Thesis

"Share repurchases and the informational efficiency of share prices"

A study of open market repurchases in the Netherlands

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Abstract

This paper studies the impact of actual share repurchases on price efficiency in the Netherlands. In doing so, I use various measures of price efficiency and manually collect data on actual repurchase activity. I find that actual share repurchases as approximated by Repurchase Intensity increase price efficiency and reduce idiosyncratic risk in program months. Subsequent analysis unveils that the observed impacts are predominantly observed in negative market information months. I deduce that share repurchases improve the accuracy by which negative information is incorporated into share prices by providing price support at intrinsic values. My results provide no evidence that share repurchases are used to manipulate stock prices. I further examine this relationship in an extended sample and find that the observed relationships only hold for open program months. I also conduct additional tests to determine if subsets of repurchases based on distinctive motivations for a repurchase program have a differential impact on price efficiency. I observe that price efficiency increases for contemporaneous repurchases related to capital structure adjustments, whereas I observe a decrease in price efficiency for excess cash related repurchases.

Keywords: actual share repurchases, price efficiency, information content, price delay, idiosyncratic risk, fixed effects, motivation, abnormal returns

JEL classification: G10, G30, G35

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1. Introduction

Historically, share repurchases have been an insignificant way of redistributing cash. This is because widespread concerns regarding repurchase-related stock price manipulation led regulators to discourage share repurchases (Jacob & Jacob, 2013). However, over the last three decades a great deal of regulatory reform has been introduced which has considerably improved a firm's ability to repurchase its own shares. In effect, share repurchases have become increasingly common around the world (Grullon & Ikenberry, 2000). In the United States for instance, the total value of share repurchases for US firms spiked at around USD 600Bn in 2007 compared to approximately USD 40Bn in 1990 (Zeng, 2014). This increase in share repurchase volumes is also observed outside the US, as many countries including Canada, France, Germany, Japan and Hong Kong introduced open market repurchases from the 1990s onwards. In the first half of the 2000s other European countries followed by engaging in legal reforms to simplify procedures or eradicate tax provisions related to share repurchases. As a result, the total value of share repurchases in the European Union increased from EUR 1Bn in 1992 to approximately EUR 58Bn in 2005 (von Eije & Megginson, 2008). Before 2001, the number of share repurchases carried out in the Netherlands was minimal. Due to several changes in civil law and dividend tax regulation between 2001 and 2008 a significant growth in open market share repurchase programs was observed. Von Eije and Megginson (2008) for instance find that following reforms, the Netherlands ranked second in the European Union in the overall value of share repurchases in 2005.

The global increase in the total value of share repurchases reinvigorates discussion as to whether these repurchases actually manipulate stock prices. Various studies argue that managers primarily use share repurchases to signal the relative undervaluation of stocks (e.g. Dann, 1983; Wansley, Lane and Sarkar, 1989; Ikenberry, Lakonishok and Vermaelen, 2000). In opposition to this, regulators have raised renewed concerns regarding the use of share repurchases merely as a tool to distort stock prices, undermine price efficiency and in turn increase managements' stock performance related compensation[1]. Busch and Obernberger (2016) address the concerns regarding the distortion of share prices by investigating the

[1] "Senators Think Stock Buybacks Might Be Manipulative" on Bloomberg (https://www.bloomberg.com /view/articles/2015-06-15/senators-think-stock-buybacks-might-be-manipulative), "Warren decries stock buybacks, high CEO pay" on Boston Globe (https://www.bostonglobe.com/news/nation/2015/06/04/sen-elizabeth-warren-decries-stock-buybacks-and-high-ceo-pay-seeks-overturn-rules/iXvsq8lGI6KOFsFY5w7FUP/story.html). Baldwin Letter to SEC on Baldwin Senate.Gov (https://www.baldwin.senate.gov/imo/media/doc/Baldwin%20Letter%20to%20SEC%204%2023%2015.pdf), "Aandelen terugkopen, verstandig of niet?" on Delta Lloyd Asset Management (http://www.deltalloydassetmanagement.nl/nl-nl/nieuwsberichten /2013/ 7/aandelen-terugkopen-verstandig-of-niet/)

potential impact of share repurchases on price efficiency in the United States. Their study's main result is that share repurchases make prices more efficient. Specifically, share repurchases in the US make prices more accurate by providing price support at intrinsic values (Busch & Obernberger, 2016).

As other stock markets are governed by different legislation and have unique tax environments, the perceived impact on price efficiency may differ among countries. It would therefore be interesting to examine whether Busch and Obernberger's (2016) main finding also holds in an international context. The Netherlands is an example of a market governed by a different set of rules than the US and thus provides a suitable setting to examine the external validity of Busch and Obernberger's (2016) inferences. This thesis consequently builds on their work by discussing the following research question in the context of the Netherlands:

"Do share repurchases improve the informational efficiency of share prices?"
A study of open market repurchases in the Netherlands

I address this question by assessing what impact share repurchases have on price efficiency and the information content of share prices. In particular, I postulate and test two hypotheses originally developed by Busch & Obernberger (2016). The first hypothesis argues that various (managerial) incentives for share repurchases increase share prices to levels above the intrinsic value (Busch & Obernberger, 2016). When share prices deviate from intrinsic values, noise is introduced into share prices. The introduction of noise into share prices reduces the overall information content and price efficiency of shares. Conversely, Busch and Obernberger (2016) argue that if firms repurchase shares at intrinsic values, share prices converge to their intrinsic values and price efficiency improves.

The second hypothesis states that share repurchases increase either the speed or the accuracy with which stock prices incorporate information and therefore enhance price efficiency. According to Busch and Obernberger (2016), the intuition is that share repurchases can only reflect positive information about a firm because it intervenes in the market for its own shares through two distinct channels: market orders and limit orders. A market order entails that shares are repurchased immediately at the prevailing market price. A firm can therefore instantaneously incorporate information into its stock price by repurchasing its own shares (Busch & Obernberger, 2016). This means that a market order can increase the speed with which positive information is reflected in the stock price. Limit orders on the other hand, imply that firms can increase the accuracy with which information

is reflected in stock prices. Submitting a limit order means that a firm orders to buy its own stock at a specific price (the limit price). Busch and Obernberger (2016) reason that a limit order therefore provides a lower bound for a stock's price. They argue that a repurchasing firm can increase the accuracy of a stock price, if a limit order provides price support (or lower bound) to reflect its intrinsic value (Busch & Obernberger, 2016). These distinct channels provide two means by which share repurchases improve price efficiency.

To empirically test the hypotheses, I manually compile a dataset of all share repurchases carried out in the Netherlands between the 1st of January 2008 and the 31st of December 2016 based on the AFM register for price sensitive information. Despite being the most comprehensive resource available for share repurchases in the Netherlands, I observe a great deal of missing transactions. To overcome these gaps, I cross-check the AFM register, company websites and investor relations departments as well as Bloomberg reports to obtain the relevant transaction information. Using this procedure, I collect the complete weekly transaction history of 68 open market repurchase programs in the Netherlands. The data I collect includes the average price paid, the number of shares repurchased and the date on or week within which the shares were repurchased. My sample includes 30 repurchasing firms, 491 program months and 2,713 firm months. This sample represents the first comprehensive dataset on actual repurchases in the Netherlands to date.

I proxy price efficiency and information content by employing two groups of measures for both price delay and idiosyncratic risk. The price delay measures are based on the relative explanatory power of a simple market model compared to an extended market model including 5 lags for market returns. The idea is that one observes greater price delays in the incorporation of new information, if the extended market model has greater explanatory power than the simple market model (Hou & Moskowitz, 2005). This price delay decreases when share repurchases improve the speed with which information is assimilated into share prices. The idiosyncratic risk measures quantify whether share price moves together with the market. I use the R-squared between the simple and extended market model as well as the absolute market correlation between stock and market returns to proxy for idiosyncratic risk. When share prices increasingly co-move with the market the relative amount of idiosyncratic risk declines. This implies that if share repurchase introduce noise into share prices the idiosyncratic risk of a stock increases and the information content declines (Busch & Obernberger, 2016).

I use the manually collected weekly repurchase transaction data to construct two measures of repurchase activity originally theorized by Busch & Obernberger (2016). The

first measure envelopes the monthly number of shares repurchased scaled by the total number of shares outstanding in the previous month. The second measure approximates the remaining number of shares that can be bought within the program scaled by the number of shares outstanding at the beginning of the program. I furthermore incorporate firm fixed effects and time effects to guarantee that my results are no affected by heterogeneity or macro-economic factors (Busch & Obernberger, 2016).

I find that share repurchases decrease price delay in program months and therefore conclude that repurchases make prices more efficient when using lagged *Repurchase Intensity* as a proxy for repurchase activity. I also infer that the co-movement between shares and the market increases upon repurchases, as evidenced by a higher R-squared and market correlation when using lagged *Repurchase Intensity.* This result entails that a share's relative idiosyncratic risk is lower when the lagged *Repurchase Intensity* is higher. My evidence therefore contradicts the idea that share repurchases introduce noise into stock returns. I extend my analysis to learn more about the mechanism that induces the improvement in price efficiency and the reduction of idiosyncratic risk. I sub-divide the sample into up markets (positive market returns) and down markets (negative market returns) to constitute whether positive or negative systematic information comes to the market in repurchase months. If the results are strongest in the up market sub-sample, I can establish that firms actively trade in their own shares to increase the speed by which positive information is incorporated into share prices (Busch & Obernberger, 2016). If the results are strongest in the down market, I can infer that firms repurchase at intrinsic value to increase the accuracy by which negative information is incorporated into share prices. I find that the results for price efficiency and idiosyncratic risk are strongest in down market months when negative information comes to the market. I deduce that share repurchases predominantly increase price efficiency and information content by providing price support at intrinsic values.

I also conduct some additional tests to identify whether subsets of repurchases based on distinctive motivations for a repurchase program have a differential impact on price efficiency. This analysis consists of two parts: a study of announcement returns and a study of actual repurchase behavior. I find that firms announcing a repurchase program to alter their capital structure or distribute excess cash experience positive abnormal returns and conclude that information is temporarily incorporated into stock prices upon repurchase announcements. Next, I interact a dummy for motivation with actual repurchase activity and find that firms carrying out repurchases to adjust the capital structure increase the price efficiency and reduce the idiosyncratic risk of their share prices. Moreover, I find that firms

conducting repurchases to distribute excess cash actually harm price efficiency. These significant relationships are however only observed when using contemporaneous *Repurchase Intensity* to proxy for actual repurchases. In sum, this approach reveals how particular types of information impact price efficiency differently.

I contribute to the literature in three particular ways. First, relatively little research has been conducted on share repurchases in the Netherlands. In fact, this thesis presents the first study of actual repurchases in the Netherlands. Repurchase transaction data is not readily available and must be hand-collected in the Netherlands. The final dataset therefore provides an invaluable addition to the growing body of data concerning the Dutch financial market in general, and share repurchases in particular. The second key contribution is that this thesis adds to the relatively uncharted field of the impact of share repurchase activity on price efficiency. Busch & Obernberger (2016) are the only authors to have investigated this relationship to date. Lastly, I provide a novel approach to study share repurchase activity, by collecting and investigating the motivation to conduct repurchases and assessing whether the distinctive motivations impact repurchase activity and price efficiency differently.

The rest of this thesis is organized as follows. Chapter 2 presents a detailed outline of the basics of share repurchases, a summary of the key regulations governing share repurchases in the Netherlands as well as a review of the key strands of academic literature concerned with share repurchases. Chapter 3 subsequently discusses the formation of two key hypotheses, which collectively aid the investigation of the impact of share repurchases on price efficiency. Chapter 4 next details the construction of the final dataset as well as the methodology used in this thesis. Chapter 5 reports the empirical results and relates the findings to previous research. Chapter 6 connects the key findings of this thesis to formulate a conclusion. Lastly, Chapter 7 debates some of the key limitations of the method and methodology used in this thesis as well as proposes certain recommendations for future research.

2. Theoretical Framework

This section is divided into three subsections. Firstly, I outline the basics of share repurchases. Subsequently, I discuss the regulatory framework governing share repurchases in the Netherlands. Lastly, I elaborate on the body of literature concerning the motivation, timing and impact of share repurchases. This section provides a crucial foundation for the empirical investigation of share repurchases in the Netherlands by providing theoretical justification for the methods and arguments used in this thesis.

2.1 The Basics of Share Repurchases

Once a firm decides to redistribute cash to shareholders via a share repurchase, it has four channels at its disposal through which the share repurchases can be carried out: (fixed-price) tender offers, Dutch auctions, privately negotiated repurchases and open market share repurchases.

A tender offer entails that a firm repurchases a number of shares through a one-off offer. The offer specifies the number of shares a firm wishes to repurchase, the particular price at which shares are to be repurchased and when the offer expires. A firm may also specify the minimum number of shares that must be tendered for the offer to not be cancelled. Upon notification of the tender offer shareholders decide whether the pre-specified repurchase price is deemed acceptable, and therefore whether they want to participate in the tender offer and how many shares they want to tender. A tender offer might oversubscribe, hence the number of shares tendered by shareholders exceeds the number sought by a firm. If this is the case the firm repurchases shares at the pre-specified price from the tendering shareholders on a proportional basis. Alternatively, if the number of shares tendered is below the number of shares a firm wishes to repurchase (undersubscribed) a firm may choose to cancel the tender offer altogether or to extend the duration of the offer. One of the key attractions of a tender offer for firms is that the repurchase price is fixed.

A Dutch auction resembles a fixed-price tender offer. Under a Dutch auction repurchase method the repurchasing firm determines a price range from which each tendering shareholder must select one particular price within the specified range (Gay, Kale, & Noe, 1996). At the end of the auction period the firm repurchases its shares in an ascending order based on the shareholders' tender price until the required number of shares has been repurchased. The same price is paid to all shareholders, rather than the share price selected by the tendering shareholder. This price corresponds to the clearing bid or to the highest accepted bid price. Like tender offers, it is possible that the number of shares originally tendered exceeds the number of shares required by the firm. In that case the firm repurchases the amount of shares required at or below the clearing price from all shareholders that selected a value in the range below the clearing price. If the number of shares tendered is smaller than required by the firm, it can decide to cancel the offer altogether or it buys back all the tendered shares at the maximum price (Bagwell, 1992).

A privately negotiated share repurchase is the least common method of buying back shares. In a privately negotiated transaction a firm decides to repurchase shares from a major shareholder. There are two key motives why a firm might engage in a privately negotiated

repurchase. First, a firm might fear that a major shareholder wishes to acquire the firm and replace its management. In such a case, the firm approaches the major shareholder to acquire its shares often at a significant premium above market price (Peyer & Vermaelen, 2005). This type of transaction is called "greenmail". Second, a major shareholder might want to sell a large number of a firm's shares, however the market for the firm's shares is insufficiently liquid. If the market is illiquid, selling such a large portion of a firm's shares might induce a substantial impact on the share price. To avoid such a disruptive impact the shareholder might approach the firm and negotiate the repurchase of shares via a private transaction.

An open market repurchase (program) is most commonly used to repurchase shares. According to Busch and Obernberger (2016) and Grullon and Ikenberry (2000) more than 90% of all share repurchases are conducted in the open market. In an open market repurchase program a firm announces its intention to repurchase a predetermined number of shares or Euro (Dollar) volume within a particular timeframe. It is not mandatory for a firm to buy the total amount of shares (or Euro volume) announced under a program nor is a firm required to complete the program within that particular timeframe. A firm may instead decide to terminate the program prematurely or to extend it past the initially announced completion date. In most EU countries including the Netherlands firms intending to repurchase shares must first seek approval from its shareholders via a shareholders meeting. The shareholder meeting further establishes the maximum amount of shares to be repurchased under the program and the repurchase price range. In EU countries shareholder approval expires after 18 months, which implies that firms must either regain approval or complete the program within the 18-month timeframe[2]. In the United States regulators do not require shareholder approval (Busch & Obernberger, 2016).

This thesis only considers open market repurchase programs, as most repurchases are carried out in the open market (as discussed above). This observation extends to the Netherlands as is established in Section 4.1. Therefore, limiting the scope to open market repurchases still yields a realistic representation of the share repurchase landscape in the Netherlands. Additionally, open market repurchases require a firm to actively participate in the market for its own shares and thus allows one to better capture the potential impact on price efficiency.

[2] *Burgerlijk Wetboek* 2 art. 98, par. 4 (Dutch Civil Code for NVs).

2.2 Regulatory Background

Share repurchases in the Netherlands are governed by two sets of regulation: the Dutch Civil code for NVs (*naamloze vennootschap*, a public limited company, hereafter NV) which directly regulates share repurchases and the Dividend Tax Act, which indirectly influences share repurchases. Both types of regulation have undergone a great deal of change over the last decade and have therefore redefined share repurchases in the Netherlands. This section outlines and discusses these regulatory reforms and the impact of these reforms on repurchase volumes. Additionally, I briefly discuss the key regulatory differences between the Netherlands and the nine other largest stock markets in the world.

The key regulations governing share repurchases are Sections 2:98-98d of the Dutch Civil Code for NVs. These provisions are based on European legislation stipulated in 2003[3]. Any transactions related to repurchases or buy backs of treasury shares of listed-NVs are also governed by Section 5.25a and subsequent sections of the Dutch Financial Supervision Act ("FSA") and the rules outlined thereunder concerned with the harmonization of transparency requirements, the disclosure requirements of major-holdings in listed companies and all rules regarding potential market abuse (Witteveen & Sombezki, 2014). These particular provisions are similarly governed by European legislation[4]. One particularly relevant provision, section 2:98 paragraph 4, outlines that a board can only repurchase shares after receiving approval from the general shareholders meeting. This approval expires 18 months after agreement and specifies the maximum Euro volume of shares to be repurchased, the purchase price range and through what channel repurchases are conducted. These provisions are similar across many EU countries as they are all guided by EU directives.

In 2006, a key share repurchase guideline was introduced: the 2006 European Directive[5]. This directive suggests a firm may repurchase all shares minus one given that they have adequate free reserves available within the firm. This directive thereby proposed an easing of the pre-existing 10% maximum margin for share repurchases[6]. The Dutch Parliament adopted an amended form of this European directive in 2008 by allowing firms to repurchase up to 50% of the total number of shares issued. Share repurchases in excess of 50% are considered to be harmful as these might cause firms to engage in takeover defenses

[3] Directive 2012/30/EU of the European Parliament and of the Council of 25 October 2012.
[4] Directive 2013/50/EC of the European Parliament and the Council of 22 October 2013 amending, *inter alia*, Directive 2004/109/EC of 15 December 2004 on the harmonization of transparency requirements for listed companies (the "Transparency Directive"); Directive 2003/6/EC of 28 January 2003 as amended on insider trading and market manipulation ("Market Abuse Directive"); and Commission Regulation (EC) 2273/2003 of 22 December 2003 regarding exemptions for buyback programs and stabilization of financial instruments (the "Regulation").

[5] European Directive 2006/68/EG
[6] Second Council Directive 1977/91/EEC

by transferring repurchased shares to associated companies. In addition, amounts above 50% inhibit the exercise of voting rights attached to these repurchased shares and thereby prevent a normal progression of the annual shareholders meeting. This regulatory change has in part facilitated a substantial increase in share repurchases in the Netherlands over the last decade (von Eije & Megginson, 2008).

Besides the Dutch Civil Code for NVs, share repurchases are also indirectly governed by dividend tax regulations, which have similarly faced reform over the last two decades. In 2001 for instance, the 1965 Dividend Tax Act (*Wet op Dividendbelasting, 1965*) was replaced by a renewed Dividend Tax Act. Before 2001, regulation included various tax provisions aimed at deterring firms from repurchasing shares. Between 2001 and 2008 many of these provisions were eradicated and in turn share repurchases became a more attractive alternative. Firstly, in 2004 a provision was eradicated stipulating that in any year the repurchase price of shares should be at least 25% of the total cash dividend paid out by a company. Secondly, a tax regulation forcing firms to pay up to 20% of additional corporate tax when authorities deem a payout policy to be disproportionate was terminated in January 2005. Lastly, in 2008 the Dividend Tax Act was further relaxed by eliminating the dividend tax exemption threshold and replacing it with a tax-free threshold *('voetvrijstelling')*. Prior to this amendment when share repurchases would exceed a certain limit, the total amount of share repurchases, including the amount below this threshold value, would be taxed. Afterwards only the share repurchases exceeding the limit were taxed. The previous discussion shows how significant regulatory reforms have provided the Netherlands with a new repurchase environment.

The introduction of reforms in the Netherlands has induced a surge in share repurchases. In particular, between 1990-2000 the total value of share repurchases in the Netherlands only equaled €5.5Bn. In the regulatory transition period between 2001-2007 the total value of share repurchases increased to €16.1Bn (CBS, 2009). Following the introduction of reforms the total value of share repurchases further increased to €31.5Bn for the period 2008-2016. These numbers illustrate how the regulatory reforms introduced in the Netherlands have significantly encouraged the use of share repurchases as a payout policy. Nevertheless, dividends remain the preferred payout policy in the Netherlands. There are two key explanations for dividend preference in the Netherlands. First, a large proportion of Dutch-listed firms have long-term stable cash flows and in general are considered value firms. According to Jagannathan, Stephens and Weisbach (2000), managers of value firms with long-term stable cash flows prefer to pay dividends. The high level of dividends

observed in the Netherlands support this finding. At the same time, Ikenberry, Lakonishok and Vermaelen (1995) contend that value stocks are more likely to repurchase shares as a means to disseminate information regarding undervaluation. These two results are seemingly conflicting and an alternative explanation may therefore be more appropriate. In particular, the global financial crisis has induced a downward pressure on interest rates. The downward pressure on interest rates have reduced the relative attractiveness of corporate bonds, as bondholders now receive lower coupon payments. As a consequence, many bondholders have switched to (high) dividend paying stocks, because stocks paying large amounts of dividend provide an attractive alternative investment with recurring cash flows (Floyd, Li, & Skinner, 2015).

Various key differences emerge when comparing share repurchase regulations in the Netherlands to regulations in other countries. Kim, Schremper and Varaiya (2005) provide an in-depth cross-country analysis of share repurchase regulations for the world's 10 largest stock markets[7] (based on market capitalization). In this study they identify various regulatory dimensions for which cross-country differences exist. These dimensions include: type of approval required (board/shareholder), whether there are any restrictions on the timing, volume and price of share repurchases, whether there are separate disclosure requirements and if insider trading restrictions exist (refer to Appendix Table A1 for a cross-country overview). In short, all EU countries, Hong Kong and Switzerland require shareholder approval, whereas in Canada, the US and Japan only board approval is required. The shareholder approval in the EU expires after 18 months (a timing restriction), whereas in the US there is no timing restriction. US repurchase programs can therefore extend over several years. In Canada and Hong Kong repurchase programs must be executed in 12 months. Japan and Switzerland respectively only have timing restrictions related to the end of a fiscal year and earnings announcements. In effect, share repurchase may only be conducted within reasonable distance from these two crucial dates. Furthermore, most EU countries as well as Hong Kong and Switzerland impose volume restrictions on program size equal to 10% of shares outstanding. The Netherlands however imposes a program size restriction of 50% of shares outstanding. Conversely, there are no program size restrictions in the US and Japan, and a restriction of 5% of total shares outstanding in Canada.

As all these stock markets are governed by different repurchase legislation, the potential impact of share repurchases on price efficiency may differ among countries.

[7] The 10 largest stock markets considered are: the US, Japan, the UK, France, Germany, Canada, Italy, the Netherlands, Switzerland and Hong Kong (ranked from largest to smallest).

However, to date only very little research has been conducted regarding this relationship. In particular, only one study carried out by Busch and Obernberger (2016) has evaluated the potential impact of open market repurchases on price efficiency in the United States. This thesis therefore attempts to fill a knowledge gap by examining this particular relationship in the context of the Netherlands.

2.3 Literature Review

The subsequent sections outline and discuss the longstanding literature on share repurchases from two different angles: the motivation for carrying out share repurchases and the timing and impact of share repurchases.

2.3.1 The Motivation for Repurchases

Share repurchases have recently been scrutinized as a growing number of regulators argue that a manager's primary motivation to buy back shares is to boost his own remuneration. However, other motivations for why a firm may actually repurchase shares have also been documented. Six key motivations for share repurchases are: *the management incentive hypothesis, the dividend substitution hypothesis, the free cash flow hypothesis, the signaling hypothesis, the optimal leverage ratio hypothesis* and lastly *the takeover defense hypothesis*. An outline of the motivation for share repurchases provides a solid foundation for the discussion of what drives repurchase activity and how it may impact price efficiency and information content in the subsequent sections. This section therefore provides a theoretical justification for the control variables used in my empirical analysis. Additionally, the six motivations discussed below provide me with a basis for distinguishing subsets of share repurchases based on motivations in my analysis of abnormal returns and price efficiency.

According to the *management incentive hypothesis,* managers are at large concerned with their own interests (Jolls, 1998). These managerial interests consist of two distinct parts: wages and job security. The premise of the *management incentive hypothesis* is that these two interests drive managerial decision making and therefore potentially influence the decision to repurchase shares. To elaborate, most managers receive two types of wage: a base wage and a variable component often tied to the firm's stock price (i.e. equity-based). The variable component is included as an attempt to align managerial interest with shareholder interests. This is because both stakeholders would benefit if a manager makes decisions that ultimately increase share prices. Hence, through this variable component, managers are incentivized to make stock price increasing decisions. One example of this type of decision making is share repurchases. In particular, as managers often receive compensation in the form of stock

options they have an incentive to repurchase shares; repurchasing shares potentially increases a firm's share price and simultaneously increases the executive's equity-based compensation. Various papers find evidence for this line of reasoning. Kahle (2000) for instance reports that managers indeed repurchase to increase their own wealth. Similarly, Fenn and Liang (2001) and Ikenberry, Lee and Wang (2010) find a statistically significant positive relationship between management stock options and repurchases, which further contributes to the notion that managers might conduct repurchases to boost their own remuneration. It is therefore conceivable that firms that compensate executives with stock-options and stocks are more inclined to repurchase shares. The *management incentive hypothesis* also discusses the impact that job security might have on share repurchase decision making. The idea is that manager's performance is often evaluated on the ability to maximize shareholder value. One way to maximize shareholder value is to increase the stock price of a firm. Thus, managers have another incentive to use share repurchases. This is because repurchases not only improve a manager's compensation but also provide a means to please shareholders and thereby secure their jobs (Busch & Obernberger, 2016). In sum, these two interests potentially incentivize a manager to repurchase shares.

The *dividend substitution hypothesis* entails that firms repurchase shares as an alternative to dividends. This intuition flows from the idea that dividends and share repurchases are perfect substitutes in perfect capital markets (Miller & Modigliani, 1961). In reality, repurchases and dividends are no perfect substitutes and instead repurchases may be preferred for two particular reasons. First, both payout methods have different tax considerations, where share repurchases often receive preferential tax treatment. This is because investors pay a capital gains tax over shares sold, which is typically lower than the tax rate incurred on dividends (DeAngelo, 1991). Additionally, investors can defer capital gain taxes until they realize the capital gain as they can choose whether or not to sell shares. Hence, once tax regulations change whereby the capital gain tax rate becomes relatively high compared to the dividend tax rate, the perceived advantage of share repurchases for investors diminishes. If dividends and share repurchases are considered to be substitutes, such a regulatory change would mean that dividends would become relatively more attractive (Dittmar, 2000). Brown, Liang and Weisbenner (2007) address this substitution effect by investigating the 2003 dividend tax cut in the United States. They find that the dividend tax cut induced firms to increase dividends and simultaneously were more inclined to reduce share repurchases. Bagwell and Shoven (1989) similarly corroborate that firms prefer the payout method which provides the greatest tax benefit for its shareholders by examining the

impact of the 1986 Tax Reform Act. The second reason is that both payout methods require different degrees of commitment. If a firm decides to repurchase stock in the open market, it is at the firm's disposal to decide whether or not it will repurchase shares. Once a firm has decided it will pay dividends it is required to uphold this commitment. Moreover, investors will expect dividends on a periodic basis. Share repurchases are therefore far more flexible and do not require a great deal of firm commitment, thereby making share repurchases preferred over dividends. Brav, Graham, Harvey and Michaely (2005) report that managers indeed prefer share repurchases as they are considered more flexible as well as provide a mechanism via which firms can time the market. Furthermore, Jagannathan, Stephens and Weisbach (2000) explain that the flexibility embedded in share repurchases allows firms to more adequately deal with volatility and uncertain "temporary" cash flows. Consequently, preferred tax treatment and flexibility provide two distinct reasons why a firm may choose share repurchases over dividends.

The *free cash flow hypothesis* proposed by Jensen (1986) assumes an agency conflict between firms (agent) and shareholders (principal). This is because the separation of ownership and control within a firm reduces a shareholders' ability to control the actions of the managers. As a result, one might observe a misalignment of interests between managers and shareholders. An agency conflict can for instance arise when a firm has excess cash available and there are no value-adding investment projects. In this situation, managers might be tempted to use the cash to engage in wasteful investments or "empire building". To reduce this potential agency conflict a firm might choose to reduce the amount of cash available within a firm (Jensen, 1986). One example of cash distribution is a share repurchase program. This hypothesis therefore suggests that firms with large cash balances are more likely to carry out repurchase programs. Vafeas and Joy (1995) and Stephens and Weisbach (1998) for instance find that US firms that have higher cash flows also have a higher propensity to repurchase shares. Similarly, Grullon and Michaely (2004) find that the market's response to repurchase announcements is more positive among firms that have a tendency to over-invest. This result therefore indicates that the market reacts positively to the discipline imposed on firms that switch from negative NPV or value decreasing projects to repurchase programs, as it reduces the possibility of managers over-investing. Nohel and Tarhan (1998) furthermore find that a firm's operating performance improves following repurchases, thus substantiating the idea that managers are disciplined by having less cash available. Vermaelen (2005) highlights one key limitation of Jensen's *free cash flow hypothesis* in relation to share repurchases, namely the existence of an external threat. In particular, Jensen (1986)

developed this hypothesis by discussing a hostile takeover bid, which reflects an external threat. Vermaelen (2005) however stresses that in most cases share repurchase decisions are carried out by management and are not the result of an external threat. The implication is that the *free cash flow hypothesis* is unable to clarify why "bad" managers would ever want to voluntarily repurchase shares in the absence of an external threat. This is because they would always give preference to spending money on wasteful investments or matters of self-interest such as empire building (Vermaelen, 2005). If there is no external threat to discipline management to repurchase shares, only good managers would engage in share repurchases. However, as these managers are considered to be good, there is no need to use share repurchases as a disciplining measure. Despite this concern other forms of external threats have been documented that still serve as a disciplining measure. Schleifer and Vishny (1997) for instance argue that large creditors or shareholders may also fulfill a disciplining role. Consequently, an external threat is a crucial condition for the validity of the *free cash flow hypothesis*, however a threat can take on many forms. To summarize, the existence of excess cash balances together with some form of external threat potentially induce firms to repurchase shares.

According to *the signaling hypothesis*, financial markets are characterized by asymmetric information. This asymmetry entails that insiders (managers) have better information than outsiders (market participants or investors). The asymmetric information may pertain to a manager's expectations regarding future cash flows or prospects and thus relates to the perceived value of a firm. The implication of this asymmetric information is that the current share price of a firm does not reflect the intrinsic value based on management's assessment of future cash flows or prospects. Hence, managers have an incentive to reduce this asymmetry by signaling information to the market. According to McNally (1999), investors perceive a share repurchase program announcement as a signal of future prospects. Additionally, various papers indicate that this signal is credible as the market responds positively to repurchase announcements (e.g. Zhang, 2005; Comment and Jarrell, 1991; Vermaelen, 1981, 1984). Likewise, Ikenberry, Lakonishok and Vermaelen (1995) find that "value" firms, as a proxy for undervaluation, experience greater abnormal returns upon repurchase announcements, thereby indicating that the signaling of a mispricing is processed adequately by the market. These results entail that repurchase program announcements serve as a credible tool for management to signal undervaluation or mispricing to the market. D'mello and Shroff (2000) further corroborate this idea as they find that managers are more prone to repurchase stock when they perceive the market price to be undervalued compared

to their own assessment of the share price. There is however one key issue of the signaling argument. In particular, Chan, Ikenberry, Lee and Wang (2010) criticize the signaling argument by stating that the inherent flexibility of open market repurchases encompass a weak and relatively costless signal, as these programs do not require any firm commitment. To address this issue, the authors attempt to identify situations where managers are encouraged to deceive investors via costless repurchase announcements and subsequently do not commit to actual repurchases. However, they only find anecdotal evidence that managers use repurchase announcements to mislead investors. What then causes the market to perceive this apparently costless signal to be credible? The key insight is that a cost can take on many forms. Peyer and Vermaelen (2008) provide a particularly compelling example. They reason that managers are very consumed with their reputation. If managers would lie about perceived mispricing or certain information contained in a repurchase program and the market realizes this, the manager would damage his own reputation. This means that false signaling or lying entails a cost in the form of a loss of reputation (Peyer & Vermaelen, 2008). This intuition pertains mainly to repurchase program announcements. Unlike announcements, actual repurchases do entail a financial cost as firms are required to commit capital. Actual repurchases are therefore another example of a costly signal by which firms can transfer information to the market regarding a manager's future expectations of the firm. In summary, the *signaling hypothesis* provides another motivation for a repurchase program and is often cited as the most popular motivation to carry out a program (cf. e.g. Dittmar, 2000; Stephens and Weisbach, 1998; Vermaelen, 1981). The expectation is that smaller firms are more prone to signal information via a share repurchase. This is because, as Hou and Moskowitz (2005) argue, these firms receive less coverage and are less visible to investors than larger firms and thus experience the greatest asymmetric information. They would therefore benefit the most from share repurchases to overcome this asymmetry.

When a firm repurchases its own shares it alters its capital structure. This is because a firm reduces the total amount of equity outstanding in a share repurchase and increases its leverage ratio. This intuition is the foundation of the *optimal leverage ratio hypothesis* or the *capital structure hypothesis*. Thus, if an optimal or target leverage ratio exists a firm may repurchase shares as a means to achieve this particular ratio (Dittmar, 2000). Bagwell and Shoven (1988) for instance report that firms experiencing a surge in general equity levels are likely to increase repurchases as a means to absorb this equity and achieve a particular leverage ratio. Moreover, Wansley, Lane and Sarkar (1989) observe that firms with additional debt capacity use share repurchases to obtain a more desirable capital structure.

One concern however arises when blending open market repurchases with the *capital structure hypothesis*. In particular, it has often been cited that on average open market repurchase programs only constitute a small fraction of the outstanding number of shares and the repurchases are smoothed over time (e.g. Zhang, 2005; Masulis, 1980). One might therefore argue that open market repurchases may not be the most suitable tool to radically optimize a firm's capital structure, as it takes time to reach the desired leverage ratio. Instead, open market repurchases are more appropriate as an instrument to refine the capital structure. Despite this apparent issue, various studies have demonstrated that target leverage ratios are a driver for initiating share repurchase programs (Bagwell and Shoven, 1988; Opler and Titman, 1996) .

Another motivation for share repurchases is that firms use it as a takeover defense, thereby giving rise to the *takeover defense hypothesis*. Firms may use share repurchases to deter a takeover as share repurchases increase a firm's share price and therefore also increase the overall acquisition price of the firm (Dittmar, 2000). Billet and Xue (2007) corroborate this idea as they find that firms with a higher probability of being a target in a takeover are more likely to carry out share repurchases as illustrated by a statistically significant positive relationship between both variables. Likewise, Bagwell (1988) argues that share repurchases can be an effective takeover defense tool if there is an upward-sloping supply curve for a firm's shares. If there is an upward-sloping supply curve, the acquisition cost of a takeover becomes greater with share repurchases compared to when a firm uses dividends or does not payout at all (Bagwell, 1988). The key take-away of this motivation is that firms that are likely targets for a takeover are more inclined to repurchase shares than firms that do not face this particular threat.

Each of the above motivations explains one particular reason why a firm or manager may repurchase shares. In reality, a firm may use a combination of these motivations or may only repurchase shares once certain market or firm conditions have been met. All studies discussed in this section are effectively investigations of market conditions, comparisons of firm characteristics between repurchasing firms and non-repurchasing firms or analyses of management surveys concerned with the question of why firms repurchase shares. In other words, most of the data used in these studies is based on certain *ex ante* market conditions or firm characteristics that describe what firms and managers repurchase shares. However, it remains difficult to empirically establish a link between the motivations outlined above and real world decision making. This section nevertheless provides some key insights into what might influence decision making. In addition, the research design of the studies considered in

this section have one common flaw: these studies rarely and often vaguely predict or imply anything regarding actual repurchase activity. Consequently, the next section discusses the growing body of literature dedicated to actual repurchases.

2.3.2 The Timing and Impact of Share Repurchases

For a long time, academic research on share repurchases was limited to considering its announcement effects and theorizing about different reasons why a firm may want to repurchase shares. This is because firms were not required to report repurchase activity and as a result there was no data available on actual repurchases in many countries. More recently a growing body of literature has been able to collect data on actual repurchases and has used this data to examine the timing and impact of share repurchases. I blend the discussion of timing and impact as both aspects are often intertwined in the academic literature. This section provides a theoretical foundation for the derivation of the key hypotheses addressed in this thesis.

One of the first papers to move away from only studying announcement effects and instead also consider actual share repurchases was carried out by Stephens and Weisbach (1998). In this study, Stephens and Weisbach (1998) attempt to establish an empirical link between repurchase announcement returns and subsequent repurchase behavior. They observe a positive relationship between abnormal announcement returns and the number of shares subsequently repurchased. This result implies that the market has some predictive ability regarding the credibility of signals. To elaborate, repurchasing more shares in the future entails a cost and thus represents a credible signal. The market already predicts this credible signal when the program is announced, as is evidenced by larger abnormal announcement returns. Stephens and Weisbach (1998) furthermore conclude that managers time repurchases to exploit perceived undervaluation as they observe that more shares are repurchased following negative share price performance. This first effort to study actual repurchases induced a significant shift in the focus of the academic debate towards the timing and impact of share repurchases. As a result, many studies now started to consider whether managers timed actual repurchases to signal certain information or achieve a desired impact.

The idea behind managerial timing ability is that it allows managers to accelerate or delay transactions in order to optimally exploit apparent differences between a manager's estimate of a share price and the market price (Barclay and Smith, 1988). Many studies have discussed the timing of share repurchases, however it remains unclear whether the complete body of empirical evidence substantiates or refutes managerial timing ability. There are two

contending theories: the *market timing hypothesis* and the *contrarian trading hypothesis*. The *market timing hypothesis* suggests that managers have private information which allows them to anticipate stock returns and knowingly time repurchases to exploit this private information. Whereas the *contrarian trading hypothesis* argues that managers repurchase shares as a response to a stock's relative underperformance. In summary, both theories suggest that firms repurchase shares at below average share prices, however the theories disagree on what causes this result. Brockman and Chung (2001) for instance establish that firms in Hong Kong are able to repurchase shares at lower prices compared to a naïve accumulation plan, and deduce that this indicates that managers exhibit timing ability. Likewise, Dittmar and Field (2015), McNally, Smith and Barnes (2006) and Zhang (2002) illustrate that managers in the U.S., Canada and Japan respectively, are able to repurchase shares at a discount compared to naïve investors. According to these authors this result is consistent with the notion of managerial timing ability. Obernberger (2014) however argues that none of these studies, focusing on the difference between market prices and repurchase prices, establishes a direct link with managerial timing ability. The author provides an alternative explanation for the results postulated in these papers, namely that the below average repurchase prices observed are explained by contrarian trading. Contrarian trading entails that firms repurchase shares at below average market prices, simply because there is a negative relationship between repurchases and realized returns implying that repurchases are driven by negative returns (Ginglinger & Hamon, 2007). In effect, contrarian trading behavior does not rely on *ex-ante* timing ability, rather it produces *ex-post* empirical patterns indicating that shares can be repurchased at below average prices (Obernberger, 2014). Furthermore, Ginglinger and Hamon (2007) find that repurchase activity in France indicates contrarian trading as opposed to managerial timing ability. They deduce that the contrarian repurchase activity patterns observed in France are consistent with the notion of price support. The price support argument hypothesizes that managers repurchase shares to support the firm's share price in a depressed market (Ginglinger & Hamon, 2007). McNally, Smith and Barnes (2006) further validate the price support argument by finding that repurchases cause firm stock prices to fall less than non-repurchasing firm stock prices in down-markets. The price support result therefore implies that managers actively intervene in the market for their own shares when they observe a price decrease to limit the price drop on the down side.

The price support argument fulfills a central role in this thesis. Busch and Obernberger (2016) assert that price support is one way by which repurchases can improve the price efficiency of shares. This intuition is based on the work of Hong, Wang and Yu

(2008) whom model repurchases as a channel via which firms can intervene when share prices drop and when other investors drive share prices down to sub-fundamental levels. By this intuition repurchases can improve efficiency as intervening at a certain price level provides a lower bound for the share below which the price should not drop (Busch and Obernberger, 2016). Repurchases thereby convey information regarding a share's fundamental or intrinsic value. The price adjustment will contain less noise as the dropping share price, conveying new market information, now has a lower limit as a result of the share repurchase intervention (Busch and Obernberger, 2016). Hence, providing price support thereby increases a stock's price efficiency and reduces its idiosyncratic risk. The price support argument does not imply managerial timing ability per se. Busch and Obernberger (2016) argue that the existence of timing ability is conditional on whether firms repurchase shares above or below the intrinsic value. If firms repurchase above intrinsic value, they merely distort stock prices. If firms repurchase below or at intrinsic values they exhibit timing ability (Busch and Obernberger, 2016). Busch and Obernberger (2016) provide empirical evidence that share repurchases indeed support prices at intrinsic values and therefore improve price efficiency. Furthermore, they find no evidence that managers manipulate prices. Repurchasing shares to provide price support is an example of how the timing of repurchases can be essential in achieving a desired impact.

The timing of repurchase may also induce an impact on the information content of shares. By blending the *management incentive hypothesis* with price impact, Busch and Obernberger (2016) propose that share repurchases may in fact reduce the information content of shares. Specifically, when managers receive equity based compensation they are incentivized to repurchase shares which ultimately increases shares prices. If share prices then increase to levels above the intrinsic value, a noise component is introduced equal to the difference between the prevalent market price and the true intrinsic value. This noise component delays the assimilation of both idiosyncratic and market information into share prices (Busch & Obernberger, 2016). As a result, the idiosyncratic risk of a share increases and the price efficiency decreases. Busch and Obernberger (2016) reject this notion as they find that US firms repurchase shares at and not above fundamental values.

Both the motivation for and the timing of share repurchases might induce a price impact on shares. The ultimate price impact of a repurchase or repurchase announcement in relation to a share's intrinsic value largely determines whether a share repurchase has an adverse or a favorable effect on the abnormal returns, information content and price efficiency of shares.

3. Hypotheses

Two key concepts instrumental in addressing what impact share repurchases might have on share prices are price efficiency and information content. Price efficiency concerns the degree to which all *available* information is incorporated into the stock price (Busch & Obernberger, 2016). Whereas information content is defined as the amount of information incorporated into the stock price. To address the research question adequately, I postulate two hypotheses related to the concepts of price efficiency and information content based on the work of Busch and Obernberger (2016) and subsequently test these using a hand-collected set of data for Dutch open market share repurchase programs.

The first hypothesis used in this thesis was derived by Busch and Obernberger (2016). As described above, the hypothesis builds on the idea that managers are incentivized to repurchase shares (*management incentive hypothesis)*. This incentive is induced by two particular managerial interests: compensation and job security. Regarding the first interest; managers receiving some form of equity-based compensation (either stocks or stock options) personally benefit from repurchasing shares. This is because simple market dynamics dictate that a decrease in supply of shares (through repurchases) usually coincides with an increase in share prices. The increase in share prices simultaneously increases the equity-based part of a manager's compensation. Actual share repurchases therefore create a perverse incentive for managers to boost their own compensation. The second interest relates to job security. Busch and Obernberger (2016) argue that a manager's performance is often evaluated on his ability to create shareholder value. Shareholder value is usually created by making decisions that increase a firm's stock price. As was previously established, one tool available to managers to increase share prices is share repurchases. According to this reasoning, managers are also incentivized to repurchase shares as a means to create shareholder value. The creation of shareholder value entails a positive performance evaluation for manager's and therefore increases the likelihood of the manager securing and retaining his or her job. Repurchases driven by managerial incentives may therefore cause a firms' share price to increase beyond its intrinsic value, as the repurchases do not reflect the dissemination of firm value related information. If repurchases increase prices beyond intrinsic value they might inadvertently introduce noise into stock prices and in turn decrease the information content (Busch & Obernberger, 2016). As the information content decreases, a stock's idiosyncratic risk increases and price efficiency decreases. Consequently, this perceived impact of share repurchases on stock price yields the following hypothesis outlined by Busch and Obernberger (2016):

Hypothesis 1: Share repurchases increase the stock price beyond its intrinsic value and therefore reduce the information content in stock prices.

The second hypothesis is based on the following intuition: one distinguishing property of share repurchases is that these transactions can only include positive information regarding a firm into the stock prices (Busch & Obernberger, 2016). This is because a firm can intervene in the market for its own shares through two particular channels: market orders and limit orders. When a firm uses a market order whereby shares are repurchased at the prevailing market price, the firm can directly include positive information into a share's price (Busch & Obernberger, 2016). This means that placing a market order can increase the speed by which a stock price reflects certain positive information. In a way a repurchasing firm acts as a market maker. The intuition is as follows: some stocks are priced relatively inefficiently because they are less visible to or neglected by investors (Hou & Moskowitz, 2005). As these stocks are less visible to investors, they are traded relatively infrequently. This means that it takes longer for these stocks to adequately incorporate information into their price and these stocks therefore experience more significant price delays. To address this price delay, firms can use a market order to repurchase their own shares and actively increase the speed with which certain positive information is incorporated into prices (Busch & Obernberger, 2016). Limit orders entail that shares are (re)purchased at a specific price known as the limit price. When firms use limit orders to repurchase shares they effectively create a lower bound for the stock price (Busch & Obernberger, 2016). This insight is known as the price support argument. According to the price support argument, firms that have funds available to repurchase shares can prevent stock prices from overshooting and therefore reduce the stock's short-term variance (Hong, Wang, & Yu, 2008). Busch and Obernberger (2016) lean into the price support argument by asserting that the price adjustment of a stock following a repurchase will have a smaller noise component. This is because the stock price is limited on the downside by the limit order price and the price adjustment therefore reduces the overall noise component. Consequently, the stock price of a firm has less idiosyncratic risk and information is therefore incorporated more accurately. One can infer that price efficiency has improved. Note that the argument that efficiency increases is conditional on whether price support is provided *at* or *below* (thus not *above*) intrinsic value and thus critically depends on timing (Busch & Obernberger, 2016).

As Busch and Obernberger (2016) assume that market orders can improve the speed by which stock prices incorporate information and that submitting a limit order can increase

the accuracy of a share's price, there are two distinct channels by which share repurchases can improve price efficiency. From these arguments Busch and Obernberger (2016) deduce the following hypothesis also addressed in this thesis:

Hypothesis 2*:* share repurchases increase either the speed or the accuracy with which stock prices incorporate information and therefore enhance price efficiency.

The hypotheses introduced above represent the core of my analysis, dedicated to determining the overall impact of share repurchases on price efficiency. I however also conduct various additional analyses. In a subsequent section, I identify various subsets of repurchases based on the motivation provided upon program announcement to assess whether these repurchases either harm or benefit price efficiency and idiosyncratic risk. This analysis is two-fold and considers both the short-term impact on price efficiency through abnormal announcement returns and the impact on price efficiency and idiosyncratic risk following actual repurchases. The study of different motivations represents an auxiliary analysis of repurchases and is therefore only considered at a later stage.

The hypotheses addressed in this thesis at large follow the methodology of various benchmark papers. The benchmark paper for the first hypothesis is Busch and Obernberger (2016) in order to determine whether repurchases increase stock prices beyond fundamental value and in turn reduce the information content. The second hypothesis at large follows the methodology of Busch and Obernberger (2016) and Hong, Wang and Yu (2008) to address whether share repurchases indeed increase the speed and accuracy with which stocks incorporate information into their prices and thereby increase efficiency.

4. Data and Methodology

4.1 Sample Construction

In this section I outline how the final data set is constructed as well as when and why observations are excluded from the sample.

The focus of this thesis is open market repurchase programs in the Netherlands. The repurchase information collected concerns all firms that currently are or have been listed on the Dutch stock exchange at any point between the 1st of January 2008 and the 31st of December 2016 and only includes firms for which there was at least one announcement during the sample period. The selection of this period is motivated by developments in corporate law in the Netherlands and amendments in EC directives concerning share

repurchases between 2001 and 2008, which have redefined share repurchases in the Netherlands.

In the Netherlands firms are required to announce open market share repurchase through a press release on the firm's website as well as notify either the AFM or the Dutch stock exchange. This requirement is guided by Article 17 of the European Market Abuse Regulation which obliges firms to report price-sensitive information by publishing, among other things, a press release (AFM, 2017a). Conducting share repurchases is one example of price sensitive information. Firms are therefore always required to notify the market and the AFM through a press release. In line with Article 1:107(3)(c) of the *Wet op financieel toezicht* (Wft), the AFM is obliged to maintain a public register for all press releases of at least the last five years. Besides a press release, firms are also required to disclose all share repurchase-related transaction details by the seventh trading day after the execution of such a transaction. (Witteveen & Sombezki, 2014). These transaction details include the number of shares repurchased, the average price per repurchased share and the total value of the shares repurchased.

As a first step, I consult the AFM public register (*Register Openbaarmaking Voorwetenschap*) and retrieve a downloadable excel file which contains all announcements of price-sensitive information reported to the AFM between the 3rd of October 2005 and the 15th of May 2017[8]. This file contains 46,653 reports on price-sensitive information published by 531 firms. After filtering this file on the key phrases "share repurchases", "share buybacks", "transaction in own shares", "*terugkoop eigen aandelen*" and "*inkoop eigen aandelen*" between the 1st of January 2008 and the 31st of December 2016, I obtain a total of 2535 reports published by 80 firms containing any one of these phrases. As mentioned, these reports may refer to announcements of the initiation, extension or completion of repurchase programs as well as periodic updates (usually weekly) of the actual transactions carried out under a program. According to the AFM, this public register is the most comprehensive database of share repurchases in the Netherlands (P-W. Van Gerwen, personal communication, 26 May 2017). However, the downloadable excel file merely contains the title of each report or press release and does not contain the actual press release. To obtain the press releases the user is required to return to the AFM website and must manually select each individual report to find a link to the actual press release outlining either an announcement, an extension, a completion or a periodic transaction update. I manually check

[8] This register is updated on a daily basis. In effect, 17 May 2017 refers to the last date I consulted the register.

each report to determine the total number of repurchase programs in the sample period and find a total of 149 repurchase announcements.

To ensure the quality of my data, I exclude various programs that do not fulfill certain requirements. Refer to Table 1 below for an overview of the sample construction. First, I drop 7 programs that were announced prior to 2008. For the remaining repurchase programs, I check whether trades are conducted in the open market and whether the repurchases were carried out in the Netherlands. I drop another 25 firms with 46 announcements that do not fulfill either of these requirements. Strikingly, of these 46 programs only 7 programs were not conducted in the open market. This implies that over 95% of the overall 149 Dutch repurchase programs were conducted in the open market. A result that coincides with the observation made by Busch and Obernberger (2016) that over 90% of all repurchases in the United States are carried out in the open market and therefore represents the preferred form of repurchasing shares. Next, I drop 17 firms with 17 programs that do not specify the size of the program (required to construct the *Repurchase Intensity* variable) or that have a missing announcement date. I am left with 33 firms announcing a total of 79 share repurchase programs between 2008 and 2016.

Now that all repurchase announcements have been considered the next step is to compile the weekly transaction details for each repurchase program. For many repurchase programs the reports on weekly repurchase transaction details are either incomplete or completely absent from the AFM register. To overcome gaps in my data I use triangulation by cross-checking different sources to obtain a comprehensive dataset. In sum, I manually consider all reports in the AFM register, all Bloomberg reports, and all press releases or statements regarding the progression of a share repurchase program published on company websites. This procedure of cross-checking data sources allows me to amass the complete weekly repurchase transaction overview of 68 open market repurchase programs carried out by 30 firms and corresponding to 1,861 AFM reports as can be observed in Table 1.

For 11 repurchase programs the periodic transaction details are unavailable. For these programs I contacted the investor relations departments of the different firms as a last resort to obtain the relevant information. For a variety of reasons this information is not available for these programs. Ballast Nedam (3 programs) and NSI (1 program) for instance were unwilling to provide the transaction details as all 4 repurchase programs were conducted more than 5 years ago (the most recent program ended in December 2011 for both firms). The firms are therefore not legally obliged to disclose any transaction information. Moreover, Arcadis (2015), DSM (2016) Exact Holding (2008), Heineken (2011), Unilever (2008),

Table 1: Sample Size. An outline of the construction of the final dataset. Starting point is the AFM-register *Openbaarmaking Voorwetenschap*, restricted to include all reports between the 3rd of October 2005 and 15th of May 2017. Each line refers to the number of Firms, Repurchase Programs or Reports with the motivation provided in the left column. The number of reports is greater than repurchase programs as reports may refer to announcements or completion of, changes to or transactions under a repurchase program.

	Firms*	Repurchase Programs	Reports
Total Sample	531	n/a	46,653
Initial Sample			
Repurchasing Firms	80	149	2,535
Programs Announced Before 2008	7	7	40
Repurchased Abroad	25	39	324
Non-OMS Programs	2	7	14
Insufficient Data/No Announcement Date	17	17	276
Final Sample (Announcements)	33	79	1,881
No Transaction Details	9	11	20
Final Sample (Repurchase Transactions)	30	68	1,861

Note: Firms are not (always) excluded from the dataset, as a firm may carry out multiple programs. Thus, the number of firms in Column (1) is not consistent.

Randstad (2014) and RELX (2012) were all reluctant to provide transactions details for these repurchase programs, as all these firms maintain company policies instructing employees not to honor students' information requests. Not being able to collect the transaction details of all 79 repurchase programs implies a potential sampling bias. However, being impeded in the collection of this missing information entails that I cannot control for this type of bias. One procedure available to address this sampling bias is to extend the research to other EU countries to obtain a greater sample size, as EU countries are governed by similar legislation and these countries thus require all firms to report the transaction details of share repurchases in a comparable manner. However, both Von Eije and Megginson (2008) and Kim, Schremper and Varaiya (2005) establish that most EU countries still have diverging tax regimes and stock market regulations, despite European Directives aimed at converging share repurchase regulations across EU nation states. Alternatively, one could extend the sample period to consider programs announced before 2008. The issue with this option is that the Dutch regulatory framework underlying share repurchases was significantly different pre-2008, which might impact data-collection and results.

After having compiled the transaction data for the 68 repurchase programs I convert the weekly transaction data into repurchase months and am left with 444 repurchase months. Next, I collect the data for all control variables employed in this study by consulting Compustat, Datastream, I/B/E/S/ and SDC and delete all observations for which the variables

used in the analysis of price efficiency are not available. I am left with a final data set including 30 repurchasing firms, 444 repurchasing months, 491 open-program months and 2,713 firm months.

To my knowledge, the manually compiled dataset of 68 open market repurchase programs represents the most comprehensive sample of repurchase transactions available for the Netherlands to date. The total volume of shares repurchases considered in this study amounts to approximately €22Bn (Appendix Table A3). Whereas the CBS reports that in the period 2008-2016 the total volume of repurchases in the Netherlands was €32Bn (CBS, 2016). After correcting the CBS repurchase volume for the volume of the 7 repurchase programs carried out in 2008, but announced before 2008 (€5.36Bn) and the 11 programs for which there is no transaction information available (€1.59Bn), the adjusted total repurchase volume for the sample period equals €25Bn. The final sample thus encompasses 89% of the adjusted total repurchase volume in the Netherlands for this period. Despite the limited size and exposure to sampling bias, the final sample is still a realistic representation of actual share repurchases in the Netherlands.

4.2 Methodology

This section discusses the methodology employed in this thesis and consists of two sub-sections. The first sub-section discusses the fixed effects methodology used to investigate the relationship between repurchase activity and price efficiency. The second sub-section discusses the event study methodology used for the auxiliary analysis regarding repurchase motivations.

4.3 Fixed Effects Model

To address the research question, I specify various measures of price efficiency and repurchase activity. These measures are then used to examine whether repurchase activity is related to price efficiency. The perceived relationship is investigated by regressing the efficiency measures (OLS and GMM) on a proxy for repurchase activity as well as a number of control variables on a monthly basis. In doing so, I follow the methodology and measures of Busch and Obernberger (2016), Hong, Wang and Yu (2008), Bris, Goetzmann and Zhu (2007) and Hou and Moskowitz (2005):

$$Efficiency_{i,t} = \alpha + \delta Efficiency_{i,t-1} + \beta Rep_{i,t} + \sum_{l=1}^{l=K} \gamma_l Control_{i,l,t} + \theta_i + \mu_t + u_{i,t} \quad (1)$$

$$IdiosyncraticRisk_{i,t} = \alpha + \delta IdiosyncraticRisk_{i,t-1} + \beta Rep_{i,t} + \sum_{l=1}^{l=K} \gamma_l Control_{i,l,t} + \theta_i + \mu_t + u_{i,t} \; . \quad (2)$$

where *Efficiency* refers to one of the two measures of price efficiency: *Delay* or *Coefficient-based Delay*[9]. *Idiosyncratic Risk* in the second specification refers to *R-squared* or *Absolute Market Correlation*[10]. *Rep* in this context refers to a measure for repurchase activity. This investigation uses two particular interpretations for *Rep*: (i) the total value of share repurchases in month *t* divided by the amount of shares outstanding in the previous month or *Repurchase Intensity* and (ii) the remaining volume of shares to be bought under the repurchase program in month *t* divided by the total number of shares outstanding at the initiation of the repurchase program or *Remaining Volume*. As the AFM obliges firms to report repurchase activity on a weekly basis, I have to convert the weekly transaction data into monthly measures. I also include several control variables denoted by *Control*. Lastly, the terms θ_i and μ_t refer to firm fixed effects and time fixed effects respectively. These two effects are added to the regressions to safeguard that one does not make spurious conclusions driven by unobserved heterogeneity or unobserved macroeconomic factors (Brooks, 2014).

Busch and Obernberger (2016) acknowledge a reverse causality concern when using *Repurchase Intensity*. This is because *Repurchase Intensity* may actually be the result of certain undetected market conditions as opposed to causing these market conditions. To address these reverse causality concerns, I employ three different specifications in a same manner as Busch and Obernberger (2016). First, I use the instruments *Program Month* and *Program Size* to predict *Repurchase Intensity*. *Program Size* is the maximum number of shares to be repurchased under a program scaled by number of shares outstanding and is determined at the outset of a program. *Program Month* refers to difference in months between the current month and the announcement month of the repurchase program. Hillert, Maug and Obernberger (2016) establish that using these two instruments to predict repurchase intensity allows one to circumvent reverse causality concerns. Second, I use a one-month lag of *Repurchase Intensity* instead of current *Repurchase Intensity* to circumvent reverse causality. Third, I use an alternative measure of repurchase activity, namely: *Remaining Volume*. Busch and Obernberger (2016) argue that *Remaining Volume* is an intuitively pleasing measure of repurchase activity as it is derived based on program characteristics determined at the outset of the program and is not impacted by prior returns.

[9] Outlined in Section 4.2.1
[10] Outlined in Section 4.2.1

Remaining Volume therefore sidesteps reverse causality. In sum, using three alternative specifications to investigate the relationship between repurchase activity and efficiency enhances the robustness of results.

4.3.1 Measures of Price Efficiency and Idiosyncratic Risk

The measures of informational efficiency I employ in this study are price delay as advocated by Hou and Moskowitz (2005) and idiosyncratic risk as proposed by Bris, Goetzmann and Zhu (2007).

The first group of measures focuses on price delay and assess the explanatory power of lagged returns in an extended market model relative to a base model to quantify how speedily and accurately systematic information is incorporated into prices (Busch & Obernberger, 2016). In line with the methodology of Boehmer and Wu (2013) and Philips (2011), I construct two measures using daily stock returns instead of weekly or monthly returns as daily returns increase the number of observations and diminish potential observation errors. Unlike the aforementioned authors I use five lagged market returns instead of four lagged returns for the extended market model to cover all trading days in a week (Busch and Obernberger, 2016). In sum, the base market model (2) and extended model (3) estimated through OLS for each firm and each month are as follows:

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

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

where $R_{i,t}$ is the daily return on stock *i*, $R_{m,t}$ is the daily return on the AEX All Share value-weighted index (a proxy for market return) and $R_{m,t-n}$ represents the lagged market returns. The key interpretation of both models is that the coefficient for concurrent market return β_i^0 reflects whether all new information available is incorporated directly into a company's stock price. If there is a delay in the incorporation of information into stock prices one observes a coefficient for lagged market returns β_i^n that is significantly different from zero in the extended model. In the latter case, the extended model (4) will have higher explanatory power than the base model (3). The two price delay measures are derived by using the regression estimates of the base and extended model. The first measure is simply one minus the ratio of the R^2 of the base model over the R^2 of the extended market model:

$$Delay = 1 - \left[\frac{R^2_{base}}{R^2_{extended}}\right] \qquad (5)$$

If new information is assimilated into stock prices rapidly due to higher price efficiency, the value of *Delay* decreases. In other words, both models have similar explanatory power exhibited by comparable R^2's. Therefore, the right side of the equation above is close to zero. The alternative measure for price delay is similarly derived from the base and extended market model. However, this measure quantifies the delay based on the coefficients of both models:

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

This measure is the ratio of the lag-weighted sum of the absolute (abs) coefficients of the lagged market returns (numerator) over the sum of all coefficients divided by the standard errors. This coefficient-based measure also declines as price efficiency increases. This second delay measure is included as the first delay measure does not capture the precision of the regression estimates nor does it control for the time-weighting of lags (Hou and Moskowitz, 2005). In effect, the second measure allows one to distinguish between shorter or longer lags.

The second group of price efficiency measures considers the impact that repurchases might have on a stock's idiosyncratic risk. According to Bris, Goetzmann and Zhu (2007), there are two measures that quantify how much idiosyncratic risk is incorporated into stock prices: R^2 and absolute *Market Correlation.* Both measures approximate the degree of co-movement between an individual firms' stock returns and the market return. In line with Busch and Obernberger (2016), I estimate R^2 and *Market Correlation* using daily returns for each month. For the first measure, I use the R^2 of the Base model in Equation (3).

4.3.2 Additional Variables

To better capture the relationship between price efficiency and share repurchases I include various controls into my regressions. The *Controls* considered in this investigation can be observed in Table A2 of the Appendix. The coefficients for the incorporated control variables are expected to be realistic and in line with previous work. Like Busch and Obernberger (2016) a control for the month in which the repurchase program begins is added to ensure that the results are not impacted by announcement effects. Appendix Table A2 outlines all variables used in this study, how these variables were constructed as well as the sources used to retrieve the relevant data.

Relative Spread is a control measure for liquidity[11] included in this study. One controls for liquidity when studying actual share repurchases, as liquidity influences how firms execute share repurchase programs (Hillert, Maug, & Obernberger, 2016). Thus, using this measure enhances the investigation of the impact of actual share repurchases on the informational efficiency of share prices. For each firm the daily *Relative Spread* is computed in a similar manner as Busch and Obernberger (2016). Note that their *Relative Spread* measure relies on the extraction of intraday trade data from the NYSE TAQ database. Intraday data on trades is not available for the Netherlands, hence in this context *Relative Spread* is computed on a daily basis. In particular, *Relative Spread* is computed as:

$$RelativeSpread_t = \frac{A_t - B_t}{Q_t} \quad (7)$$

Where A_t reflects the prevailing ask quote, B_t reflects the prevailing bid quote and Q_t represents the midpoint quote. The midpoint quote is calculated as the average of the prevailing ask and bid quotes ($Q_t = \frac{A_t + B_t}{2}$). All the required data for this measure is retrieved from Thomson DataStream.

4.4 Event Study Methodology

The second part of my empirical analysis consists of some additional tests geared towards assessing whether distinctive repurchase motivations have a differential impact on price efficiency. To investigate this, I use a two-step approach. First, I investigate the abnormal returns surrounding the announcement of a repurchase program using an event study methodology and sub-divide these announcement returns into categories based on the stated motivation for a repurchase program. This approach allows me to investigate how information embedded in the stated motivation affects announcement returns. Next, I employ an adjusted specification of my fixed-effects model (outlined above) to determine how sub-sets of repurchases based on stated motivations interact with repurchase activity and whether these motivations have a differential impact on price efficiency.

The objective of an event study is to examine if new (company specific) information is incorporated into the stock price in one single jump upon a public release (Mitchell & Netter, 1994). In this thesis the public release refers the announcement of a share repurchase program. One key element of an event study is that the event is clearly defined and that the information becomes public at a single moment (MacKinlay, 1997). Ball and Brown (1968)

[11] For a thorough analysis of the relationship between liquidity and actual share repurchases please refer to Hillert, Maug and Obernberger (2016).

for instance examine the information content of earnings announcements. Furthermore, Fama, Fisher, Jensen and Roll (1969) study the effects of stock splits. Both these papers study a clearly defined event and assess how information encapsulated in these events affect stock prices in the short run. Studying the incorporation of information into stock prices in this manner implies that an event study is a study of price efficiency.

The first step of an event study is to define a day "zero" or event date which represents the day information is released. In this case the event date is the share repurchase program announcement date. Next, one must calculate the daily returns for stock *i* for a particular timeframe surrounding the event date. These returns reflect the actual returns for stock *i.* These actual returns can be subdivided into the expected returns in the absence of an event (normal returns) and the returns caused by an event (abnormal returns) as can be observed in Equation 8 below:

$$R_{i.t} = E(R_{i.t}) + AR_{i.t} \quad (8)$$

where $R_{i.t}$ represents the actual daily return on stock *i,* $E(R_{i.t})$ represents the normal return for stock *i,* and $AR_{i.t}$ represents the abnormal return of stock *i.* To determine the abnormal returns, one must rearrange the actual returns as observed in Equation 9 and estimate the normal return:

$$AR_{i.t} = R_{i.t} - E(R_{i.t}) \quad (9)$$

Various techniques exist to compute the normal return. This thesis uses the market model, whereby a proxy for market return is used to estimate the normal return. This methodology is in line with previous research on repurchase announcements (cf. e.g. Peyer and Vermaelen, 2008; Grullon and Michaely, 2004, Ikenberry, Lakonishok and Vermalen, 1995). In particular, I use the market model parameters of the daily return on the AEX All Share index as a proxy for normal return:

$$E(R_{i.t}) = b_0 + b_1 * (R_{m.t}) \quad (10)$$

Plugging Equation (10) into Equation (9) yields:

$$AR_{i.t} = R_{i.t} - (b_0 + b_1 * (R_{m.t})) \quad (11)$$

Once the abnormal return has been estimated, one must calculate the daily average abnormal returns over all *N* events (repurchase programs) in the sample:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t} \quad (12)$$

Where AAR_t is the average abnormal return across all events on day *t* and *N* is the number of events. Subsequently, one can compute the cumulative average abnormal return by adding up individual average abnormal returns for separate timeframes. This thesis considers the 30 days surrounding a repurchase program announcement. I use this particular time-frame for two reasons. First, it has been observed that it is difficult to control for overlapping effects when longer time-frames are used (McWilliams & Siegel, 1997). Second, using very long time frames, considerably reduces the power of the test statistic (Brown & Warner, 1980). In line with Zhang (2005), I separate these 30 days into three particular time-frames: the pre-event returns, the event-window returns and the post-event returns. The pre-event returns refer to the 15 days until the 3 days before the announcement denoted as [-15:-3]. The event-window returns refer to either the 2 days before until the 2 days after or the 1 day before until 1 day after the announcement respectively denoted as [-2:+2] or [-1:+1]. These two particular event-window frames are consistent with most literature on share repurchase announcement returns (cf. e.g. Peyer and Vermaelen (2008); Zhang (2005); Grullon and Michaely (2004)). The great advantage of using a small event window is that it accounts for the possibility of leakage in the days before the event and it overcomes issues associated with determining the event date accurately. Regarding the latter, sometimes announcements are made post-closing or pre-opening of a trading day, which makes it difficult to pinpoint the right announcement date (MacKinlay, 1997). As a consequence, event studies often include the day(s) before and after the event date to control for these issues. Lastly, the post-announcement returns refer to the 3 days until the 15 days after the announcement of the repurchase program and is denoted as [+3:+15]. The calculation of the cumulative average abnormal returns for these three timeframes is as follows:

$$CAAR_T = \sum_{t=t}^{T} AAR_t \quad (13)$$

where $CAAR_T$ is the cumulative average abnormal return over time period T. I use this event study methodology for my sample as a whole and subsequently redo the analysis for various sub-samples, categorized on the basis of the stated motivation for a repurchase program.

Event studies however pose various key limitations. In particular making statistically and economically correct inferences based on event studies are conditional on three factors: i) markets are at least somewhat efficient ii) the event was unanticipated, otherwise no new information would come to the market iii) there are no conflicting events within the event

windows that could affect results (McWilliams & Siegel, 1997). Hence, conclusions can only exhibit some validity if these three issues have been taken into account. Various papers have documented that stock prices in the Netherlands display at least some degree of efficiency (cf. e.g. Chan, Gup, & Pan, 1997; Worthington and Higgs, 2004). I extend this assumption to my sample period and further assume that stock-related information technology has improved over time, thus on average stock prices should adequately reflect (available) information. Whether the event is entirely unanticipated is hard to determine as some leakage may occur prior to the event. To limit the impact of this leakage I limit the event window to 3 days and 5 days surrounding the announcement. To ensure that there are no confounding events, I use two particular procedures. First, regarding share repurchase announcements there are two types of announcements: 1. announcements of the intention to repurchase shares outlined in a firm's (quarterly or annual) reports and 2. explicit announcements (usually press releases) regarding the actual start of the program. The former type of announcement merely reflects a firm's intention to repurchase shares, thus the firm does not have to commit itself to a share repurchase program. In addition, this type of announcement is often released together with other firm-specific information such as earnings announcements, which would represent a confounding event. This type of share repurchase announcement is therefore omitted from investigation. Instead, I only focus on the latter type. In this thesis, the announcement date therefore refers to the first publication date of a press release explicitly regarding the start of a share repurchase program. Second, I limit the event study window to the 30 days surrounding a share repurchase announcement. I do this to ensure that previous or subsequent share repurchase announcements by the same firm do not affect results (refer to Appendix Table A3 for announcement dates).

4.5 Descriptive Statistics

Table 2 below presents the summary statistics for the main variables used in the analysis of share repurchases, and is restricted to only consider repurchasing firms' data. Panel A discusses the descriptive statistics for the fixed effects models and Panel B discusses the descriptive statistics for the event study methodology. I first consider Panel A.

My sample considers a total of 2,713 firm months. Repurchase programs cover 491 of these firm-months and firms actually conduct share repurchases in 444 of these months. In effect, in 91% of the open program months firms actually repurchase shares. One can therefore infer that Dutch firms are relatively frequent repurchasers. The first two measures for price efficiency are *Delay* and *Coefficient-based Delay*. Consistent with the original

specification of the two variables by Hou and Moskowitz (2005), *Delay* ranges between 0 and 1, whereas *Coefficient-based Delay* is strictly defined between 0 and 5. Both variables exhibit similar means and medians, which implies that their distributions are not skewed. Moreover, the values and distributions for *Delay* and *Coefficient-based Delay* are comparable in magnitude to the delay measures employed by Busch and Obernberger (2016). Like the *Delay* measure, the *R-squared* and |*Market Correlation*| measures are defined between 0 and 1. These two measures too display non-skewed distributions as exhibited by comparable means and medians.

In the 444 repurchase months, the mean *Repurchase Volume* equals €37.8 million. This amount corresponds to the repurchase of 0.41% of outstanding shares (median: 0.26%) or alternatively represents an average of 6.34% of the total monthly trading volume (median: 3.88%) of the repurchasing firms. Busch and Obernberger (2016) found that the average *Repurchase Volume* in repurchase months equals $49.3 million. When converting this amount to Euro's for that particular timeframe, the repurchase volumes are approximately the same for both countries. The average *Remaining Volume* is equivalent to 3.38% of the per firm total amount of shares outstanding at the start of the program. In comparison, I find an average *Remaining Volume* that is significantly lower than Busch and Obernberger (2016) as they observe a mean of 6.90% of shares outstanding. This difference is attributable to the shareholder approval requirement in the Netherlands, which expires after 18 months. The implication is that on average firms in the Netherlands should repurchase relatively more shares in a shorter period of time. The fact that I observe a lower *Remaining Volume* in the Netherlands substantiates this intuition. Moreover, a repurchase program (Program Month) extends on average over a period of 8 months and the average Program Size equals approximately 4.13% (median: 2.66%) of the total number of shares outstanding for the sample under investigation. Busch and Obernberger (2016) found that the average program extended over a period of 16 months, more than double the period I observe. This difference is also attributable to the shareholder approval requirement expiring after 18 months. I further find that the average program completion rate equals 57.83% after 12 months, 66.81% after 18 months and 74,42% after 24 months[12]. Stephens and Weisbach (1998) report 54.10%, 68.70% and 73.80% completion rates for 1, 2 and 3 years after a program was first announced. Moreover, the average completion rates found by Busch and Obernberger (2016) are 45.53% (after 1 year), 53.17% (after 2 years) and 59.13% (after 3 years). Unlike these

[12] I omit completion rates after 36 months as only one repurchase program in my final sample extends over 36 months.

two articles, I report the completion rate after 18 months to capture the impact of the shareholder approval requirement. One would expect relatively high completion rates after 18 months, as firms push to complete repurchase programs instead of awaiting renewed shareholder approval. My results confirm this intuition as I find higher completion rates compared to the aforementioned papers. I furthermore find that the average completion rate for the overall sample is 92.15%[13]. This indicates that firms in the Netherlands are relatively committed to carrying out a repurchase program. One might argue that the shareholder approval requirement in the Netherlands, which encompasses additional work and preparation for management and enhanced inquiry from shareholders, induces greater dedication for firms to actually repurchase shares. This is because not repurchasing shares within a repurchase program would entail a loss of credibility for management and could ultimately decrease the likelihood of receiving shareholder approval for subsequent repurchase programs.

The descriptive statistics for the control variables also highlight various interesting aspects of the Dutch stock market and share repurchase environment. In general, I find that most control variables have comparable means and medians. This implies that, on average, the distributions are non-skewed. Two key exceptions are *Market Capitalization* and *Total Assets*: in both cases I observe a mean that is significantly larger than the median. This highlights a right-skewed distribution. This means that most firms in my sample are relatively small (left side of the distribution) with several very large firms (right side of the distribution). To ensure that this skewness does not impact my regression results I perform a natural logarithmic transformation to these variables. For other variables that similarly exhibit some skewness I perform the same transformation (refer to Appendix Table A2). Furthermore, I report that the mean *Cash-to-Assets* for the sample under consideration is 10.13%, whereas Dittmar and Field (2015) find 19.50% for the same measure. This result seemingly indicates that repurchasing firms in the US have more cash on hands (as a percentage of total assets) and potentially use this (excess) cash to repurchase shares. Peyer and Vermaelen (2008) provide some evidence for this idea as they find that distribution of cash is the second most popular reported motivation for conducting a repurchase program in the US. Second, I find that the *Dividends-to-Assets* measure has a mean of 1.63% for th e Netherlands compared to 0.92% for the US (Busch & Obernberger, 2016). This implies that on average Dutch repurchasing firms pay higher dividends as a percentage of total assets than

[13] When limiting maximum completion rate to 100%. If I do not impose this limit average completion rate is 95.22%

Table 2: Descriptive Statistics. This table provides descriptive statistics for all efficiency measures (the dependent variables), repurchase variables, abnormal returns and control variables of all Dutch firms with at least one open market repurchase program between the 1st of January 2008 and the 31st of December 2016. Panel A considers the descriptive statistics for the fixed effects models and Panel B displays the results for abnormal returns on the announcement date as well as for the 30 days surrounding the announcement date (full sample). Moreover, Panel A provides specific information regarding the characteristics of repurchase programs in repurchase months. The specification of all variables is found in Appendix Table A2. Please note that none of the variables is expressed as a natural logarithm. In Panel A and B, I report the arithmetic mean, the median, the standard deviation and the 1st and 99th percentile of the distribution for each variable. Additionally, Panel A also reports the within firm standard deviation, whereas Panel B also considers the number of positive and negative abnormal returns.

Panel A

Variable	Mean	Median	SD	SD (within)	1st Perc.	99th Perc.	Observations
Dependent Variables							
Delay	0.405	0.359	0.296	0.260	0.020	0.999	2,713
Coefficient-based Delay	1.780	1.738	0.613	0.565	0.606	3.324	2,713
R-squared	34.30%	32.24%	23.97%	20.60%	0.03%	84.90%	2,713
|Market Correlation|	0.534	0.568	0.240	0.225	0.018	0.921	2,713
Repurchase measures							
Repurchase Volume (mln)	6.0	0.0	2.4	2.2	0.0	54.45	2,713
Repurchase Intensity	0.02%	0.00%	0.08%	0.08%	0.00%	0.04%	2,713
Repurchase Intensity (TV)	0.34%	0.00%	1.25%	1.23%	0.00%	6.98%	2,713
Remaining Volume	0.22%	0.00%	1.02%	1.00%	0.00%	4.47%	2,713
Repurchase measures in repurchase months							
Repurchase Volume (mln)	37.8	27.6	48.6	32.4	0.0	285.1	444
Repurchase Intensity	0.41%	0.26%	0.59%	0.32%	0.00%	1.17%	444
Repurchase Intensity (TV)	6.34%	3.88%	9.01%	5.61%	0.00%	62.90%	444
Remaining Volume	3.38%	3.76%	2.48%	2.80%	0.00%	18.64%	444
Program characteristics							
Program Month	8	6	6.87	5.25	1	34	68
Program Size (scaled)	4.13%	2.66%	4.84%	3.10%	0.13%	24.98%	68
Control variables							
AEX	0.541	0	0.498	0.182	0	1	2,713
Acquiror	0.077	0	0.087	0.082	0	1	2,713
AMX	0.193	0	0.394	0.193	0	1	2,713
Analysts	14.941	13	10.544	3.918	0.000	35	2,713
ASCX	0.129	0	0.394	0.186	0	1	2,713
Book-to-Market	0.590	0.498	0.388	0.364	-0.357	1.897	2,713
Cash-to-Assets	10.13%	7.82%	8.05%	4.18%	0.24%	37.36%	2,713
Dividends-to-Assets	1.63%	1.55%	1.50%	0.96%	0.00%	5.53%	2,713
EBITDA-to-Assets	0.028	0.029	0.019	0.015	-0.041	0.078	2,713
Leverage	0.490	0.475	0.189	0.108	0.056	1.000	2,713
Market Capitalization (mln)	6277.8	2783.8	8053.6	3917.9	26.30	40688.3	2,713
Relative Spread	0.03%	0.01%	2.05%	2.01%	0.00%	9.14%	2,713
Repurchase Dummy	0.159	0	0.365	0.320	0	1	2,713
Return	0.001	0.002	0.005	0.005	-0.014	0.011	2,713
Return>0	0.002	0.001	0.003	0.003	0	0.011	2,713
Return <0	-0.002	0	0.003	0.004	-0.014	0	2,713
Target	0.004	0	0.064	0.060	0	1	2,713
Total Assets	25892.7	6478	69798.9	10475.0	49.2	375988	2,713
Trading Volume (mln)	476.3	206.1	624.4	279.1	0.0	2633.9	2,713
Volatility	0.021	0.017	0.013	0.012	0.006	0.074	2,713

Panel B

Variable	Mean	Median	SD	1st Perc.	99th Perc.	Observations	Positive Observations	Negative Observations
Abnormal Returns (announcement date)	0.44%	0.31%	3.46%	-8.31%	12.39%	68	40	28
Abnormal Returns (full sample)	-0.01%	0.00%	1.99%	-4.99%	5.31%	2108	1049	1048

firms in the United States. This difference was expected as Von Eije and Megginson (2008) report that European firms are more inclined to pay dividends and that the amount of real dividends on a per firm basis has increased. Consequently, the total amounts of dividends paid are higher compared to the US. Additionally, Dutch listed firms are, on average, considered to be value firms with stable long-term cash flows and this characteristic entails that firms have a preference for dividends. Lastly, I observe that the average *Market Capitalization* for my sample is €6277.8 million with a median of €2783.8 million, whereas Busch and Obernberger (2016) report an average market value of $4796.7 million and a median value of $629.0 million. After correcting for exchange rate differences, I can infer that the average firm included in my sample is significantly larger compared to their sample. The key implication of this difference in average firm size relates to the *investor recognition hypothesis.* According to this hypothesis, small and neglected firms tend to be priced inefficiently as they are ignored by investors (Hou & Moskowitz, 2005). This means that information may not be incorporated into share prices sufficiently. These firms could therefore benefit a great deal from repurchasing their own shares to improve price efficiency. As I observe larger firms, the relative impact of repurchases on price efficiency measures might be significantly lower in the Netherlands, which I will discuss in the next section.

Panel B summarizes the abnormal returns both on the announcement date as well as for the 30 days surrounding the announcement [-15:+15]. I find that firms announcing a share repurchase program on average experience a positive abnormal return of 0.44% on the announcement date (in Section 5.5.2 I will elaborate on how this result compares to other papers). This number indicates that in general the market responds positively to share repurchase announcements, which coincides with an excess return for a firm compared to the market return (i.e. abnormal return). This idea is further substantiated by the number of positive abnormal returns (40) on the announcement date compared to negative abnormal return (28). Strikingly, for the full sample [-15:+15] I find that the number of positive and negative abnormal returns are approximately equal. Note that the sum of positive and negative observations does not equal the full sample as in various instances an abnormal return of 0 was documented. I further find a median of 0 and that the 1st percentile equals to -4.99% and the 99% percentile equals 5.31% All these observations combined seemingly indicate that returns are relatively evenly distributed.

5. Empirical Analysis

The analysis section starts with a brief discussion of what factors drive and influence repurchase activity. Subsequently, I empirically test the two key hypotheses postulated above and evaluate how robust the obtained results are. I furthermore conduct additional tests to examine whether distinctive motivations for repurchase programs have a differential impact on abnormal returns and price efficiency. I restrict my analysis to only consider open program months.

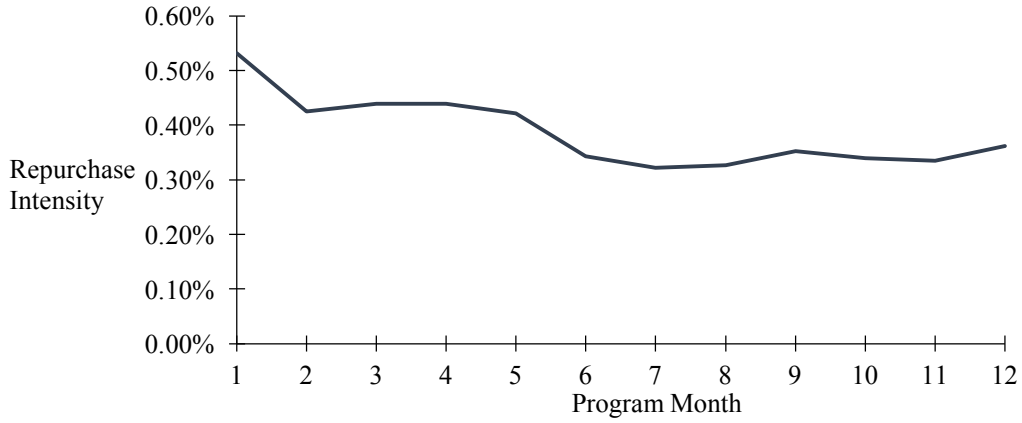
5.1 Analysis of the Repurchase Measures

The analysis of the repurchase measures *Repurchase Intensity* and *Remaining Volume* deals with reverse causality concerns and consists of three parts. First, I investigate the relationship between the repurchase variables and the instruments *Program Month* and *Program Size* as well as determine the relevance of these instruments. Next, in line with Busch and Obernberger (2016) I examine whether lagged *Repurchase Intensity* is a realistic proxy for current *Repurchase Intensity*. Lastly, I assess what (additional) factors drive and influence repurchase activity, by regressing a repurchase measure on a number of control variables. The results of this three-part analysis are reported in Table 3 below.

5.1.1 Analysis of Program Month and Program Size

As a first step in assessing the relationship between *Repurchase Intensity* and the instruments *Program Month* and *Program Size,* I plot *Repurchase Intensity* as a function of *Program Month* in Figure 2. The expectation is that repurchasing firms front-load their trades (Hillert, Maug and Obernberger, 2016). This expectation flows from the models of Almgren and Chriss (2001) and Vayanos (2001). Hillert, Maug and Obernberger (2016) hypothesize that we can view repurchasing firms as risk-averse block traders who wish to buy a great number of shares within a limited time frame. This creates a trade-off for these firms, which dictates trading patterns. In particular, if firms front-load their trades they reduce exposure to the uncertain market price of a stock and increase risk-sharing (Hillert, Maug, & Obernberger, 2016). However, the downturn is that front loading trades prompts a higher adverse price impact (Almgren and Chriss, 2001) or an inefficient exploitation of private information (Vayanos, 2001). According to Hillert, Maug and Obernberger (2016) these observations imply that firms are risk averse and that parametric restrictions prevent firms from optimally manipulating the market over time, which induces front-loading. In effect, one observes a higher *Repurchase Intensity* at the beginning of a program and lower intensities in later

Figure 1: Repurchase Intensity and Program Month. The figure plots *Repurchase Intensity* against *Program Month*. *Repurchase Intensity* is the ratio of the average number of shares repurchased to the number of shares upstanding. *Program Month* is the number of calendar months since the initiation of the repurchase program. The figure uses the average intensity across firms. The sample is restricted to the first 12 months of a repurchase program.



months. *Program Month* would for that reason have a negative effect on repurchase activity. The downward sloping curve observed in Figure 1 below seemingly indicates firms have a moderate tendency to front-load their trades as the *Repurchase Intensity* decreases over time when restricting the sample to the first 12 months[14].

In column (1) and (2) of Table 3, I further investigate the relationship between *Repurchase Intensity* and *Program Month* by adding the instrument *Program Size* as well as control variables. In line with expectations the coefficient on *Program Month* is negative yet it lacks statistical significance after including controls. I therefore cannot establish its relevance as an instrument for *Repurchase Intensity*. Additionally, I find no statistical support for firms front-loading their trades. A potential explanation may be that Dutch firms are in fact relatively less risk averse than Hillert, Maug and Obernberger (2016) assume and thus smooth trades over a program's course. In line with the expectation of Busch and Obernberger (2016) the coefficient on the instrument *Program Size* is positive and highly significant, as a larger *Program Size* induces a higher *Repurchase Intensity* to complete the program. I only establish the relevance of *Program Size* as an instrument. Therefore, I cannot use the combination of the instruments *Program Month* and *Program Size* to predict *Repurchase Intensity* as a means to circumvent the reverse causality concerns.

[14] The sample is restricted to the first 12 months as 58 out of 68 programs do not extend over more than 12 months. Plotting the relationship with the unrestricted sample yields noisy results.

Table 3: Repurchase Activity Analysis. An overview of the OLS-regressions of the repurchase variables (*Repurchase Intensity* and *Remaining Volume)* on *Returns*, the instruments *Program Month* and *Program Size*, lagged *Repurchase Intensity* and various control variables in repurchase months. Refer to Appendix Table A2 for variable definitions. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level.

Dependent Variable:	Repurchase Intensity	Repurchase Intensity	Remaining Volume
	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Repurchase Intensity$_{t-1}$		0.3313***	
		(3.31)	
Program Month$_t$ (ln)	-0.0002	-0.0002	-0.0195***
	(-0.39)	(-0.74)	(-5.99)
Program Size$_t$	0.0082***	0.0058***	0.0289
	(7.97)	(5.19)	(-0.60)
Return$_{t-1}$ > 0	-0.1007	-0.0840	-0.0860
	(-1.67)	(-1.67)	(-0.17)
Return$_{t-1}$ < 0	-0.2431*	-0.1833*	0.223
	(-1.79)	(-1.70)	(0.47)
Book-to-Market$_{t-1}$	0.0041***	0.0018**	0.0149
	(5.24)	(2.30)	(0.84)
Total Assets$_{t-1}$ (ln)	-0.0004**	-0.0003**	0.0001
	(-2.17)	(-2.49)	(0.07)
Cash-to-Assets$_{t-1}$	0.0045	0.0032	0.0968*
	(1.30)	(1.17)	(1.83)
EBITDA-to-Assets$_{t-1}$	0.0237	0.0127	0.5570**
	(0.97)	(0.76)	(2.64)
Dividends-to-Assets$_{t-1}$	-0.0044	-0.0062	0.0994
	(-0.33)	(-0.50)	(0.39)
Leverage$_{t-1}$	0.0028	0.0031	-0.0119
	(1.08)	(1.47)	(-0.79)
Acquiror Dummy$_t$	-0.0021***	-0.0019***	-0.0011
	(-5.60)	(-6.43)	(-0.42)
RelativeSpread$_{t-1}$ (ln)	0.0001	0.0001	0.0021**
	(0.79)	(0.66)	2.67
Constant	0.0016	0.0027*	0.0438**
	(1.02)	(1.93)	(2.74)
R^2 (within firm)	0.2016	0.2893	0.3036
Observations	480	480	470
Firm FE and Month FE	Yes	Yes	Yes

5.1.2 A Proxy for Repurchase Intensity

Busch and Obernberger (2016) argue it would be more difficult to obtain significant results for the hypotheses under investigation if lagged *Repurchase Intensity* were a weak proxy for current *Repurchase Intensity*. Hence, they add a lagged dependent variable to their regression analysis of repurchase activity. Similarly, I add a lag for *Repurchase Intensity* in Column (2) of Table 3 to evaluate whether the lagged measure is appropriate as a proxy for repurchase activity. Like Busch and Obernberger (2016), I control for firm fixed effects and I find a positive and highly significant coefficient of approximately 0.3 for the lagged dependent variable. If lagged *Repurchase Intensity* were a noisy measure, I would have obtained a

coefficient not significantly different from 0. This suggests that the impact of lagged *Repurchase Intensity* is economically highly significant, as firm fixed effects already capture the average effect of *Repurchase Intensity* (Busch & Obernberger, 2016). Busch and Obernberger (2016) further argue that if firms only repurchase occasionally and spread these repurchases arbitrarily, lagged *Repurchase Intensity* might not be an appropriate proxy for exogenous variation. In section 4.5 however, it was established that in 91% of all program months Dutch firms repurchase shares. I can therefore infer that on average firms repurchase frequently, which further supports the premise that lagged *Repurchase Intensity* is an appropriate proxy. The significance of the lagged dependent variable coincides with a higher explanatory power of the model as the R^2 (within firm) increases from 20% to 29% between column (1) and (2). The increased explanatory power therefore means that the estimated lagged *Repurchase Intensity* is a good proxy for current *Repurchase Intensity.*

5.1.3 Further Drivers of Repurchase Activity

The results on the controls for *Repurchase Intensity* in Table 3 are mostly in line with extant literature. As reported by Stephens and Weisbach (1998) and Jagannathan, Stephens and Weisbach (2000), I find that lagged positive returns have no statistically significant impact on *Repurchase Intensity.* In contrast, I only find limited statistical support that prior negative returns drive *Repurchase Intensity* in column (1). A firm's perceived value (book-to-market ratio) influences whether or not the firm repurchases more shares. This is because a higher book-to-market ratio, which reflects relative undervaluation, leads to more repurchases. This observation therefore aligns with the *signaling hypothesis* that firms use share repurchase to signal undervaluation (e.g. Wansley, Lane and Sarkar, 1989; D'mello and Shroff, 2000; Zhang, 2005). Furthermore, firm size is inversely related to repurchase activity as evidenced by a negative and highly significant coefficient on *Total Assets.* This is consistent with the notion of smaller firms having greater information asymmetry and that these firms therefore repurchase more shares (Billett & Xue, 2007). Like Busch and Obernberger (2016), I find no statistical evidence that *EBITDA-to-Assets* or *Dividends-to-Assets* drive share repurchases. According to Busch and Obernberger (2016) the insignificant result for dividends corresponds to the view that firms use dividends in addition to repurchases as opposed to as a substitute for repurchases, therefore negating the validity of the *dividend substitution hypothesis*. Strikingly, in contrast to Busch and Obernberger (2016), Bagwell and Shoven (1988) and Wansley, Lane and Sarkar (1989) I do not find that firms use share repurchases as a means to increase a firm's leverage (*optimal leverage ratio hypothesis*). Instead, I observe a

positive and insignificant relationship between leverage and repurchase activity. Not being able to determine statistical significance warrants further examination. Upon further investigation of the dataset I find that 17 of the in total 68 programs under consideration were carried out by firms classified as financial institutions based on ICB codes (refer to Appendix Table A3). Various authors report that financial institutions maintain a highly leveraged capital structure (e.g. Bhagat, Bolton and Lu (2015); Adrian and Shin, (2010); Kashyap, Stein and Hanson (2010); Barber and Lyon (1997); Berger, Herring and Szegö (1995)). Consequently, one might argue that the results for leverage are confounded primarly by the prevalence of financial firms. When omitting financial firms from the dataset the results and significance across most variables, including leverage, remain largely the same (refer to Appendix Table A4). Von Eije and Megginson (2008) reason that higher leverage might actually be a proxy for more mature, stable and profitable blue-chip firms, which can more easily afford share repurchases. Although the positive sign for the coefficient on *Leverage* does suggest this intuition might be the case, I do not find any statistical support to substantiate Von Eije and Megginson's argument. I also control for the potential impact of takeovers on repurchase activity by including dummies[15] for status in a takeover. For the sample period under consideration none of the firms were a target, thus this dummy is omitted as a control. I am only left with a dummy for acquiror status in a takeover. The results indicate a statistically significant negative impact of *Acquiror* on repurchase activity as was previously observed by Busch and Obernberger (2016). A potential interpretation of this result may be that acquiring firms refrain from deploying company resources to repurchase shares and instead focus on the (potential) takeover.

I also consider *Remaining Volume* as a measure for repurchase activity in Column (3) of Table 3. *Remaining Volume* follows the original specification by Busch and Obernberger (2016) and is denoted as the remaining number of shares that can be repurchased under a program at the beginning of a certain month divided by the number of shares outstanding at the start of the program. In line with my results for *Repurchase Intensity* both instruments come in with the right sign. However, for *Remaining Volume* I find that *Program Month* is highly significant, whereas *Program Size* is not significant. The results for *Program Month* are intuitive as the specification of *Remaining Volume* implies that fewer shares can be repurchased as the program progresses, hence one observes a significant negative coefficient on *Program Month.* In contrast, the relation between *Program Size* and *Remaining Volume*

[15] The dummy equals one from the announcement date until the effective completion or withdrawal date in a takeover

does not yield statistical support. The coefficients on the lagged returns in column (3) are both insignificant. The number of shares that can still be repurchased under a repurchase programs are therefore not driven by prior returns. Busch and Obernberger (2016) reason this result is intuitive as a firm can always initiate an additional repurchase program if required. Moreover, the authors argue this result entails two benefits for *Remaining Volume* compared to *Repurchase Intensity* as a measure of repurchase activity. First, one of the key issues one might observe is a co-movement between *Remaining Volume* and an informational efficiency measure, if both are driven by previous returns (Busch & Obernberger, 2016). However, as *Remaining Volume* is not impacted by previous returns, the concern for co-movement dissolves. Second, Busch and Obernberger (2016) conclude that the number of shares to be repurchased (or Euro volume) is fixed at the outset of the program and the subsequently derived *Remaining Volume* measure is therefore precluded from reverse causality concerns. For most other controls included I find insignificant results. I find limited statistical support that *Cash-to-Assets* has a positive impact on *Remaining Volume*, which implies that higher cash increase the volume of shares that can be repurchased in the next period. Furthermore, the coefficient on *EBITDA-to-Assets* is positive and statistically significant which entails that in line with Jensen's (1986) *free cash flow hypothesis*, firms can repurchase greater share volumes in the next month if they have stronger cash flows in the current month. I find no statistical support that a firm's leverage is inversely related to *Remaining Volume.* Lastly, the impact of liquidity (*Relative Spread)* on *Remaining Volume* is statistically significant and positive, which indicates that higher liquidity increases the volume that can be repurchased in the next month. This observation is in line with Hillert, Maug and Obernberger (2016) who find that repurchase volumes react strongly to changes in a stock's liquidity as a result of firms engaging in liquidity timing.

I also estimate a Tobit censored regression model as a robustness check for the three specifications above. Table A5 in the Appendix reports the results. The results are qualitatively analogous. Compared to the OLS results the statistical significance of the repurchase variables improves. The coefficients on *Program Month, Program Size* and lagged *Repurchase Intensity* come in with the right sign. *Program Month* is significant in Column (2) and Column (3). Furthermore, I find that *Program Size* is statistically significant across all specifications. Similarly, I find that lagged *Repurchase Intensity* is statistically different from zero, thereby reducing the possibility of it being a noisy measure (Busch & Obernberger, 2016).

5.2 Repurchases and the Informational Efficiency of Share Prices

Table 4 presents the regression results for the impact of repurchase activity on price efficiency. Columns (1) and (2) outline the results for Delay, whereas Columns (3) and (4) report the results for Coefficient-based Delay. Moreover, in Columns (1) and (3) I use lagged Repurchase Intensity as a proxy for repurchase activity and in Columns (2) and (4) I use Remaining Volume as an alternative measure for a firm's repurchase activity.

I find mixed results for the impact of actual repurchase on price efficiency, dependent on the proxy for repurchase activity I use. Both measures of repurchase activity display the right sign. However, I find that lagged *Repurchase Intensity* improves price efficiency, whereas *Remaining Volume* merits no statistically significant impact on price efficiency. Strikingly, I find relatively large coefficients (factor 8-10 increase) for all measures of repurchase activity compared to Busch and Obernberger (2016). Two potential explanations for this disparity exist. First, Busch and Obernberger (2016) argue that a potential reason for why they observe very small coefficients for lagged *Repurchase Intensity* is that it potentially represents a noisy measure of contemporaneous repurchase activity, which therefore biases estimates towards zero. As I observe significantly larger coefficients for lagged *Repurchase Intensity*, I might deduce that this measure is not as noisy for the Netherlands. This intuition warrants some validity as Busch and Obernberger (2016) suggest that the noise of this measure increases if firms repurchase sporadically and spread these repurchases arbitrarily. In my sample I observe that, on average, firms repurchase in 91% of the open program months, I therefore find some evidence to validate that lagged *Repurchase Intensity* might not be a noisy measure within my research setting. This however does not explain why I also observe larger coefficients for *Remaining Volume* compared to their study. Hence, another explanation might be more relevant. A comparison of the two research designs reveals another compelling explanation. In particular, a more appropriate clarification for the difference in magnitude compared to these authors is that I limit my analysis to only consider open program months. Whereas Busch & Obernberger (2016) extend their analysis to consider all firm-months for repurchasing firms between 2004-2010. Limiting the scope of the analysis to program months entails that the relative impact of repurchase activity measures is likely to be larger. In section 5.6.4 I extend my analysis to consider firm-months and examine whether the size and significance of the coefficients changes. In Column (1) under the assumption of *ceteris paribus,* increasing lagged *Repurchase Intensity* by one within firm standard deviation reduces *Delay* by 0.0312 percentage points

Table 4: The Impact of Repurchases on Delay. This table outlines the OLS regressions of *Delay* and *Coefficient-based Delay* on the repurchase measures *Repurchase Intensity* or *Remaining Volume* and various control variables. In specification (1) and (2) the dependent variable is Delay, whereas in specification (3) and (4) the dependent variable is Coefficient-based Delay. In specification (1) and (3) the repurchase variable constitutes the previous periods' *Repurchase Intensity*. In specification (2) and (4) *Remaining Volume* is used as a measure of repurchase activity. Refer to Appendix Table A2 for variable definitions. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level.

Dependent Variable:	Delay		Coefficient-based Delay	
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
Repurchase Intensity$_{t-1}$	-9.7576***		-16.7904**	
	(-2.70)		(-2.47)	
Remaining Volume$_{t}$		-0.4278		-0.5758
		(-1.03)		(-1.00)
Delay$_{t-1}$	0.0241	0.0045		
	(0.49)	(0.09)		
Coefficient-based Delay$_{t-1}$			-0.0817*	-0.0972*
			(-1.94)	(-2.02)
Program Initiation$_{t}$	-0.0161	0.0331	-0.0288	0.0142
	(-0.24)	(0.68)	(-0.15)	(0.13)
Return$_{t-1}$ > 0	4.8955	1.9744	16.5165	7.2064
	(1.05)	(0.34)	(1.37)	(0.54)
Return$_{t-1}$ < 0	2.2189	6.6417	-0.9844	7.7819
	(0.40)	(1.52)	(-0.09)	(0.71)
Book-to-Market$_{t-1}$	-0.0587	-0.0269	-0.0523	-0.1374
	(-0.60)	(-0.22)	(-0.25)	(-0.57)
Market Capitalization$_{t-1}$ (ln)	-0.1244***	-0.0807**	-0.2554***	-0.2347***
	(-3.67)	(-2.10)	(-3.75)	(-3.14)
RelativeSpread$_{t-1}$ (ln)	0.0098*	0.0155***	0.0304***	0.0353***
	(1.86)	(4.27)	(2.97)	(3.42)
Volatility$_{t-1}$ (ln)	-0.0523	-0.1011**	-0.0772	-0.1654
	(-1.12)	(-2.09)	(-0.77)	(-1.47)
Analysts$_{t-1}$ (ln)	0.0630	-0.0267	0.1157	-0.0105
	(1.49)	(0.65)	(1.19)	(-0.12)
Trading Volume$_{t-1}$	-0.0001**	-0.0001***	-0.0001**	-0.0001**
	(-2.10)	(-3.23)	(2.45)	(-2.23)
AEX$_{t}$	-0.1137	-0.2843	-0.3444	-0.5702
	(-0.95)	(-1.67)	(-0.90)	(-1.58)
AMX$_{t}$	-0.1577	-0.1218	-0.2073	-0.4488
	(-1.69)	(-0.83)	(-0.63)	(-1.42)
ASCX$_{t}$	-0.0341*	-0.0296*	-0.1258**	-0.0966**
	(-1.79)	(-1.71)	(-2.50)	(-2.14)
Constant	1.2829***	1.9584**	3.9594***	2.963***
	(3.65)	(2.34)	(6.39)	(3.47)
R^2 (within firm)	0.0523	0.0455	0.0389	0.0434
Observations	481	464	479	463
Firm FE and Month FE	YES	YES	YES	YES

(= 0.0032 x -9.7576: SD (within) of *Repurchase Intensity* from Table 2 x *Repurchase Intensity*$_{t-1}$ coefficient from Table 4 Column (1)). This corresponds to 8.70% of median *Delay* (=0.0312/0.359, where 0.359 is the median *Delay* in Table 2). This result is therefore both statistically and economically significant. Moreover, it entails a stronger effect of actual repurchases (as proxied by lagged *Repurchase Intensity*) on price efficiency than reported by Busch and Obernberger (2016). Busch and Obernberger (2016) find that predicted *Repurchase Intensity* reduces Delay by 0.0227 percentage points. Note that I consider the lagged *Repurchase Intensity*, whereas Busch and Obernberger (2016) consider the economic impact of the predicted *Repurchase Intensity* using instruments for *Program Month* and *Program Size.* My results for *Delay* extend to *Coefficient-based Delay* as is exhibited in Column (3). Increasing lagged *Repurchase Intensity* by one within firm standard deviation reduces the *Coefficient-based Delay* by 0.0537 percentage points (SD (within) of *Repurchase Intensity* from Table 2 x *Repurchase Intensity*$_{t-1}$ coefficient from Table 4 Column (3) = 0.0032 x -16.7904). Hence, lagged *Repurchase Intensity* also improves price efficiency when controlling for the time-weighting of lags, as *Coefficient-based Delay* distinguishes between shorter and longer lags (refer to Section 4.2.1). According to Busch and Obernberger (2016) *Remaining Volume* precisely captures a firm's ability to repurchase shares. Moreover, they argue that *Remaining Volume* is a suitable proxy to assess a firm's ability to intervene in the stock market when prices drop below a share's intrinsic value (Busch & Obernberger, 2016). Nevertheless, despite obtaining the predicted sign for *Remaining Volume*, I cannot establish a statistically significant impact on price efficiency. This result holds for both *Delay* and *Coefficient-based Delay*.

In conclusion, I find some statistical support that share repurchases indeed increase the speed and accuracy with which stock prices incorporate information in program months (Hypothesis 2). The impact ultimately depends on the measure for repurchase activity used. This implies that to some extent repurchases induce both higher price efficiency and higher information content of stock prices. My results therefore partly align with the results obtained by Busch and Obernberger (2016). Alternatively, if share repurchases would manipulate stock prices I would observe a higher price delay as opposed to a lower price delay. My results therefore reject the idea of stock price manipulation.

My results for the control variables are realistic and largely corroborate conclusions from previous literature. The results generally hold across all specifications. Like Philips (2011) I find that *Book-to-Market* comes in with the right sign and lacks statistical significance. I include the dummy *Initiation*, which indicates the month a program was

started to control for announcement effects. However, unlike previous authors I am unable to establish a statistically significant positive relationship with announcement effects (cf. e.g. Dittmar and Field, 2015; Peyer and Vermaelen, 2008). Consequently, in a subsequent section I will provide an in-depth analysis of the announcement effects by considering abnormal returns surrounding a program announcement (refer to Section 5.5.1). Furthermore, I find a statistically significant inverse relationship between size (proxied by *Market Capitalization*) and *Delay*. This result corresponds with the *investor recognition hypothesis* posed by Hou and Moskowitz (2005). In effect, large firms receive more coverage and are more visible compared to smaller firms and are therefore neglected less by investors (Hou & Moskowitz, 2005). As a result, larger stocks require less time to adequately incorporate new information into their price and thus experience smaller price delays. According to Hou and Moskowitz (2005) the *investor recognition hypothesis* also holds for liquidity; more recognized firms tend to have more liquid stock and therefore incorporate information more rapidly (smaller price delays). My results substantiate this idea as I find that illiquidity (a higher *Relative Spread*) increases price delay. Likewise, Philips (2011) finds a positive relationship between illiquidity and price delays in the context of short selling. I observe that higher *Volatility* coincides with a lower *Delay* across all specifications, albeit that I only find statistical support in Column (2). This relationship was previously also observed by Busch and Obernberger (2016). Boehmer and Wu (2013) investigate the relationship between short selling and price efficiency and further document the impact of certain firm characteristics on efficiency. Among these characteristics they investigate the number of *Analysts* and *Trading Volume*. As can be observed, I find no statistically significant relationship for *Analysts* in any of the columns, I therefore cannot establish its relevance in this context. Boehmer and Wu (2013) further find that stock prices are more accurate when investors are more active. This result entails an inverse relationship between price delays and *Trading Volume* (a measure for investor activity) or the delay is smaller when trading volume is higher. My results align with this as I indeed observe a statistically significant negative impact of *Trading Volume* on price delay across all specifications. Lastly, I examine the impact that index inclusion has on price delays. To address this, I include three dummies, one for each Dutch stock index (AEX, AMX and ASCX). Firms are included in an index based on free-float market capitalization and liquidity conditions (Euronext, 2017). As my study considers all Dutch listed firms I automatically circumvent a potential dummy trap by not including a dummy for firms that are listed but are not included in an index. The results for the dummies must therefore be interpreted in relation to listed non-index firms. The expectation is that *AEX* is (relatively)

inversely related to price delays compared to listed non-index firms, whereas *ASCX* is also (relatively) inversely related to *Delay,* but the magnitude of this effect is smaller than for *AEX*. The reasoning is that the largest, most liquid firms are included in the AEX and the smaller, less liquid firms are included in the ASCX. However, firms included in both indices should still experience a negative impact on *Delay* compared to listed non-index firms. My results align with expectations as I find that the all three dummies have a negative coefficient. I can however only establish a statistically significant relationship for *ASCX*. This seemingly indicates that the impact of index inclusion on *Delay* is strongest when firms are included in the *ASCX*. These observations further corroborate the *investor recognition hypothesis*, as these small firms now receive relatively more coverage and therefore experience a stronger improvement in price efficiency (Hou & Moskowitz, 2005).

5.3 Repurchases and Idiosyncratic Risk

This section analyzes the regression results in relation to one aspect of Hypothesis 2, namely that share repurchases increase the accuracy by which information is incorporated into stock prices. To examine this, I analyze the impact that share repurchases have on a stock's idiosyncratic risk. If managers only use share repurchases to drive stock prices above intrinsic value, the idiosyncratic risk (information content) of a stock increases (decreases). Instead if the idiosyncratic risk decreases as Hong, Wang and Yu (2008) suggest, firms may actually increase the accuracy by which information is incorporated into stock prices. In Table 5, I analyze *R-squared* in Column (1) and (2) and *Market Correlation* in Column (3) and (4).

Again, I find mixed results for the impact of actual repurchases on idiosyncratic risk, dependent on the proxy for repurchase activity I use. Both measures of repurchase activity display the right sign. However, I only establish a statistically significant relationship between lagged *Repurchase Intensity* and idiosyncratic risk. In Column (1), *ceteris paribus*, an increase by one within-firm standard deviation increases the *R-squared* by 0.0256 percentage points (= 0.0032 x 7.9935: SD (within) of *Repurchase Intensity* from Table 2 x $Repurchase\ Intensity_{t-1}$ from Table 5 Column (1)). This corresponds to 7.93% of median *R-squared* (=0.0256/0.3224, where 0.3224 is the median of *R-squared* from Table 2). I can infer that share repurchases decrease idiosyncratic risk, when using lagged *Repurchase Intensity* as a measure for repurchase activity. In Column (3) I repeat the analysis for lagged *Repurchase Intensity* with absolute *Market Correlation* as a contemporaneity measure. Similarly, I find a statistically and economically significant positive relationship between lagged *Repurchase Intensity* and absolute *Market Correlation*. In particular, increasing lagged *Repurchase*

Table 5: The Impact of Repurchases on R-squared and Absolute Market Correlation. The table outlines the OLS regression results of *R-squared* and *Absolute Market Correlations* on either lagged *Repurchase Intensity* or *Remaining Volume* and a number of control variables. Column (1) and (2) provide the results for R-squared, whereas Column (3) and (4) provide the results for *Absolute Market Correlation*. Specification (1) and (3) use lagged *Repurchase Intensity* as a repurchase activity measure. Specification (2) and (4) use *Remaining Volume* as a repurchase activity measure. Refer to Appendix Table A2 for variable definitions. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level.

Dependent Variable:	R-squared		|Market-correlation|	
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
Repurchase Intensity$_{t-1}$	7.9935***		9.3482***	
	(2.73)		(2.81)	
Remaining Volume$_t$		0.2305		0.3210
		(0.63)		(0.90)
R-squared$_{t-1}$	0.1107**	0.0924*		
	(2.08)	(1.72)		
|Market-correlation|$_{t-1}$			0.1173**	0.0913*
			(2.26)	(1.80)
Program Initiation$_t$	-0.0054	-0.0352	0.0082	-0.0282
	(-0.11)	(-1.06)	(0.20)	(-0.84)
Return$_{t-1}$ > 0	-2.1398	1.1328	-3.7676	-0.5655
	(-0.55)	(0.22)	(-1.10)	(-0.12)
Return$_{t-1}$ < 0	1.6333	-3.8889	1.6165	-4.6563
	(0.31)	(-0.73)	(0.37)	(-1.04)
Book-to-Market$_{t-1}$	0.0794	0.0235	0.0124	-0.0280
	(0.75)	(0.19)	(0.14)	(-0.28)
Market Capitalization$_{t-1}$ (ln)	0.1256***	0.1104***	0.0820**	0.0766**
	(4.16)	(3.48)	(2.10)	(2.09)
RelativeSpread$_{t-1}$ (ln)	-0.0082**	-0.0124***	-0.0094***	-0.0130***
	(-2.33)	(-3.66)	(-2.70)	(-4.28)
Volatility$_{t-1}$ (ln)	0.0689*	0.0998***	0.0972***	0.1021**
	(1.81)	(2.74)	(2.86)	(2.45)
Analysts$_{t-1}$ (ln)	-0.0716	-0.0043	-0.0536	-0.0223
	(-1.54)	(-0.16)	(-1.50)	(-0.63)
Trading Volume$_{t-1}$	0.0001***	0.0001***	0.0001***	0.0001***
	(3.29)	(3.62)	(3.06)	(3.71)
AEX$_t$	0.0499	0.2467	0.0372	0.2440
	(0.39)	(1.24)	(0.30)	(1.20)
AMX$_t$	0.0272	-0.1677	0.0767	-0.0922
	(0.24)	(-1.57)	(0.73)	(-0.95)
ASCX$_t$	-0.0445**	-0.0157	-0.0122	-0.0200
	(-2.28)	(-0.32)	(-0.70)	(-0.41)
Constant	-0.4334	-0.0967	0.2185	0.3152
	(-1.43)	(-0.27)	(0.56)	(0.81)
R^2 (within firm)	0.0859	0.0785	0.0885	0.0692
Observations	481	464	481	464
Firm FE and Month FE	YES	YES	YES	YES

Intensity by one within-firm standard deviation (*ceteris paribus*) entails a 0.0299 percentage point increase in the absolute *Market Correlation* (=0.0032 x 9.3482: SD (within) of *Repurchase Intensity* from Table 2 x *Repurchase Intensity*$_{t-1}$ from Table 5 Column (3)). This corresponds to 5.26% of median *Market Correlation* (=0.0299/0.568 where 0.568 is the median of *Market Correlation* from Table 2). When using *Remaining Volume,* I find no statistically significant relationship with either *R-squared* or absolute *Market Correlation.*

For most control variables included in the analysis I observe the expected sign and significance. In line with Busch and Obernberger (2016), Spiegel and Wang (2005) and Durnev, Morck and Yeung (2004) I find that size (proxied by *Market Capitalization*) induces a higher *R-squared*, which implies lower idiosyncratic risk for larger firms. A higher *Relative Spread* (illiquidity) is associated with a lower *R-squared*. This result aligns with Bris, Goetzmann and Zhu (2007) and Spiegel and Wang (2005) who argue that higher liquidity entails lower idiosyncratic risk and higher *R-squared.* As I use an illiquidity measure as opposed to a liquidity measure, I logically find inverse results compared to Bris, Goetzmann and Zhu (2007) and Spiegel and Wang (2005). I find that *Trading Volume* positively impacts *R-squared* as indicated by a statistically significant relationship between both variables. This result was previously observed by Lamourex and Lastrapes (1990), who find that daily trading volume, used as a proxy for the speed by which information travels, has a significant positive impact on the explanatory power of daily return variance (i.e. *R-squared)*. Similarly, Bali, Cakici, Yan and Zhang (2005) argue that *Trading Volume* is a natural measure of stock liquidity. One would therefore find a relationship between *Trading Volume* and *R-squared* that is statistically similar to when using other measures of liquidity. My results for *Trading Volume* therefore confirm the previously discussed results of Bris, Goetzmann and Zhu (2007) and Spiegel and Wang (2005) in relation to liquidity. Lastly, I investigate the impact of index inclusion on idiosyncratic risk. I find that the most pronounced effect on *R-squared* is found for the *ASCX* dummy. However, the observed statistically significant relationship only holds in Column (1). I therefore find limited evidence for a meaningful relationship between index inclusion and idiosyncratic risk.

My results partly support the idea that share repurchases increase the contemporaneity between a stock and the market and I find no evidence opposing this result, when using lagged *Repurchase Intensity* as a measure of activity. Like Busch and Obernberger (2016), I can infer that there is no statistical evidence that share repurchase increase the idiosyncratic risk nor that share repurchases incorporate private information into stock prices. I therefore

find limited evidence that share repurchases increase the accuracy by which information is incorporated into stock price (Hypothesis 2).

5.4 Price Efficiency and Idiosyncratic Risk in Up and Down Markets

In the previous sections I analyzed the impact of share repurchases and have been able to establish that share repurchases, at least in part, enhance price efficiency and reduce the idiosyncratic risk of shares. However, it would be interesting to determine what mechanism brings about this effect. As discussed earlier, there are two distinct mechanisms via which share repurchases can improve price efficiency. The first channel entails that firms can use market orders to repurchase shares on the basis of positive public information not having been assimilated into the stock price yet. The second channel dictates that firms can intervene in the market for their own shares by repurchasing them to prevent prices from dropping below intrinsic value. By the latter channel, firms improve the accuracy with which negative public information is incorporated into stock prices (Busch & Obernberger, 2016). I therefore take my analysis one step further to determine what distinct mechanism increases price efficiency.

Both mechanisms yield testable predictions. If price efficiency increases in months of positive market returns, this should reflect that firms incorporate positive public information into the stock price. Alternatively, if price efficiency increases in negative market return months this reflects that firms intervene to increase the accuracy by which stock prices reflect negative public information. This is achieved by establishing a lower bound for a share price to reflect its intrinsic value (Busch & Obernberger, 2016). To empirically investigate which mechanism is relevant, I must separate repurchase activity into up markets (positive market return months) and down markets (negative market return months). I use the monthly AEX All-Share index returns as a proxy for market return. Next, I create a dummy variable *Up Market* indicating 1 if in any given month the average market return is positive. I also create a dummy *Down Market*, which equals 1 if in any given month the average market return is negative. Subsequently, I create an interaction term between a repurchase activity measure and one of the two dummy variables to test whether positive or negative information months drive the impact on price efficiency. Busch & Obernberger (2016) argue that using this specification precludes one from using level variables due to collinearity. I therefore only use the interaction term.

Table 6 displays the regression results for *Up Market* and *Down Market.* Panel A presents the results for the delay measures, whereas Panel B concerns idiosyncratic risk. I

first analyze whether the coefficients obtained for up and down markets are statistically significantly different from zero. I analyze this using a Wald test, which tests for differences between the coefficients for up and down market repurchases. If the interaction terms are not statistically different from zero, then removing these interaction terms would not significantly reduce the fit of the model. My results indicate that the coefficients are different from zero across all specifications, as I find that all interaction terms are significantly different from zero at a 1% significance level

In up markets I find that almost all of the estimated coefficients are statistically insignificant, with the exception of Column (4) of Panel A. In down markets however, I find that share repurchases improve price efficiency. Additionally, I find that the magnitude of the coefficients increases by a factor of approximately 2 compared to Table 4 and Table 5 results and by a factor of 10 between up markets and down markets, this suggests that the impact on price efficiency is both statistically and economically driven by share repurchases in down markets. In Panel A Column (1), a down market share repurchase with median *Repurchase Intensity* size decreases the *Delay* by 0.0385 percentage points, which corresponds to 11.96% of median *Delay*. Similarly, In Panel B Column (1) I observe that a down market repurchase equal to the median *Repurchase Intensity* increases the *R-squared* with 0.0374 percentage points, analogous to 11.59% of the median *R-squared.* Similar results were also observed in down markets by Busch and Obernberger (2016). Specifically, they find that a down market repurchase with the size of median *Repurchase Intensity* causes *Delay* to decrease by 0.0365 points, representing 7.68% of median Delay. Likewise, Busch and Obernberger (2016) find that a median size share repurchase increases *R-squared* by 0.0294 points in down markets which represents 13.26% of median *R-squared.* My results are highly consistent, which allows me to infer that regardless of the price efficiency measure or specification, share repurchases increase price efficiency and reduce idiosyncratic risk in negative public information months (i.e. when the market goes down).

Another interesting result is that I find that the interaction term between *Remaining Volume* and *Up Market* comes in with a positive sign in both Column (2) and (4) of Panel A and with a negative sign in the same columns of Panel B. This result implies an inverse relationship between share repurchases and price efficiency between up and down markets, using this measure of repurchase activity. Additionally, the positive relationship between the interaction term *Remaining Volume* Up Market* and *Coefficient-based Delay* is statistically significant at the 10% level in Column (4) of Panel A. In the previous sections I could not

Table 6: The Impact of Repurchases on Price Delay and Idiosyncratic Risk in Up and Down Markets. The table displays the OLS regression results of *Delay* and *Coefficient-based Delay* (Panel A) and *R-squared* and absolute *Market Correlation* (Panel B) on an interaction term consisting of a repurchase activity measure and a dummy variable indicating either an up market or a down market and control variables (not tabulated). The control variables are the same as in Table 4 and Table 5. Refer to Appendix Table A2 for variable definitions. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level. The Wald statistic tests for differences between the coefficients for up market and down market repurchases. The table presents the test statistics and corresponding p-values for these tests.

Panel A

Dependent variable:	Delay		Coefficient-based Delay	
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
$Rep.Intensity_{t-1}$ x $Up\ Market_t$	-1.2795		-1.0966	
	(-0.34)		(-0.13)	
$Rep.Intensity_{t-1}$ x $Down\ Market_t$	-14.8296***		-16.2698***	
	(-3.94)		(-4.20)	
$Rem.Vol_t$ x $Up\ Market_t$		0.1704		0.9585*
		(0.45)		(2.00)
$Rem.Vol_t$ x $Down\ Market_t$		-1.4754***		-3.2677***
		(-4.01)		(-3.30)
R^2 (within firm)	0.0674	0.0683	0.0503	0.0756
Observations	481	464	479	463
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Wald (up - down)(test)	9.63	16.83	10.14	12.88
Wald (up - down)(p-value)	0.0009	0.0000	0.0007	0.0002

Panel B

Dependent variable:	R-squared		|Market correlation|	
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
$Rep.Intensity_{t-1}$ x $Up\ Market_t$	-2.7359		0.4519	
	(-0.74)		(0.10)	
$Rep.Intensity_{t-1}$ x $Down\ Market_t$	14.3765***		14.6578***	
	(4.85)		(3.98)	
$Rem.Vol_t$ x $Up\ Market_t$		-0.3880		-0.2426
		(-1.35)		(-0.74)
$Rem.Vol_t$ x $Down\ Market_t$		1.2982***		1.3046***
		(3.89)		(4.79)
R^2 (within firm)	0.1206	0.1126	0.1101	0.0966
Observations	481	464	481	464
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Wald (up - down)(test)	16.91	11.43	13.80	15.11
Wald (up - down)(p-value)	0.0000	0.0004	0.0001	0.0001

establish a statistically significant impact of *Remaining Volume* on price efficiency. The results in this section however suggest that repurchases in up markets, to a limited extent, confound the overall impact of *Remaining Volume* on price efficiency. I now find a highly statistically significant increase in price efficiency as a result of share repurchases in down markets across all specifications. The statistically significant positive impact of share repurchases on delay in Column (4) of Panel A might indicate that shares are sometimes repurchased at prices above intrinsic value in up markets.

This section presents statistically strong and economically meaningful support that share repurchases improve price efficiency in down markets. I can conjecture that firms repurchase shares to provide price support and prevent their share price from falling below intrinsic values. Hypothesis 1 can therefore be rejected in the context of down markets. I further find that price delay indisputably decreases as a result of share repurchases in down markets. Repurchases consequently increase the speed and accuracy by which new negative information arrives to the market and improve price efficiency. This statistically supported intuition implies that I cannot reject Hypothesis 2. Moreover, I find no evidence that firms repurchase shares as a means to actively assimilate positive information into share prices, as exhibited by insignificant results for share repurchases in positive market information months (up markets). My results therefore largely align with the results of Busch and Obernberger (2016), who find that share repurchases in the US increase price efficiency by providing price support at intrinsic values.

5.5 Motivation and the Impact on Price Efficiency and Idiosyncratic Risk

Thus far my analysis has focused on what drives repurchase activity, the impact that share repurchases has on price efficiency and idiosyncratic risk as well as what mechanism brings about this effect. Another interesting dimension to evaluate is whether particular types of information, in this case the stated motivation, impact repurchasing behavior and price efficiency differently. To address this, I use a two-step approach. First, I investigate the (abnormal) announcement returns of a share repurchase program as well as whether diverse motivations for repurchase programs impact announcement returns differently. Next, I examine how different motivations (types of information) relate to repurchase activity and price efficiency, using the same measures for activity and price efficiency as before.

In previous sections, various firm characteristics and fundamentals were used to proxy for potential motivations underlying share repurchase programs. For example, book-to-market ratios were used to proxy for (under)valuation reflecting the *signaling hypothesis*,

cash-to-assets ratios were used to proxy for cash balances reflecting the *free cash flow hypothesis,* takeover status dummies reflected the *takeover defense hypothesis* and leverage ratios reflected the *capital structure hypothesis.* In this section, I investigate the actual motivation provided by management to carry out a share repurchase program and determine how it corresponds to announcement returns, repurchase activity and price efficiency. I thereby evaluate whether managerial repurchase activity is consistent with economic theory. Additionally, I evaluate how announcement returns relate to subsequent repurchase behavior. I use this approach to examine the predictive ability of share repurchase motivations. It is important to note that theoretical signaling models do not make any conjectures regarding the predictive ability of managerial statements. This is because a signal is only considered to be credible, if it entails some sort of cost. Peyer and Vermaelen (2008) argue that managers care about their reputation and that damaging their reputation entails a cost. Lying about the motivation for a repurchase program could damage a manager's reputation. Managers are therefore discouraged to lie about their motives. I use this assumption in my analysis of motivation. In sum, this section provides a novel approach to assessing the impact that motivation has on repurchase activity and price efficiency.

When Dutch firms announce repurchase programs via a press release, they usually do not only disclose the anticipated size and duration of a repurchase program, but also the motivation for initiating a repurchase program (Section 2.2.1 extensively discusses sex key motivations for a repurchase program). I collect the repurchase program announcements for all 68 programs under consideration and identify the stated motivation. In 66 cases, I can retrieve the motivation (Appendix Table A3). Upon further investigation of the information, I find that the motivations can be grouped into three particular categories[16]: 1. to exploit undervalued shares (9 programs) 2. to optimize/alter capital structure (42 programs) 3. To distribute excess cash (15 programs). These three motivations have diverse implications for announcement returns and provide distinct empirical predictions regarding how these motivations might impact the incorporation of information through repurchases. I first discuss the announcement returns.

[16] This categorization is seemingly arbitrary. However, I largely follow the methodology of Brav, Graham, Harvey and Michaely (2005) and Peyer and Vermaelen (2009) to make categorizations.

5.5.1 Abnormal Returns

I investigate the abnormal announcement returns of share repurchase programs to examine if new information is incorporated into the stock price in one single price jump upon announcement. I first formulate various expectations based on the motivation and subsequently examine if results are consistent with previous studies. Moreover, in previous sections I included a dummy for *Initiation* to ensure that results were not driven by announcement effects. In this section, I zoom in on the announcement effects to determine the impact of new information coming to the market. In doing so, I use an event study methodology to assess abnormal returns surrounding repurchase program announcements. Stephens and Weisbach (1998) argue that a stock price increase surrounding a share repurchase announcement can be interpreted as information signaling, whereby managers convey information about a firm. Additionally, the information signaling explanation of repurchases predicts that the size of the event-day returns of a program announcement should be related to the information contained in that announcement (Stephens & Weisbach, 1998).

In short, based on the empirical evidence[17] regarding repurchase announcement returns I expect that on average share repurchase announcements experience a significant positive abnormal return. This result indicates that the market responds positively to a repurchase announcement. When I sub-divide announcements based on motivations I expect to observe abnormal returns of different sizes and significance. This differential impact reflects the amount of information contained in an announcement (Stephens and Weisbach, 1998). In particular, I expect that repurchase announcements related to *Undervaluation* experience the highest abnormal announcement returns, followed by *Capital Structure* and lastly *Excess Cash* related announcements. The intuitions flow from the *signaling hypothesis*. To elaborate, firms announcing a program to alleviate undervaluation believe that stock prices do not reflect intrinsic values. These firms therefore signal information regarding the future prospects of a firm through an announcement. This announcement therefore contains a great deal information regarding the value of a firm and corresponds to significant abnormal returns. (Peyer & Vermaelen, 2008). I expect the second largest and significant abnormal returns from *Capital Structure* announcements, as *Capital Structure* adjustments indirectly signal information about firm value. This is because a firm becoming more leveraged, signals information about the firm's future cash flows and its abilities to deal with the increased responsibilities and risks associated with the adjusted capital structure. Lastly, I assume that

[17] For an in-depth discussion of announcement returns please refer to Peyer and Vermaelen (2008); Grullon and Michaely (2004); Stephens and Weisbach (1998); Ikenberry, Lakonishok and Vermaelen (1995).

Excess Cash announcements observe the smallest or no abnormal returns as distributing excess cash does not necessarily signal any information about firm value. Instead, it is more likely to reflect the absence of positive NPV investments to which cash can be allocated.

Table 7 reports the cumulative abnormal return (CAR) results. In Column (1) for the full sample I find that the CAR is 0.88% in the 3 days [-1:+1] surrounding the repurchase. This result is highly statistically significant. This abnormal stock price jump therefore implies that, on average, new information is incorporated into the stock price surrounding a repurchase program announcement. This result aligns with previous literature. Obernberger (2014) for instance finds a CAR of 0.65% for the 3-day period surrounding repurchase announcements in the US between 2004-2010. Ikenberry, Lakonishok and Vermaelen (2000) examine repurchase announcements in Canada and find a CAR of 0.93% [-1:+1] for the period 1989-1997. Previous research regarding share repurchases in the Netherlands display similar results. Erken (2012) finds a CAR of 1.10% for AEX-listed firms in the period 2002-2011. Likewise, Manconi, Peyer and Vermaelen (2014) find a 3-day CAR of 1.57% for repurchasing firms in the Netherlands between 1998 and 2010. Strikingly, I find a slightly lower 3-day CAR in the Netherlands compared to the previous two authors. One potential explanation might be that both these studies largely incorporate periods reflecting the pre-reform share repurchase environment in the Netherlands. The pre-reform period was characterized by a stricter regulatory environment. Consequently, the market might perceive the repurchase program announcement as a more credible signal as repurchase programs were widely discouraged before reforms and thus entail a greater cost to initiate. I further report the pre-announcement and post-announcement CAR for the 15 until 3 days before the announcement and the 3 to 15 days after the announcement respectively. I find that the pre-announcement CAR is -1.54% and highly statistically significant. This result seemingly indicates that, on average, Dutch firms announce repurchase programs following share price underperformance and is therefore consistent with previous authors (Peyer and Vermaelen, 2008; Stephens and Weisbach, 1998). I also observe that the post-announcement CAR is 0.50% and also statistically significant. Figure 3 reports these results graphically. As can be observed in Panel A, there is a clear jump in CAR around the announcement date. Pre-announcement the CAR is negative; however post-announcement the 30-day CAR moves towards 0. The market interprets the announcement of a share repurchase as conveying positive information. Additionally, one observes that the CAR starts to decline again approximately 10 days after the announcement. This could indicate that the price change is

Table 7: Cumulative Abnormal Returns (CARs) and Stated Repurchase Motivation. The table examines the stated motivation for repurchases for 68 repurchase programs and announcement returns. Repurchase announcements are categorized into several categories of motivation for the share repurchase. These categories are: undervaluation, capital structure adjustments and excess cash distribution. The table reports the cumulative abnormal announcement returns for all programs under consideration as well as for various sub-samples only containing a particular repurchase motivation in columns (1) - (4). For 2 programs I am unable to determine the stated motivation. The sub-samples therefore only consider 66 programs in total. The cumulative abnormal returns are reported for a number of different time periods to distinguish between pre-announcement returns, event window returns, and post-announcement returns. [-30:-3] and [-15:-3] respectively represent the cumulative abnormal return between 30 days and 3 days and 15 days to 3 days before the announcement or the pre-announcement returns. [-2:+2] and [-1:+1] respectively reflect 2 days before until 2 days after and 1 day before until 1 day after the announcement or the event-window returns. [+3:+15] reflects the 3 to 15 days after the announcement or the post-announcement returns. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively.

(Sub) sample:	(1) All Firms	(2) Undervaluation	(3) Capital Structure	(4) Excess Cash
CAR [-15:-3]	-1.54%***	-7.81%***	-1.24%***	0.98%***
	(-6.40)	(-6.07)	(-5.02)	(3.63)
CAR [-2:+2]	0.74%***	-1.95%	0.73%**	2.18%***
	(2.19)	(-1.06)	(2.05)	(4.21)
CAR [-1:+1]	0.88%***	-0.27%	0.78%**	2.23%***
	(2.74)	(-0.34)	(1.94)	(2.92)
CAR [+3:+15]	0.50%**	-2.31%*	1.01%***	0.63%**
	(2.17)	(-1.82)	(4.04)	(1.99)
Observations	68	9	42	15
Robust standard error	Yes	Yes	Yes	Yes

only temporary. One might deduce that the information conveyed in the program announcement is perceived by the market as only having limited informativeness. This is because the announcement only reveals a firm's intention to repurchase shares, however does not require an actual commitment to repurchase shares. In effect, the market initially overreacts to the share repurchase announcement. The market might thus perceive the signal to only have limited credibility as it does not entail a significant cost. The market may actually feel that actions speak louder than words.

In Columns (2) – (4), I sub-divide the repurchase announcements into different categories based on stated motivation. In column (2) I find that the CAR associated with programs that are initiated to deal with *Undervaluation* is negative and insignificant. I cannot make any statistically meaningful inferences. However, this sub-sample only considers 9 repurchase programs which constrains the ability to find statistically significant results. In Column (3), I investigate the motivation *Capital Structure* and find a CAR of 0.78% in the 3 days surrounding the announcement, which is statistically significant at the 5% level. I

conclude that repurchase program announcements associated with adjusting a firm's capital structure are considered to convey credible positive information about a firm. This positive information possibly relates to the firm's ability to take on additional leverage, which is perceived by the market as a sign of stability and good prospects. This positive jump surrounding the announcement can also be observed graphically in Figure 3 Panel C. Like with the overall sample, I find statistically significant negative pre-announcement CARs [-15:-3] and positive post-announcement CARs [+3:+15] (see Table 7). If I refer back to Panel C, I find that approximately 10 days after the repurchase program announcement the CAR declines again. This seemingly indicates that the information contained in the *Capital Structure*-related program announcement is only considered to have temporary credibility. This is because a more permanent impact implies a flat CAR in the post-announcement window. Lastly, I examine the CARs for *Excess Cash* in Column (4) of Table 7. Once again I find a statistically significant positive CAR in the 3 days surrounding an announcement, equal to 2.23%. Like before, this implies that the announcement of an *Excess Cash*-related repurchase program is perceived as conveying positive information about a firm. This result contradicts with expectations, as I would assume that the announcement of this type of program contains a relatively small or insignificant amount of information (i.e no significant positive abnormal returns). The market might perceive the announcement of this type of repurchase program as a sign of good intentions or a discipline mechanism for managers to not engage in wasteful investments and thus implies improved governance. For *Excess Cash* repurchase programs I too find a slight decline in CARs approximately 10 days following the announcement, albeit less pronounced than previous cases. My results for the different motivations generally align with previous work. Peyer and Vermaelen (2008) find that repurchase programs with *Undervaluation* as a stated-motivation experience the greatest CAR surrounding announcement equal to 3.70%, followed by *Excess Cash* with 2.78% and lastly *Capital Structure* with 1.17%. My results do not align for *Undervaluation*, however I do observe a CAR of 2.23% for *Excess Cash* and a CAR of 0.78% for *Capital Structure*, which is in the same order of magnitude as observed by Peyer and Vermaelen (2008). Although I find statistically significant positive announcement returns, I also observe that the price jump is largely temporary. This might indicate that the market does not perceive the information contained in the announcement to be permanently credible. Moreover, although I find positive abnormal returns surrounding the announcement for all three types of motivation (of which 2 are significant), this need not be associated with that particular

Figure 2: Cumulative Abnormal Returns. This figure graphically displays the average abnormal returns (AR) and cumulative abnormal returns (CAR) for a 30-day period surrounding a repurchase program announcement using the market model methodology. 0 indicates the announcement date. Returns are displayed in percentages. Panel A displays the results for the full sample. Panel B displays all program announcements where 'Undervaluation' was the stated motivation. Whereas Panel C reflects all repurchase program announcements with 'Capital Structure' as a stated motivation and Panel D reflects all program announcements where 'Excess Cash' was the stated motivation.

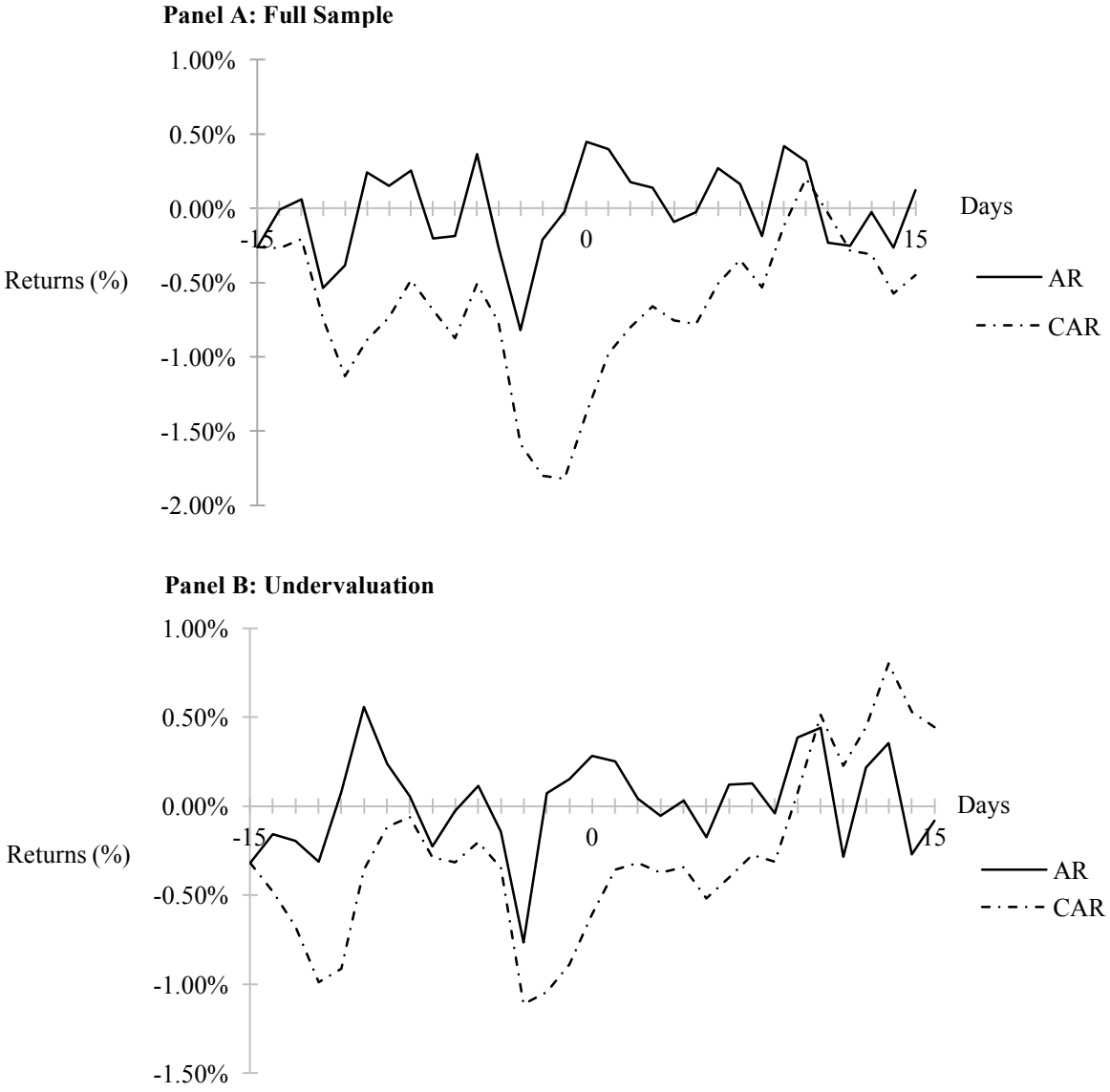
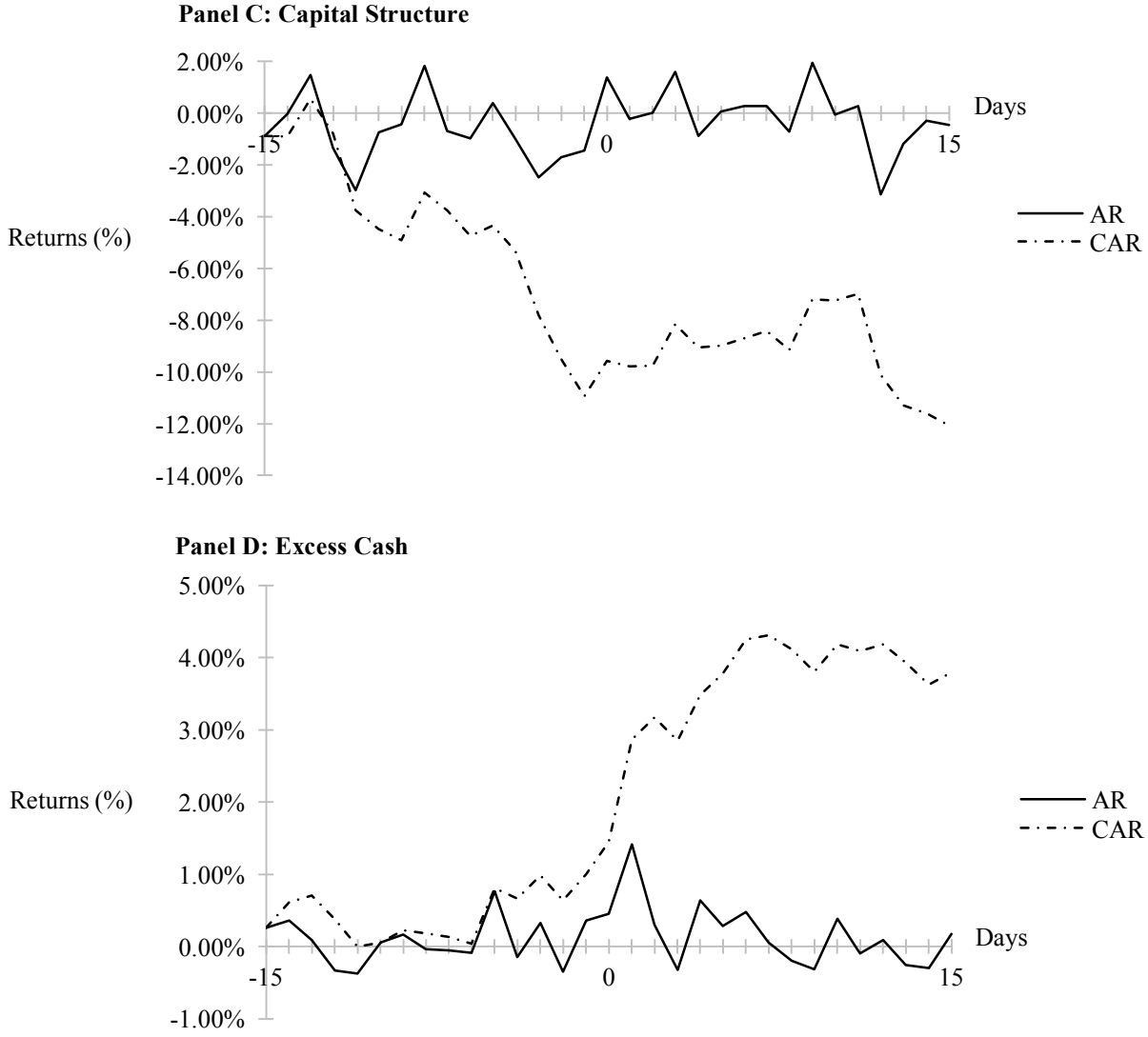


Figure 2: Cumulative Abnormal Returns (Continued).



motivation per se. An alternative explanation might be that the market only processes the general announcement of a repurchase program and discounts or underreacts to the stated motivation. It would be interesting to assess how the market processes subsequent repurchase activity. Consequently, the next step is to investigate whether actual repurchases further incorporate information into share prices and increase the speed and accuracy by which this information is incorporated into share prices.

5.5.2 Motivation, Repurchase Activity and Price Efficiency

The three different motivations considered in this thesis all provide empirical predictions about the incorporation of information.

In general, when firms repurchase shares to signal undervaluation one can expect that repurchase activity increases following poor stock performance and will decrease after good

stock performance, as this trading pattern best conveys the undervaluation message (Stephens & Weisbach, 1998). More specifically, one would expect that firms conducting repurchases to exploit or signal undervalued shares would experience a decrease in *Delay* and an increase in R^2. This intuition flows from the previously established argument regarding the two channels via which firms can increase price efficiency, namely market and limit orders. If firms actively use market orders or limit orders to repurchase shares they can alleviate perceived undervaluation by increasing the speed and accuracy by which this information is reflected into share prices as well as increase the information content of share prices overall. In effect, repurchases motivated by undervaluation are expected to decrease *Delay* and increase R^2.

Vermaelen (1981) argues that repurchasing shares to increase leverage, like undervaluation, has a signaling function. This intuition flows from Ross (1977) who reasons that increasing financial leverage is a positive signal. Using share repurchases to increase leverage therefore conveys information regarding the positive future prospects of a firm. Firms with good prospects are more likely to maintain higher debt levels as they can better cope with the demands that increased leverage impose. Actively repurchasing shares to convey this information therefore increases the speed and accuracy by which this positive information is reflected in share prices as well as increases the overall information content of shares. The expectation is therefore that the capital structure or leverage motivated repurchase activity increases price efficiency and reduces idiosyncratic risk (Koch & Shenoy, 1999).

Jensen (1986) finds that firms with greater cash flows tend to repurchase more shares. One can therefore expect that a firms' repurchase intensity is high when excess cash balance is used to motivate the initiation of a repurchase program. Busch and Obernberger (2016) argue that firms with high cash balances may be forced to conduct share repurchases in a short period of time, which could potentially harm price efficiency. They argue that firms may not be able to adequately align repurchase behavior with stock liquidity, which could induce an increase in share prices. As a result of this misaligned repurchase behavior, share prices might deviate from intrinsic values (Busch & Obernberger, 2016). One could expect that repurchase activity related to high cash balances decreases price efficiency and reduces the information content of shares.

I use a research design that allows me to single out subsets of repurchases based on motivation to determine the impact on price efficiency. I adjust my model specification from Sections 5.2 and 5.3 across two particular dimensions. First, I use contemporaneous

Repurchase Intensity which potentially includes endogenous variation. Second, I create a dummy variable indicating the motivation for a repurchase program which equals 1 for all program months and interact these dummies with *Repurchase Intensity*. These three dummies are *Undervaluation, Capital Structure* and *Excess Cash*. I then employ an approach where I regress either *Delay* or *R-squared* on contemporaneous *Repurchase Intensity*, the dummy variable and an interaction term $Repurchase\ Intensity_t$ * $Interaction\ variable_t$ as well as control variables. This specification permits me to test the null hypothesis of the groups' having no impact on the dependent variables *Delay* and *R-squared*. I subsequently repeat this approach, instead for the second set of tests I include lagged *Repurchase Intensity* as a measure of repurchase activity.

Table 8 presents the regression results for the investigation of repurchase activity and price efficiency. I only report the results for *Delay* (Panel A and B) and *R-squared* (Panel C and D). In Columns (1) – (3), I identify the three different motivations driving share repurchase activity. In Panel A Column (1), I interact contemporaneous *Repurchase Intensity* with *Undervaluation,* which is equal to one for all program months if a firm specified undervalued shares as the key motivation to initiate a repurchase program. My coefficient of interest, the interaction between *Undervaluation* and *Repurchase Intensity* is not significantly different from zero. I can therefore not make any statistically significant inferences regarding *Undervaluation*. A potential explanation may be that the relatively low number of undervaluation programs (9) impedes the ability to retrieve statistically meaningful results. In Column (2), I find that the interaction term between *Repurchase Intensity* and *Capital Structure* is negatively related to *Delay* and is statistically significant at the 1% level. This result implies that the repurchasing activity reflecting capital structure adjustments induces a downward pressure on price delay. Repurchasing firms increase the speed and accuracy whereby this type of information is incorporated into the share price, which supports expectations. The results for *Excess Cash* in Column (3) are in line with expectations. I find that firms using repurchase programs to distribute excess cash have a harmful effect on price efficiency, as signified by the positive relationship between the interaction term and *Delay*. My results therefore corroborate the intuition provided by Busch and Obernberger (2016) that cash balance-induced repurchases cause share prices to move away from intrinsic values. In Panel B, I use lagged *Repurchase Intensity* as a measure of repurchase activity and find no statistically significant results across all specifications. I therefore infer that the relationship between the interaction term and *Delay* only holds when I use a more lenient specification,

Table 8: The Motivation for Repurchases and the Impact on Price Efficiency and Idiosyncratic Risk. The table presents the OLS regressions of *Delay* and *R-squared* on dummy variables, interaction terms of either contemporaneous *Repurchase Intensity* or lagged *Repurchase Intensity* with the dummy variables for motivation and control variables (untabulated). The controls are the same as in Table 5 and Table 6 respectively. Refer to Appendix Table A2 for variable definitions. The dependent variable is *Delay* in Panel A and B and *R-squared* in Panel C and D. In Panel A and C contemporaneous *Repurchase Intensity* is used as a measure for repurchase activity, whereas lagged *Repurchase Intensity* is used in Panel B and Panel D. The former measure of repurchase activity allows for endogenous variation, whereas the latter only captures exogenous variation. *Undervaluation*, *Capital Structure* and *Excess Cash* are dummy variables equal to 1 if the repurchasing firm provided that particular motivation to conduct a share repurchase program. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level.

Panel A

Dependent variable:	Delay		
	(1)	(2)	(3)
Interaction variable:	Undervaluation	Capital Structure	Excess Cash
Interaction variable$_t$	0.0122	-0.0348	-0.0132
	(0.12)	(-0.70)	(-0.29)
Rep.Intensity$_t$	-6.4843	6.3290	-12.1761***
	(-1.46)	(1.34)	(-2.86)
Rep.Intensity$_t$ * Interaction variable$_t$	10.6719	-19.5769***	20.3515***
	(0.72)	(-3.13)	(4.35)
R^2 (within firm)	0.0516	0.0644	0.0581
Observations	477	485	485
Firm FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Panel B

Dependent variable:	Delay		
	(1)	(2)	(3)
Interaction variable:	Undervaluation	Capital Structure	Excess Cash
Interaction variable$_t$	0.0153	-0.0509	0.0168
	(0.17)	(-0.98)	(0.29)
Rep.Intensity$_{t-1}$	-10.2044**	-7.3962**	-10.6356**
	(-2.67)	(-2.11)	(-2.04)
Rep.Intensity$_{t-1}$ * Interaction variable$_t$	4.7264	-3.3332	2.6395
	(0.70)	(-0.59)	(0.33)
R^2 (within firm)	0.0527	0.0561	0.0530
Observations	477	485	485
Firm FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Continued

Table 8: The Motivation for Repurchases and the Impact on Price Efficiency and Idiosyncratic Risk (Continued).

Panel C

Dependent variable:	R-squared		
Interaction variable:	(1) Undervaluation	(2) Capital Structure	(3) Excess Cash
Interaction variable$_t$	0.0090	0.0445	-0.0224
	(0.11)	(1.23)	(-0.64)
Rep.Intensity$_t$	7.6844**	-0.6949	11.1052**
	(2.23)	(-0.16)	-2.59
Rep.Intensity$_t$ * Interaction variable$_t$	-4.8053	11.6124**	-13.9159***
	(-0.37)	(2.04)	(-3.45)
R^2 (within firm)	0.0904	0.0971	0.0954
Observations	477	485	485
Firm FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Panel D

Dependent variable:	R-squared		
Interaction variable:	(1) Undervaluation	(2) Capital Structure	(3) Excess Cash
Interaction variable$_t$	-0.0478	0.0585	-0.0453
	(-0.65)	(1.36)	(-0.96)
Rep.Intensity$_{t-1}$	8.3769**	6.2827*	8.1828*
	(2.71)	(1.77)	(-1.96)
Rep.Intensity$_{t-1}$ * Interaction variable$_t$	-4.3145	2.0955	-0.6646
	(-0.98)	(0.41)	(-0.10)
R^2 (within firm)	0.0875	0.0918	0.0885
Observations	477	485	485
Firm FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

which allows for endogenous variation.

Panels C and D reflect the results for idiosyncratic risk. In Column (1) of Panel C, I cannot reject the null hypothesis that *Undervaluation* has no impact on *Delay.* For *Capital Structure,* I do find that the interaction term has a positive relationship with *R-squared* in Column (2) of Panel C. This relationship indicates that repurchases motivated by a change in capital structure increase the information content of shares. The information incorporated into the share prices via these repurchases relates to the positive future prospects of the firm. This

result implies that by actually repurchasing shares, firms credibly incorporate this information into share prices. Firms must therefore not only announce a capital structure-related repurchase program, but must also commit to it by repurchasing shares. In Column (3), I cannot establish any statistically significant relationship between the *Excess Cash* and *R-squared*. I conclude that capital structure related repurchases improve price efficiency, whereas repurchases related to excess cash and undervaluation do not warrant any statistically meaningful impact on price efficiency. The key take away is that firms incorporate information into stock prices, not simply by announcing a repurchase program, but must also commit to the program to credibly signal this information.

In Panel D, I repeat the analysis of Panel C, however now I use lagged *Repurchase Intensity*, which excludes endogenous variation, as a measure of repurchase activity. Across all three motivations I am not able to establish a statistically meaningful relationship between the interaction term and R-squared. I therefore conclude that the statistically significant relationship observed between idiosyncratic risk and the interaction variable only holds for the special case where I use contemporaneous *Repurchase Intensity* and firms conduct share repurchases to alter the capital structure or increase leverage.

5.6 Robustness Checks

This section assesses the validity of results by determining whether the previously observed relations still hold under alternative model specifications. In this section I look at alternative measures of price efficiency and repurchase activity. Furthermore, I extend the sample to consider all months as opposed to only including program months.

5.6.1 Alternative Measures of Price Efficiency

To determine whether the observed relationship between repurchase activity and price efficiency hold in a broader context, I employ a variety of alternative measures for price efficiency and idiosyncratic risk. However, I must first establish whether the alternative measures for these measures are feasible within the context of my analysis.

As the AFM requires Dutch firms to report share repurchases within 7 days following the transaction, one would be able to construct weekly repurchase activity measures and accordingly construct weekly delay measures. This would increase the number of observations, diminish potential observation errors and increase the overall sample size. In addition, it would allow me to better capture the short term impact of share repurchases on price efficiency. However, a problem unfolds when constructing the weekly delay measures. This is because one can only use the five trading days of a week to compile a weekly delay

measure. I can therefore not employ weekly delay measures as a robustness check.

An alternative proxy of idiosyncratic risk is idiosyncratic volatility. Fu (2009) and Campbell, Lettau, Malkiel and Xu (2001) for instance use idiosyncratic volatility, which is the variability of the error term from a simple market model, to quantify idiosyncratic risk. My results for idiosyncratic volatility can be observed in Table A6 of the Appendix. The coefficients on the measures of repurchase activity display the predicted negative sign. In addition, I find that this relationship is statistically significant at the 5% level when using *Remaining Volume* as a proxy for activity. This result implies that when more shares can be repurchased the idiosyncratic volatility is low. Busch & Obernberger (2016) similarly observed an inverse relationship between repurchase activity and idiosyncratic volatility. The results for idiosyncratic volatility therefore, at least in part, corroborate my previous findings for idiosyncratic risk.

5.6.2 Alternative Measures of Repurchase Activity

Throughout the analysis of repurchase activity and price efficiency one of the key concerns has been reverse causality. To adequately deal with these concerns I have only included repurchase activity measures that identify exogenous variation in repurchases and subsequently test what impact these measures have on price efficiency.

In this section I use a research design that relaxes these stringent conditions by using two alternative measures of repurchase activity. First, I use contemporaneous *Repurchase Intensity,* a measure that allows for endogenous variation and for which reverse causality concerns cannot be eliminated. The implication of this endogeneity is that the estimated coefficient for contemporaneous *Repurchase Intensity* has a positive bias if firms use repurchases to prevent a stock from deviating from its intrinsic value (Busch & Obernberger, 2016). Next, I create the dummy variable *Repurchase Dummy* that equals one for each month in which a firm repurchases shares. The *Repurchase Dummy* therefore does not account for the size of the repurchase, it merely indicates whether a share repurchase has been carried out in a certain month. According to Busch and Obernberger (2016) using a dummy to proxy for repurchase activity is less susceptible to endogeneity and reverse causality, as endogeneity primarily relates to the actual size of a repurchase and not so much to the decision to repurchase.

Appendix Table A7 reports the results for these two measures. My results for contemporaneous *Repurchase Intensity* in Panel A do not indicate that there is a positive bias. Instead, I find limited evidence (at the 10% significance level) that there is a negative

relationship between contemporaneous *Repurchase Intensity* and *Coefficient-Based Delay.* This result therefore somewhat contradicts with Busch & Obernberger (2016), who cannot establish any statistically significant relationship. A potential explanation may be that share repurchases cannot fully prevent a mispricing in the Netherlands. My results in previous sections substantiate this idea, as I only find partial statistical evidence that Dutch firms use share repurchases to provide price support and prevent a mispricing of stock. Although the coefficients of the dummy variable come in with the right sign in Panel B, I find no statistically significant relationship between *Repurchase Dummy* and price efficiency. This result supports the notion that the size of the repurchase is the primary driver of the impact on price efficiency. Moreover, the result seems consistent with the assumptions underlying the *signaling hypothesis,* as a signal is only considered to be credible if it entails a cost. In this case, the size of a repurchase proxies for the cost of the signal.

5.6.3 Price Efficiency and the Financial Crisis

In Table 6 it was established that the most pronounced effects of repurchase activity on price efficiency and idiosyncratic risk are observed in down markets. To ensure that the inferences made are not driven by the financial market crisis, I omit all program months between October 2008 and December 2009. This particular period is selected as the CBS[18] identified this timeframe as the series of months where the Dutch economy experienced negative GDP-growth. Table A8 of the Appendix displays the results for the restricted sample. In sum, I redo the analysis of Table 6 and find that my results in previous sections are robust to restricting my dataset to non-financial crisis months.

5.6.4 Analysis of Price Efficiency in an Extended Sample

In the previous sections I evaluated whether share repurchases improve price efficiency by only considering program months. To better capture the relative impact of share repurchases on price efficiency, I extend my analysis to consider all firm-months between January 2008 and December 2016, while still limiting my analysis to only consider firms that have an open market repurchase program in at least one month between 2008 and 2016. This procedure expands my sample size from 491 program months to 2,713 firm months. Table A9 in the Appendix displays the results for the extended sample, where Panel A considers price delay measures and Panel B considers idiosyncratic risk and market correlation. The results generally corroborate previous findings. In particular, I find that most variables come in with the predicted sign. The key difference however is that I observe no statistically significant

[18] CBS: *Centraal Bureau voor de Statistiek* (The Dutch Statistics Bureau).

relationship between repurchase activity and the delay or idiosyncratic risk measures across all specifications. Furthermore, I find that the coefficients for my repurchase activity measures significantly decrease in size (factor of 8-10), which is largely attributable to the extension of my sample period. As a consequence, the relative impact of repurchase activity on delay reduces significantly. The implication is that *Repurchase Intensity* and *Remaining Volume* have a negligible effect on price delay and idiosyncratic risk when extending the sample to consider all firm months. Alternatively, the previously observed relationship between repurchase activity and measures of price efficiency only hold in open program months. I deduce that my previous conclusions only hold in a particular case as opposed to a general case and therefore warrant limited robustness.

6. Conclusion

In this thesis I examine what factors drive repurchase activity and assess whether open market repurchases affect price efficiency and the information content of stock prices in the Netherlands. I manually collect weekly open market repurchase transaction data for all firms that are listed or have at some point been listed on the Dutch stock exchange between 2008 and 2016. I employ two measures of price delay to proxy for price efficiency and two measures of idiosyncratic risk to assess the information content of stock prices and regress these measures on the repurchase activity measures *Repurchase Intensity* and *Remaining Volume* and a number of control variables. I further distinguish between two channels via which shares repurchases potentially increase price efficiency.

The statistical evidence suggests that share repurchases, as approximated by lagged *Repurchase Intensity*, improve price efficiency and the information content of stock prices by reducing price delays and idiosyncratic risk in program months. This evidence is particularly strong in down markets, which is consistent with the notion that share repurchases increase the accurate assimilation of negative market information into stock prices. I can therefore infer that Dutch firms use open market repurchases to provide price support at intrinsic values. However, when extending my sample to consider all firm months, I find that the previously observed relationships lose statistical significance. This implies that share repurchases only improve price efficiency under certain conditions.

I conduct additional tests to gain insights into the impact that different share repurchase motivations have on announcement returns and price efficiency. First, I find positive abnormal returns for repurchase program announcements related to excess cash distributions and capital structure adjustments, which indicates that share prices temporarily

incorporate information for these motivations. Subsequently, I analyze how the different motivations interact with repurchase activity and examine the differential impact on price efficiency. I find that repurchase programs motivated by capital structure changes improve price efficiency, whereas excess cash motivated repurchases reduce price efficiency. This result only holds for contemporaneous repurchases

All in all, the concerns raised by regulators that share repurchases only serve as a tool to manipulate stock prices seem ill-informed, as I find no evidence for stock price manipulation or decreases in price efficiency. My research therefore implies a policy recommendation for the Netherlands and more generally the EU. In particular, the evidence I provide suggests that policy makers should further encourage share repurchases or at least ensure that regulations do not transition back to a setting in which share repurchases are effectively dissuaded.

7. Limitations and Recommendations

This section briefly elaborates on various limitations of the empirical research conducted in this thesis and proposes various recommendations to overcome these limitations as well as provides suggestions for future research. Although I have endeavored to plan and carry out this thesis meticulously, I am aware of the fact that there are several limitations which I discuss next.

7.1 Limitations

One of the apparent limitations of this thesis is sample size. While my sample is economically representative (89% of the corrected total repurchase volume between 2008-2016), one might argue that the 444 repurchase months considered limit statistical relevance. I believe that the substantial economic representativeness of the sample justifies my ability to make statistically meaningful inferences regarding share repurchases in the Netherlands. This is because the Dutch stock market is by nature a relatively small market compared to for instance the United States or Japan. It is therefore highly likely that sample size is limited when considering the Dutch stock market for research purposes. Moreover, imposing very stringent restrictions on sample size would probably preclude the Dutch stock market from being considered on a stand-alone basis in many contexts.

The second key limitation pertains to the limited amount of data available for a number of control variables. Various other papers addressing share repurchases report the impact that certain additional firm and investor characteristics have on share repurchases,

which includes: insider ownership, institutional ownership, short selling, and insider trading (cf., e.g., Busch and Obernberger, 2016; Bonaime and Ryngaert, 2013; Boehmer and Kelly, 2009; Fenn and Liang, 2001). Controlling for these (and other) factors would therefore enhance the investigation of share repurchases in relation to price efficiency and the information content of share prices. For a number of reasons however this information was not available for the Netherlands. Insider ownership and institutional ownership data is only readily available from March 2010 onwards, as my sample covers the period 2008-2016, I cannot only include data from 2010 onwards. Furthermore, short selling regulations in the Netherlands only require short-selling investors to report all positions in excess of 0.2% of a firm's total issued share capital and this report is only made public if the position exceeds 0.5% of issued share capital (AFM, 2017b). These regulations imply that all transactions (both under and above the threshold) do not have to be reported to the AFM, as only final positions necessitate reporting. This procedure therefore precludes one from controlling for actual short selling transactions when examining actual share repurchases. Information concerning insider trading transactions is available for the Netherlands, as the AFM maintains a register (*Register transacties leidinggevenden MAR19)* for all transactions in a firms' shares carried out by executives and insiders of that firm. One issue however is that the downloadable excel file of this register, like the AFM register for share repurchases only contains announcements of insider trading. Obtaining usable insider trading data therefore requires the user to personally construct a dataset containing all transactions per firm by manually selecting each announcement and extracting the information from that announcement. Given the relatively limited time available to conduct this research, personally constructing such a dataset is beyond the scope of this thesis.

7.2 Recommendations

The limitations mentioned in the previous section can be addressed and one can thereby reduce the potentially detrimental effect of these limitations on results and inferences. For the limited sample size, a variety of distinct sample extending options exist. The most obvious option is to extend the sample to also consider years preceding 2008. The AFM register however only reports share repurchase transactions from October 2005 onwards, hence one can only marginally extend the sample period backwards or all firms should be approached individually to assess if they still have repurchase transaction data for all years before 2005. In addition, as outlined in section 2.3 a great deal of regulatory reform has been carried in relation to share repurchases in the Netherlands between 2005-2008. Two particularly

important amendments facilitating share repurchases were only introduced in 2008. Extending the sample period to consider these years would therefore only limitedly increase the sample size and would require one to control for the impact of regulatory transition. The alternative option to extend the sample size would be to consider other stock markets facing regulations similar to the Netherlands. The discussion in section 4.1 however highlights that although the Netherlands shares many regulatory commonalities with other EU nations one still observes widely different tax regimes and stock market regulations across the nation-states. If one would incorporate these countries, the resulting study would likely become more comparative in nature regarding cross-country differences. Alternatively, one could attempt to control for cross-country differences. The other sample size recommendations include: selecting a different stock market altogether or to consider the Dutch share repurchase environment in the future, when more share repurchases have been carried out.

To overcome the data availability limitation, the key recommendation is to find alternative proxies for the particular firm and investor characteristics. To date no particular freely available alternative proxies have been identified for these control measures in the Netherlands. Another option is to manually collect the data from the AFM register (for some variables) or to directly request this information from investors or Dutch firms.

For future research it would be interesting to keep track of share repurchase activity in the Netherlands, as I expect a further increase in the volume of share repurchases in the future, given that current regulations remain. Another interesting path for future research would be to investigate how share repurchases in the Netherlands (and many other EU nations) are impacted by the shareholder approval requirement compared to other countries (like the US) that only require board approval for share repurchases. Lastly, I present and analysis of the impact of stated motivation on repurchases and make a juxtaposition between announcement returns and price efficiency. A suggestion for future research would be to establish a more explicit link between announcements, repurchase activity and price efficiency.

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9. Appendices

Table A1: Key Share Repurchase Regulations for Ten Largest Stock markets. The table summarizes the 6 key regulatory provisions governing open market share repurchases across the ten largest stock markets based on the work of Kim, Schremper and Varaiya (2005). Column (1) refers to whether board or shareholder approval is required. Column (2) - (4) denote whether and what price, timing and volume restrictions exist. Column (5) specifies reporting frequency for repurchase activity. Column (6) displays if the stock market allows insider trading.

Country	Approval (1)	Price Restriction (2)	Timing Restriction (3)	Volume Restriction (4)	Separate disclosure (5)	Insider Trading (6)
European Union						
France	Shareholder	Max. is daily high price	18 month limit	i) 10% of shares outstanding. ii) 25% of daily trading volume	Monthly	Yes
Germany	Shareholder	Shareholder meeting determines min. And max. price	18 month limit	10% of shares outstanding	Differs; various repurchase volume thresholds exist	None
Italy	Shareholder	Max. is most recent price	18 month limit	i) 10% of shares outstanding. ii) 25% of monthly trading volume	Yes	N/A
Netherlands	*Shareholder*	*Shareholder meeting determines min. And max.*	*18 month limit*	*50% of shares outstanding*	*Within 7 days following transaction*	*Yes*
United Kingdom	Shareholder	Max is 105% of 5-day average market price	18 month limit	15% of shares outstanding	Daily	Yes
Rest of World						
Canada	Board	Max. is most recent price	12 month limit	i) 5% of shares outstanding ii) 10% of public float	Monthly	Yes
Hong Kong	Shareholder	None	i)12 month limit. ii)1 month before earnings announcement	i) 10% of shares outstanding ii) 25% of monthly trading volume	Daily	Yes
Japan	Board	Max. is yesterday's closing price	i) Max. 30 minutes before end of trading day ii) Max. 1 week before end of fiscal year	25% of daily trading volume	Daily	Yes
Switzerland	Shareholder	Max is 105% of current market price	At least 10 days before earnings announcement	i) 10% of shares outstanding ii) 25% of monthly trading volume	Second Trading line	Yes
United States	Board	None	None	None	None	None

Table A2: Variables Description. The table gives an outline of all variables used in this study. This includes repurchase variables, efficiency variables and control variables. The table further reports the definition of each variable, the source of data and the unit in which a variable is denominated. (Ln) refers to variables transformed to natural logarithms.

Name	Definition	Source	Unit
Acquiror	1 if firm is currently (time between announcement and end of the offer) bidding for another company	SDC	binary
AEX	1 if firm is currently in the AEX-index	Datastream	binary
AMX	1 if firm is currently in the AMX-index	Datastream	binary
Analysts	Number of analysts (ln)	I/B/E/S	unit
ASCX	1 if firm is currently in the ASCX-index	Datastream	binary
Book-to-Market	Book value equity / market cap, winsorized at 1%	Datastream	ratio
Book Value Equity	Common equity	Datastream	million
Cash	Cash and short-term investments	Datastream	million
Coefficient Based Delay	Price efficiency measure constructed as the ratio of the lag-weighted sum of the coefficients of the lagged market returns relative to the sum of all	Datastream	ratio
Delay	Price efficiency measure constructed as the ratio of the R2 estimates of the extended market model and the base model	Datastream	ratio
Dividends	Total dividends	Compustat	million
EBITDA	Operating income before depreciation	Comp.	million
Idiosyncratic Volatility	Volatility of the residual from a simple market model regression estimated each month using daily returns	Datastream	unit
Leverage	(Total asset - book value equity) / (total asset - book value equity + market cap)	Compustat	ratio
Market Cap	Monthly average of daily market capitalization (ln)	Datastream	million
Market Correlation	Correlation between daily stock return and contemporaneous market return	Datastream	unit
Market Returns	monthly AEX All Share value-weighted returns	Datastream	unit
Program Month	Difference between current month and month before start of the repurchase program plus 1 (ln)	AFM	unit
Program Size	Size of the repurchase program scaled by shares oustanding as of the beginning of the program	AFM	ratio
Relative spread	Monthly average of daily relative spread (ln)	AFM	ratio
Remaining Volume	Remaining volume at the beginning of the months that can be repurchased under the program scaled by shares outstanding	AFM	ratio
Repurchase Dummy	1 if repurchase transaction takes place	AFM	binary
Repurchase Intensity	Number of shares repurchased during the month divided by the number of shares outstanding at the last trading day of the previous month	AFM	ratio
Repurchase Intensity (TV)	Number of shares repurchased during the month divided by the number of shares traded over the current month	AFM	ratio
Repurchase Volume	Euro volume of shares repurchased during the month	AFM	million
Return	Monthly stock return	Datastream	unit
Return<0	Monthly stock return if positive, else zero	Datastream	unit
Return>0	Monthly stock return if negative, else zero	Datastream	unit
R-squared	R-squared estimate of the market model	Datastream	ratio
Shares Outstanding	Number of shares outstanding at last trading day of month	I/B/E/S	million
Stock Split	The stock split rate for which current stocks are exchanged	Compustat	ratio
Target	1 if firm is currently (time between announcement and end of the offer) a target of another company	SDC	binary
Total Assets	Total assets (ln)	Compustat	million
Trading Volume	Monthly total trading volume	Compustat	million
Turnover	Trading volume scaled by market cap	Datastream	ratio
Volatility	Standard deviation of daily returns over one month (ln)	Datastream	unit

Table A3: Overview of All Repurchase Programs. The table provides a summary of all open market repurchase programs considered in this study. Column (1) displays the company name. Column (2) displays the company's industry (ICB codes). The table furthermore lists the Announcement Date, Completion Date, Period, Announced Program Size (M EUR and M Shares), the Completed Amount, Completion rate and the Motivation in Columns (3) - (10). The Motivation for a share repurchase program is coded 1-3 to denote one of the three key motivations for starting a repurchase program. The three categories are: 1. Undervalued shares 2. Capital structure optimization 3. Excess cash distribution.

Company Name	Industry (ICB)	Announcement date	Completion date	Period (months)	Announced Program Size (M EUR)	Announced Program Size (M Shares)	Completed Amount (M EUR)	Completion (%)	Motivation
AEGON N.V.	Financials	17/09/2013	14/10/2013	1	100		107	100%	2
AEGON N.V.	Financials	17/06/2014	17/07/2014	1		14.5	93	100%	2
AEGON N.V.	Financials	17/09/2014	15/10/2014	1	106		106	100%	3
AEGON N.V.	Financials	17/06/2015	14/07/2015	1		16.3	108	100%	2
AEGON N.V.	Financials	16/09/2015	13/10/2015	1	106		107	101%	2
AEGON N.V.	Financials	04/07/2016	12/08/2016	1		29.3	103	100%	2
AEGON N.V.	Financials	13/01/2016	19/05/2016	4	400		404	101%	2
AEGON N.V.	Financials	03/10/2016	11/11/2016	1		30.8	118	100%	2
AkzoNobel N.V.	Basic Materials	17/03/2008	31/07/2008	4	1,000		1,208	121%	2
ARCADIS N.V.	Industrials	07/01/2016	24/06/2016	5		1	15	100%	1
ASM International N.V.	Technology	09/05/2008	09/05/2008	1		0.25	4	100%	1
ASM International N.V.	Technology	29/10/2014	20/05/2015	6	100		100	100%	3
ASM International N.V.	Technology	28/10/2015	11/11/2016	12	100		100	100%	2
ASML Holding N.V.	Technology	19/01/2011	22/11/2012	22	1,130		1,130	100%	2
ASML Holding N.V.	Technology	18/04/2013	22/12/2014	20	1,000		1,000	100%	2
ASML Holding N.V.	Technology	21/01/2015	31/12/2015	11	1,000		1,000	100%	3
ASML Holding N.V.	Technology	20/01/2016	Still active	Still active	1,500		1,160	77%	3
BE Semiconductor Industries N.V.	Technology	10/05/2011	21/12/2011	7		3.4	15	100%	2
BE Semiconductor Industries N.V.	Technology	23/10/2012	26/04/2013	6		1.5	4	100%	1
BE Semiconductor Industries N.V.	Technology	25/09/2015	20/10/2016	12		1	22	100%	1
BE Semiconductor Industries N.V.	Technology	27/10/2016	Still active	Still active	67		4	6%	2
BinckBank N.V.	Financials	30/09/2008	22/12/2009	14	25		24	94%	2
BinckBank N.V.	Financials	16/11/2011	28/06/2013	19	25		28	112%	2
BinckBank N.V.	Financials	19/02/2016	23/09/2016	7	25		25	99%	3

Continued

Table A3: Overview of All Repurchase Programs (Continued).

Company Name	Industry (ICB)	Announcement date	Completion date	Period (months)	Announced Program Size (M EUR)	Announced Program Size (M Shares)	Completed Amount (M EUR)	Completion (%)	Motivation
Corbion N.V.	Consumer Goods	02/03/2015	01/10/2015	6	50		50	100%	2
Corbion N.V.	Consumer Goods	21/03/2016	31/10/2016	7	50		47	94%	3
Delta Lloyd N.V.	Financials	05/09/2016	30/09/2016	1		5	20	100%	2
Esperite N.V.	Health Care	06/01/2011	12/01/2011	1		0.5	1	100%	n/a
Esperite N.V.	Health Care	30/01/2013	31/01/2013	1		0.12	1	100%	n/a
Fugro N.V.	Oil & Gas	03/06/2014	25/07/2014	1	72	1.7	66	93%	2
Heineken N.V.	Consumer Goods	18/02/2015	26/10/2015	8	750		365	49%	1
Kardan N.V.	Real Estate	13/07/2011	03/11/2011	3	2		1	13%	1
Kardan N.V.	Real Estate	26/09/2011	08/11/2011	1	15		15	100%	2
Koninklijke Ahold Delhaize N.V.	Consumer Services	04/03/2010	24/02/2011	11	500		550	110%	2
Koninklijke Ahold Delhaize N.V.	Consumer Services	03/03/2011	12/03/2012	12	1,000		1,000	100%	2
Koninklijke Ahold Delhaize N.V.	Consumer Services	28/03/2013	12/12/2014	20	2,000		2,000	100%	3
Koninklijke Ahold Delhaize N.V.	Consumer Services	09/03/2015	24/06/2015	3	500		161	32%	3
Koninklijke Boskalis Westminster N.V.	Industrials	14/08/2014	07/11/2014	2	416	10.0	26	6%	3
Koninklijke DSM N.V.	Basic Materials	23/02/2011	16/05/2011	1	215	5.0	220	102%	2
Koninklijke DSM N.V.	Basic Materials	07/09/2011	02/11/2011	1	126	4.0	137	109%	2
Koninklijke DSM N.V.	Basic Materials	06/11/2013	19/05/2014	6	260	5.0	263	101%	2
Koninklijke DSM N.V.	Basic Materials	14/05/2015	28/07/2015	2	115	2.3	123	107%	2
Koninklijke DSM N.V.	Basic Materials	04/11/2016	08/12/2016	1	93	1.7	96	103%	3
Koninklijke KPN N.V.	Telecommunications	22/02/2008	17/09/2008	6	1,000		1,000	100%	3
Koninklijke KPN N.V.	Telecommunications	19/11/2008	11/12/2009	13	1,000		1,000	100%	2
Koninklijke KPN N.V.	Telecommunications	04/02/2010	10/12/2010	10	1,000		1,000	100%	2
Koninklijke KPN N.V.	Telecommunications	21/02/2011	23/09/2011	7	1,000		988	99%	2

Continued

Table A3: Overview of All Repurchase Programs (Continued).

Company Name	Industry (ICB)	Announcement date	Completion date	Period (months)	Announced Program Size (M EUR)	Announced Program Size (M Shares)	Completed Amount (M EUR)	Completion (%)	Motivation
Koninklijke Philips N.V.	Health Care	18/07/2011	20/06/2013	23	2,000		2,000	100%	3
Koninklijke Philips N.V.	Health Care	17/09/2013	20/10/2016	37	1,500		1,500	100%	2
Macintosh Retail Group N.V.	Consumer Services	02/09/2011	06/09/2011	1	5		5	100%	3
Macintosh Retail Group N.V.	Consumer Services	27/10/2011	31/10/2011	1	3		3	96%	2
NN Group N.V.	Financials	26/05/2016	31/05/2017	12	405		405	100%	1
Nutreco N.V.	Consumer Goods	26/08/2014	31/01/2015	5	100		102	102%	2
PostNL N.V.	Industrials	07/01/2008	15/02/2008	1	100		100	100%	2
PostNL N.V.	Industrials	28/04/2008	30/06/2008	2	200		200	100%	2
RANDSTAD HOLDING N.V.	Industrials	14/02/2013	18/02/2013	1		0.3	9	100%	2
RANDSTAD HOLDING N.V.	Industrials	29/10/2015	17/02/2016	3	50	0.9	50	99%	1
RELX N.V.	Consumer Services	16/12/2013	04/12/2014	11	100		149	149%	2
RELX N.V.	Consumer Services	04/12/2014	30/11/2015	11	100		120	100%	3
RELX N.V.	Consumer Services	03/12/2015	23/06/2016	1	100		100	100%	2
RELX N.V.	Consumer Services	28/07/2016	06/12/2016	10		93.9	700	100%	2
SBM Offshore N.V.	Oil & Gas	10/08/2016	20/12/2016	4	150		150	100%	2
Van Lanschot N.V.	Financials	16/08/2011	31/12/2011	4		0.2	5	100%	2
Van Lanschot N.V.	Financials	15/08/2012	07/09/2012	1		0.05	1	100%	2
Van Lanschot N.V.	Financials	26/08/2014	06/11/2014	2		0.15	3	100%	2
Van Lanschot N.V.	Financials	09/03/2016	04/05/2016	1		0.25	5	100%	3
Vastned Offices N.V.	Real Estate	18/11/2008	26/11/2008	1		2	10	100%	1
Wolters Kluwer N.V.	Consumer Services	02/11/2016	30/12/2016	1	95		95	100%	2
Total	**68**						**21,824**	**95%**	

Table A4: Repurchase Activity Analysis for Non-Financial Firms. An overview of the OLS-regressions of the repurchase variables (*Repurchase Intensity* and *Remaining Volume)* on *Returns*, the instruments *Program* Month and *Program* Size, lagged *Repurchase Intensity* and various control variables. Refer to Appendix Table A2 for variable definitions. The sample is restricted to only include non-financial firms based on ICB industry codes. The dummies *Acquiror* and *Target* reflecting status in a takeover are omitted due to collinearity. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively.

Dependent Variable:	Repurchase Intensity	Repurchase Intensity	Remaining Volume
	(1)	(2)	(3)
Method:	OLS	OLS	OLS
Repurchase Intensity$_{t-1}$		0.3250***	
		(3.11)	
Program Month$_t$ (ln)	0.0004	-0.0003	-0.0199***
	(0.81)	(-0.72)	(-5.28)
Program Size$_t$	0.0075***	0.0053***	0.0229
	(12.33)	(5.51)	(0.47)
Return$_{t-1}$ > 0	-0.0923	-0.0758	-0.2674
	(-1.34)	(-1.02)	(-0.47)
Return$_{t-1}$ < 0	-0.2688	-0.1755	-0.1415
	(-1.40)	(-0.97)	(-0.19)
Book-to-Market$_{t-1}$	0.0056***	0.0024	0.0253
	(8.81)	(1.20)	(0.86)
Total Assets$_{t-1}$ (ln)	-0.0004**	-0.0016	-0.0002
	(-2.47)	(-0.91)	(-0.09)
Cash-to-Assets$_{t-1}$	0.0040	0.0010	0.1102
	(1.31)	(0.24)	(1.90)
EBITDA-to-Assets$_{t-1}$	0.0437***	0.0232	0.633***
	(3.89)	(1.32)	(3.80)
Dividends-to-Assets$_{t-1}$	0.0011	-0.0002	0.1436
	(0.07)	(-0.07)	(0.46)
Leverage$_{t-1}$	0.0004	0.0232	-0.0164
	(0.31)	(1.32)	(-1.11)
RelativeSpread$_{t-1}$ (ln)	0.0001	0.0001	0.0017**
	(1.52)	(0.50)	(2.27)
Constant	0.0017	0.0147	0.0395**
	(1.00)	(0.84)	(2.63)
R^2 (within firm)	0.2162	0.2917	0.3916
Observations	405	366	403
Firm FE and Month FE	Yes	Yes	Yes

Table A5: Tobit Censored Regression Analysis of Repurchase Activity. This table presents the Tobit regressions of *Repurchase Intensity* and *Remaining Volume* on the instruments *Program Month* and *Program Size*, *Returns* and various control variables. The censored regression has a lower limit of 0 and an upper limit of 1. Refer to Appendix Table A2 for variable definitions. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level.

Dependent Variable:	Repurchase Intensity	Repurchase Intensity	Remaining Volume
	(1)	(2)	(3)
Method:	Tobit	Tobit	Tobit
Repurchase Intensity$_{t-1}$		0.4734***	
		(10.29)	
Program Month$_t$ (ln)	-0.0004	-0.0004*	-0.0121***
	(-1.10)	(-1.87)	(-6.63)
Program Size$_t$	0.0140***	0.0065***	0.0912***
	(5.48)	(4.34)	(7.10)
Return$_{t-1}$ > 0	-0.0139	-0.1087	0.0811
	(-0.12)	(-1.54)	(0.14)
Return$_{t-1}$ < 0	-0.7160***	-0.0817	-0.1450
	(-6.08)	(-1.07)	(-0.23)
Book-to-Market$_{t-1}$	0.0006	0.0005	-0.0045
	(0.72)	(0.87)	(-0.98)
Total Assets$_{t-1}$ (ln)	-0.0001	-0.0001	-0.0039***
	(-0.44)	(-0.43)	(-3.99)
Cash-to-Assets$_{t-1}$	0.0011	0.0034*	0.0769***
	(0.34)	(1.77)	(4.73)
EBITDA-to-Assets$_{t-1}$	-0.0128	0.0107	0.3501***
	(-0.66)	(0.90)	(3.47)
Dividends-to-Assets$_{t-1}$	-0.0225	-0.0051	-0.0009
	(-1.40)	(-0.52)	(-0.01)
Leverage$_{t-1}$	-0.0012	0.0009	0.0013
	(-0.71)	(0.85)	(0.14)
Acquiror Dummy$_t$	-0.0011	-0.0016	0.0018
	(-0.33)	(-0.85)	(0.11)
RelativeSpread$_{t-1}$ (ln)	0.0001	0.0001	0.0059***
	(0.17)	(0.68)	(9.30)
Constant	0.0041*	0.0017	0.0282**
	-1.94	(1.10)	-2.69
sigma	0.0053***	0.0030***	0.0268
	(29.25)	(27.88)	(30.66)
Pseudo-R^2	-0.0253	-0.0636	-0.1324
Observations	442	426	470
Firm FE and Month FE	Yes	Yes	Yes

Table A6: The Impact of Repurchase Activity on Idiosyncratic Volatility. This table displays the OLS regression results of *Idiosyncratic Volatility* as a measure for idiosyncratic risk on either lagged *Repurchase Intensity* or *Remaining Volume* and control variables. *Idiosyncratic Volatility* is specified as the volatility of the residual from a simple market model regression estimated on a monthly basis using daily stock returns. In specification (1) the repurchase variable is lagged one month to circumvent reverse causality concerns. Refer to Appendix Table A2 for variable definitions. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level.

Dependent Variable:	Idiosyncratic Volatility (ln)	
	(1)	(2)
Method:	OLS	OLS
Repurchase Intensity$_{t-1}$	-14.9799	
	(-1.54)	
Remaining Volume$_{t}$		-0.519**
		(-2.22)
Idiosyncratic Volatility$_{t-1}$	0.1265	0.0522
	(1.43)	(0.64)
R^2 (within firm)	0.0704	0.0637
Observations	481	464
Firm FE and Month FE	Yes	Yes
Controls	Yes	Yes

Table A7: The Impact of Contemporaneous Repurchases. The table presents the OLS regression results of *Delay*, *Coefficient-based Delay, R-squared* and absolute *Market Correlation* on contemporaneous *Repurchase Intensity*, *Repurchase* Dummy and a number of control variables. The dependent variable is *Delay* in Column (1), *Coefficient-based Delay* in Column (2), *R-squared* in Column (3), and absolute *Market Correlation* in Column (4). In Panel A, *Repurchase Intensity* is used as a measure for repurchase activity, whereas in Panel B *Repurchase Dummy* is used. *Repurchase Intensity* and *Repurchase Dummy* are interacted with a dummy variable for either Up markets or Down Markets in Panel C and Panel D, respectively. The control variables are the same as in Table 5 and Table 6. Refer to Appendix Table A2 for variable definitions. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level.

A. Contemporaneous Repurchase Intensity				
Dependent variable:	Delay	Coeff.-based Delay	R-squared	Market Correlation
	(1)	(2)	(3)	(4)
$RepurchaseIntensity_t$	-5.4594	-18.9015*	6.5210*	6.4415*
	(-1.21)	(-1.91)	(1.75)	(1.87)
R^2 (within firm)	0.0435	0.0372	0.0826	0.0719
Observations	485	484	485	485
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
B. Contemporaneous Repurchase Dummy				
Repurchase $dummy_t$	-0.0330	-0.1525	0.0304	0.0248
	(-0.86)	(-1.30)	(0.73)	(0.72)
R^2 (within firm)	0.0409	0.0328	0.0762	0.0655
Observations	485	485	485	485
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
C. Contemporaneous Repurchase Intensity in Up and Down Markets				
$RepurchaseIntensity_t$ x Up $market_t$	3.5091	2.0750	-0.8399	0.7854
	(0.69)	(0.19)	(-0.18)	(0.15)
$RepurchaseIntensity_t$ x Down $market_t$	-8.9491**	-27.1326***	9.3466**	8.6324***
	(-2.28)	(-3.27)	(2.57)	(2.66)
R^2 (within firm)	0.0554	0.0513	0.0749	0.0784
Observations	485	484	485	485
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
D. Contemporaneous Repurchase Dummy in Up and Down Markets				
Rep. $Dummy_t$ x Up $market_t$	-0.0065	-0.0998	0.0039	0.0038
	(-0.17)	(-0.83)	(0.09)	(0.11)
Rep. $Dummy_t$ x Down $market_t$	-0.0752*	-0.2397**	0.0732*	0.0585*
	(-1.91)	(-2.02)	(1.71)	(1.68)
R^2 (within firm)	0.0551	0.0457	0.0968	0.0778
Observations	485	484	485	485
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Table A8: The Impact of Repurchases on Price Delay and Idiosyncratic Risk in Up and Down Markets-Excluding Financial Crisis Months. The table displays the OLS regression results of *Delay* and *R-squared* on an interaction term consisting of a repurchase activity measure and a dummy variable indicating either an up market or a down market and control variables (not tabulated). The control variables are the same as in Table 5 and Table 6. Refer to Appendix Table A2 for variable definitions. All program months between October 2008 and December 2009 are excluded to control for the (potentially) distorting impact of the financial crisis. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level. The Wald statistic tests for differences between the coefficients for up market and down market repurchases. The table presents the test statistics and corresponding p-values for these tests.

Dependent variable:	Delay		R-squared	
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
$Rep.Intensity_{t-1}$ x $Up\ Market_t$	-6.8966		6.0587	
	(-1.53)		(1.51)	
$Rep.Intensity_{t-1}$ x $Down\ Market_t$	-16.302***		13.4409***	
	(-3.72)		(4.52)	
$Rem.Vol_t$ x $Up\ Market_t$		-0.2735		0.0368
		(-0.48)		(0.09)
$Rem.Vol_t$ x $Down\ Market_t$		-0.8511**		0.7056*
		(-2.31)		(1.91)
R^2 (within firm)	0.0633	0.0547	0.0936	0.0869
Observations	451	437	451	437
Firm FE	Yes	Yes	Yes	Yes
Month FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Wald (up - down)(test)	6.94	2.69	10.34	1.90
Wald (up - down)(p-value)	0.0046	0.0901	0.0007	0.1734

Table A9: The Impact of Repurchases on Price Efficiency and Idiosyncratic Risk for All Firm-Months. This table outlines the OLS regressions of *Delay* and *Coefficient-based Delay* (Panel A) and *R-squared* and absolute *Market Correlation* (Panel B) on the repurchase measures *Repurchase Intensity* or *Remaining Volume* and various control variables. For Panel A: In Column (1) and (2) the dependent variable is Delay, whereas in Column (3) and (4) the dependent variable is Coefficient-based Delay. For Panel B: Column (1) and (2) provide the results for R-squared, whereas Column (3) and (4) provide the results for Absolute Market Correlation. For both Panels: in specification (1) and (3) the repurchase variable constitutes the previous periods' *Repurchase Intensity*. In specification (2) and (4) *Remaining Volume* is used as a measure of repurchase activity. Refer to Appendix Table A2 for variable definitions. The t-statistics are provided in parentheses. The asterisks *, **, *** denote significance levels of 10%, 5% and 1% respectively. Standard errors are clustered at the firm level.

Panel A: Price Efficiency				
Dependent Variable:	Delay		Coefficient-based Delay	
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
Repurchase Intensity$_{t-1}$	-0.7278		-0.3353	
	(0.27)		(-0.07)	
Remaining Volume$_{t}$		-0.1051		-0.0919
		(-0.21)		(-0.13)
Delay$_{t-1}$	0.1176***	0.1175***		
	(5.31)	(5.32)		
Coefficient-based Delay$_{t-1}$			0.0636***	0.0636***
			(2.87)	(2.83)
Program Initiation$_{t}$	0.0454	0.0475	0.0652	0.0680
	(1.02)	(1.06)	(0.75)	(0.74)
Return$_{t-1}$ > 0	2.8033	2.8468	8.1915*	8.1815
	(1.37)	(1.39)	(1.72)	(1.69)
Return$_{t-1}$ < 0	-0.2649	-0.1441	-2.0217	-1.9579
	(-0.15)	(-0.08)	(-0.49)	(-0.47)
Book-to-Market$_{t-1}$	0.0161	0.0163	0.0047	0.0047
	(0.85)	(0.86)	(0.16)	(0.17)
Market Capitalization$_{t-1}$ (ln)	-0.0724***	-0.0715***	-0.1440***	-0.1437***
	(-3.57)	(-3.57)	(-3.87)	(-3.95)
RelativeSpread$_{t-1}$ (ln)	0.0003	0.0002	0.0013	0.0014
	(0.08)	(0.05)	(0.17)	(0.18)
Volatility$_{t-1}$ (ln)	-0.0804***	-0.0806***	-0.1865***	-0.1865***
	(-5.74)	(-5.81)	(-5.49)	(-5.44)
Analysts$_{t-1}$ (ln)	-0.0018	-0.0015	-0.0227	-0.0228
	(-0.09)	(-0.08)	(-0.61)	(-0.61)
Trading Volume$_{t-1}$	0.0001**	0.0001**	0.0001***	0.0001***
	(2.09)	(2.02)	(4.15)	(4.06)
AEX$_{t}$	-0.0296	-0.0296	-0.0169	-0.0176
	(-0.26)	(-0.26)	(-0.09)	(-0.09)
AMX$_{t}$	-0.0158	-0.0162	-0.1291	-0.1300
	(-0.17)	(-0.17)	(-0.83)	(-0.83)
ASCX$_{t}$	-0.0294	-0.0306	-0.0757	-0.0751
	(-0.58)	(-0.59)	(-0.71)	(-0.70)
Constant	0.5814***	0.5755***	2.0368***	2.0346***
	(3.70)	(3.70)	(8.07)	(8.08)
R^2 (within firm)	0.0438	0.0438	0.0290	0.0290
Observations	2,414	2,414	2,412	2.412
Firm FE and Month FE	YES	YES	YES	YES

Panel B: Idiosyncratic Risk

Dependent Variable:	R-squared		|Market-correlation|	
	(1)	(2)	(3)	(4)
Method:	OLS	OLS	OLS	OLS
Repurchase Intensity$_{t-1}$	0.2736		0.1596	
	(0.13)		(0.07)	
Remaining Volume$_t$		0.0779		0.0856
		(0.31)		(0.29)
R-squared$_{t-1}$	0.2044***	0.2045***		
	(9.10)	(9.10)		
|Market-correlation|$_{t-1}$			0.1498***	0.1498***
			(6.25)	(6.25)
Program Initiation$_t$	-0.0421	-0.0444	-0.0347	-0.0372
	(-1.43)	(-1.43)	(-1.17)	(-1.20)
Return$_{t-1}$ > 0	-2.8501**	-2.943**	-2.5512	-2.5499
	(-2.10)	(2.08)	(-1.58)	(-1.56)
Return$_{t-1}$ < 0	-0.2084	-0.2604	-0.3576	-0.3902
	(-0.16)	(-0.19)	(-0.26)	(-0.27)
Book-to-Market$_{t-1}$	-0.0043	-0.0042	-0.0048	-0.0049
	(-0.26)	(-0.26)	(-0.28)	(-0.28)
Market Capitalization$_{t-1}$ (ln)	0.0644***	0.0641***	0.0667***	0.0664***
	(4.38)	(4.42)	(3.78)	(3.79)
RelativeSpread$_{t-1}$ (ln)	-0.0001	-0.0001	0.0001	-0.0001
	(-0.01)	(-0.03)	(0.01)	(-0.02)
Volatility$_{t-1}$ (ln)	0.0740***	0.0741***	0.0873***	0.0874***
	(6.10)	(6.10)	(8.59)	(8.63)
Analysts$_{t-1}$ (ln)	-0.0019	-0.0018	0.0075	-0.0074
	(-0.14)	(-0.13)	(0.45)	(-0.44)
Trading Volume$_{t-1}$	0.0001	0.0001	-0.0001**	-0.0001**
	(1.64)	(1.50)	(-2.63)	(-2.60)
AEX$_t$	0.0294	0.0288	0.0413	0.0408
	(0.31)	(0.31)	(0.40)	(0.39)
AMX$_t$	0.0190	0.0197	0.0098	0.0106
	(0.27)	(0.28)	(0.12)	(0.13)
ASCX$_t$	0.0297	0.0292	0.0184	0.0181
	(0.82)	(0.79)	(0.42)	(0.40)
Constant	0.0643	0.0661	0.2870*	0.2894**
	(0.55)	(0.57)	(1.99)	(2.01)
R^2 (within firm)	0.0872	0.0872	0.0658	0.0659
Observations	2,414	2,414	2,414	2,414
Firm FE and Month FE	YES	YES	YES	YES