1}$	0.00813***	0.00580	0.00570	0.0102***	0.00928*	0.00914*
(scaled)	(3.086)	(1.618)	(1.564)	(3.051)	(1.946)	(1.894)
Constant		-0.190***	-0.188***		-0.0431	-0.0405
		(-2.994)	(-2.944)		(-0.667)	(-0.624)
Observations	12,468	12,468	12,468	12,468	12,468	12,468
R^2 (within firm)	0.041	0.293	0.293	0.030	0.256	0.256
Firm FE	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y
Hansen's J (test)	0.635			0.737		
Hansen's J (p-value)	42.57%			39.07%		
Kleibergen-Paap (test)	63.148			63.150		
Kleibergen-Paap (p-value)	0.00%			0.00%		

Table A4 reports the results of the GMM and OLS regressions of *R-squared* and *Absolute market correlation* on *Repurchase intensity* or *Remaining volume* and the control variables. Models (1) to (3) have *R-squared* as dependent variable and models (4) to (6) have *Absolute market correlation.* The repurchase measures are instrumented by *Program* and *Program size* in models (1) and (4). Models (2) and (5) use the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. Table A1 in the appendix reports the description of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. For both tests table 4 reports the test-statistics and the p-values.

Table A7 the effect of share repurchases on price efficiency without the crisis period in different market situations

Dependent variable:	Delay			Coefficient-based delay		
	(1)	(2)	(3)	(4)	(5)	(6)
Method:	GMM	OLS	OLS	GMM	OLS	OLS
$Intensity_t$ x Up $market_t$	-3.549			-3.331		
	(-1.570)			(-0.606)		
$Intensity_t$ x Down $market_t$	-16.12***			-33.083***		
	(-6.670)			(-6.191)		
$Intensity_{t-1}$ x Up $market_t$		-2.813**			-1.843	
		(-2.465)			(-0.626)	
$Intensity_{t-1}$ x Down $market_t$		-2.418*			-5.726**	
		(-1.958)			(-2.379)	
Rem. $vol._t$ x $Upmarket_t$			-0.312**			-0.730**
			(-2.311)			(-2.130)
Rem. $vol._t$ x $Downmarket_t$			-0.199			-0.466
			(-1.378)			(-1.609)
Observations	12,468	12,468	12,468	12,468	12,468	12,468
R-squared	0.023	0.201	0.201	0.0112	0.150	0.150
Firm FE	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES
Hansen's J (test)	6.472			8.763		
Hansen's J (p-value)	3.93%			1.25%		
Kleibergen-Paap (test)	59.202			59.2077		
Kleibergen-Paap (p-value)	0.00%			0.00%		
Wald (up – down) (test)	26.16	0.07	0.55	21.53	0.95	0.48
Wald (up – down) (*p*-value)	0.00%	79.66%	45.8%	0.00%	33.14%	49.17%

Table A5 reports the results of the GMM and OLS regressions of *Delay* and *Coefficient-based delay* on *Repurchase intensity* or *Remaining volume,* interactions terms of the repurchase measures with dummy variables that indicate *Up* and *Down markets* and the control variables (untabulated). Models (1) to (3) have *Delay as* dependent variable and models (4) to (6) have *Coefficient-based delay.* The repurchase measures are instrumented by *Program* and *Program size* in models (1) and (4). Models (2) and (5) use the lagged value of *Repurchase intensity* instead of contemporaneous *Repurchase intensity*. Table A1 in the appendix reports the description of the variables. The standard errors are clustered at the firm level. The t-statistics of the coefficients are reported in the parentheses. The 10%, 5%, and 1% levels of significance are indicated by *, **, and ***. The Hansen-J statistics tests the validity of the overidentifying restrictions and the Kleibergen-Paap test determines the underidentification. The Wald statistic examines whether the coefficients on *Up* and *Down market significantly* differ. For all the tests table A5 reports the test-statistics and the p-values.