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Actual Share Repurchases and Price Efficiency in Hong Kong

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Preface

This thesis marks the end of my 'career' as a student at the Erasmus University Rotterdam. The process has been a verstile experience. It has given me the chance to put what the people of the Erasmus School of Economics have thought me over the years into practice. This thesis will hopefully propagate to readers the expertise of the people of the Erasmus University and all its employees.

Though this thesis will become history over time, carrying my name, I would like to thank P.H.M. Rooijmans and M.H.R. Stuurman for the helpful feedback. Many thanks to M.I. Beermann for the critical remarks, great insights and sustained support. Finally, special thanks to dr. Stefan Obernberger for the supervision, the professional approach, the helpful comments and the sustained patience.

"I have never tried that before, so I think I should definitely be able to do it"

- Pippi Longstockings

Abstract

This research shows that open market share repurchases increase price efficiency in Hong Kong. Furthermore, the magnitude of the repurchase activity also significantly influences the change in price efficiency. The effects of open market share repurchases on the price efficiency of a stock are more pronounced in months where negative information enters the market which implies that firms provide price support at fundamental values. This notion of price support implies an increase in the accuracy with which new negative information is incorporated in the price. Further analysis shows that the increase in price efficiency, caused by the provided price support by firms, is more pronounced for small firms and firms in high book-to-market periods.

JEL classification: G10 - G30

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1 Introduction

This thesis will research the effects of an open market share repurchase on price efficiency. This research and analysis relates to a study done by Busch and Obernberger (2017) who use data from the United States. The analyses and results of this thesis will add to the existing literature by broadening the framework of open market share repurchases and price efficiency using a recent dataset and places the results into perspective surrounding firm size and book-to-market ratios among firms. The research is performed using data from firms listed on the Hong Kong Stock Exchange and actual share repurchases in Hong Kong in the period 31-12-2003 until 31-12-2015.

Open market share repurchases have become more and more popular over the years as a form of pay-out to shareholders for firms. Dividends were the most common way for firms to payout excess earnings to shareholders. Grullon and Michaely (2002), however, document that in 1999 open market share repurchases first exceeded dividends in the United States as a form of payout. There have been many studies which investigate the implications of, and the phenomena related to, open market share repurchases. Most studies surrounding this topic have been done using data from United States' stocks. Open market share repurchases are an interesting topic as they provide the most pay-out flexibility for firms relative to other repurchase programs (Ikenberry and Vermaelen, 1996 and Stephen and Weisbach, 1998). Prior research has documented several motivations for initiating or announcing an open market share repurchase. A popular motivation, according to Chan, Ikenberry and Lee (2004), is the mispricing theory. When managers suspect that their stock is undervalued, they might announce or initiate an open market share repurchase to repurchase stocks at low costs.

Busch and Obernberger (2017) research the effects of open market share repurchases on price efficiency in the United States. They argue that open market share repurchases make prices more efficient by increasing the accuracy with which negative information is incorporated into prices. Hou and Moskowitz (2005) argue that open market share repurchases increase the speed with which positive information is incorporated into prices. This thesis will look at whether open market share repurchases make prices more efficient in Hong Kong and how this possible increase comes about.

In order to research how open market share repurchases affect price efficiency in Hong Kong, several hypotheses have been constructed. The primary analysis will look into the effect that an open market share repurchase has on the price efficiency of a stock. The first hypothesis

states that open market share repurchases make prices more efficient. The secondary analysis will put the results from the primary analysis into perspective and will go into depth about the channels through which the effects of the primary analysis come about. The secondary analysis also takes firm size and book-to-market ratios into account. The second hypothesis argues that open market share repurchases make price more efficient by providing price support at fundamental values. The third hypothesis relates to firm size and states that the effect of open market share repurchases on price efficiency is more pronounced for large firms. The final hypothesis, relating to book-to-market ratios across firms, states that open market share repurchases will more strongly affect price efficiency for high book-to-market stocks. The argumentation of the hypothesis will be elaborated on in section four.

The dataset consists of all firms listed on the Hong Kong stock exchange (HKEX) from 31-12-2003 until 31-12-2015. Daily stock price data and actual repurchase data are obtained and the analyses are done using monthly data. The final dataset consists of 38,004 monthly observations, which contains 2,140 repurchase months, across 318 repurchasing firms.

The results of this research show that in general, an open market share repurchase significnatly increases price efficiency. In months where the market goes down, the results are stronger compared to months where the market goes up. This result indicates that open market share repurchases increase price efficiency when negative information enters the market. This result support the notion that open market share repurchases make prices more efficient by providing price support at fundamental values. This price support increases the accuracy with which negative information is incorporated into prices. Further analysis on firm characteristics show that the increase in price efficiency by open market share repurchases is more pronounced for small firms and firms in high book-to-market periods. This research adds to the existing literature in a way that its focus is on Hong Kong specifically. Furthermore, the results show that the effects of open market share repurchases on price efficiency differ significantly across small and large firms and whether firms experience high or low book-to-market ratios.

The remainder of this thesis is structured in the following way. Sections two and three will respectively construct a theoretical framework surrounding open market share repurchases and price efficiency. In section four, several hypotheses for the primary and secondary analysis will be discussed. Section five will elaborate on the collection and construction of the final dataset and section six will cover the description of the essential variables of the analyses. Sections seven and eight include the methodological setup and the results of the primary and secondary

analyses. Section nine will provide several robustness checks and the thesis will be concluded in section ten.

2 Open Market Share Repurchases

This section captures characteristics and phenoma relating to open market share repurchases. Prior research relating to open market share repurchases and how it relates to efficiency and information content are discussed. An open market share repurchase is a program where a firm generally announces that it will repurchase a certain amount of its shares in the open market. Though the firm sets a certain amount of shares it intends to repurchase, it has no obligation to honour this. Firms who announce an open market share repurchase on average repurchase between 74 to 82 percent of the announced number of shares in the three subsequent years (Stephens and Weisbach, 1998).

2.1 Motivation

Chan, Ikenberry and Lee (2004) suggest three possible motivations for share repurchases. The first motivation relates to mispricing. This mispricing theory states that if managers think their stock price is below intrinsic value, they use repurchase announcements as a signalling mechanism. The second suggested motivation is the free cash flow hypothesis. When the market suspects agency problems as a result of overinvestment by management, repurchases serve as a tool for distributing free cash flow available to management to shareholders. This motivation follows the argumentation of Jensen (1986) who argues that firms repurchase shares in order to reduce the free cash flow that would be available for managers and reduce the risk of overinvestment. This reduces agency problems due to the decrease of the available funds for overinvestment by management. The third motivation is the altering capital structure hypothesis. Stock repurchases increase the debt-to-equity ratio of a firm. Repurchases are therefore a tool for managing capital structure of a firm. This theory states that firms with below target leverage will initiate or announce a repurchase in order to increase leverage. In their study, Chan et al. (2004) find evidence for the mispricing theory which serves as a signalling tool. Their results are less consistent with the free cash flow hypothesis and they find no evidence for the capital structure hypothesis. This study suggests that the most important motivation for announcing or initiating a share repurchase is the perception by management that their stock is undervalued. A repurchase announcement will inform investors about the managers' belief that the share is underpriced. The information incorporated into prices will increase as a result of these informed investors.

2.2 Signalling

There has been a lot of prior research on the effects of open market share repurchases on stock price performance, risk and the signalling power of such a program. Vermaelen (1981) argues that open market share repurchases are informative and signal the market. Vermaelen considers both a negative and a positive signal related to an open market share repurchase. Vermaelen argues that the announcement or execution of an open market share repurchase could signal the market that a firm has no profitable investment prospects and therefore lacks growth opportunities. As a result, a firm decides to use the available cash to repurchase its shares. Another possible signal could be the undervaluation of the stock. This undervaluation motivates management to repurchase shares. Management will act on the perceived undervaluation of the stock to repurchase shares at a price which is less than the believed value of the stock. Vermaelen further argues that repurchases in general are informative and contribute to efficiency as repurchases allow firms to correct mispricing.

Asquith and Mullins Jr. (1986) stress the importance of false signalling. False signalling occurs when the distribution of cash, through open market repurchases, leads to equity financing in the future. The negative market reaction to an equity issue is referred to as 'the cost to false signalling' (Asquith and Mullins Jr., 1986). A firm should therefore be careful when initiating an open market share repurchase. When the distribution of cash through a repurchase is not sustainable over the future, the positive reaction will possibly be overshadowed by the negative market reaction of an equity issue in the future. This 'cost of false signalling' makes it less likely that open market share repurchases are used as common tool for to boost the stock price. It does make it more likely that a repurchase actually is informative.

Research done by Comment and Jarrel (1991) contributes to the signalling hypothesis of Vermaelen (1981) and suggests that open market share repurchases are a positive signal to the market. They document significant positive abnormal returns for firms which repurchase shares. These findings are in line with the explanation of Vermaelen (1981) that open market share repurchases contribute to the efficiency and information is incorporated more accurately. Miller and Modigliani (1961) suggest that when markets are incomplete, and are thus inefficient, the payout policy serves a substantial goal for firms. A change in payout policy by a firm signals the market about the future earnings expectations. An open market share repurchase, as a form of payout to shareholders, signals the market that higher earnings in the future are expected. In general, the signals associated with a change in payout policy reveal information to the market. Grullon and

Michaely (2004) argue that an announcement to initiate an open market share repurchase should be accompanied with an immediate increase in the stock price. When prices are not efficient, it is not unlikely that the revealed information about future earnings will not immediately be incorporated into prices.

2.3 Flexibility

An open market share repurchase contributes strongly to the flexibility of a firm when distributing cash to its shareholders. An open market share repurchase allows firms to repurchase shares and to set a target, but it does not obligate them to actually repurchase shares, let alone meet the afore set target. Stephens and Weisbach (1998) argue that open market share repurchases have gained in popularity because of this flexibility. They are popular, in comparison to other repurchasing methods, due to stock price fluctuations and cash flow uncertainty in the future. In comparison with dividends, which have been the most common way of distributing cash before repurchasing programs, an open market share repurchase does not raise the expectation that it occurs regularly and consistently (Dittmar, 2000). The expectation that a distribution of cash to shareholders will occur regularly is troublesome for firms as they can not predict whether they will be able to meet this expectation. If a firm has to decrease the distribution of cash to shareholders, the negative market reaction is possibly more intense than the positive reaction at the implementation of the cash distribution. Jagannathan, Stephens and Weisbach (2000) add to this view of flexibility and find in their research that firms which have more volatile cash flows are more likely to use open market share repurchases as a mechanism to distribute cash. This volatility suggests that firms using repurchases as method of pay-out to shareholders, are more flexible in their pay-out behaviour as opposed to firms who use dividends. Furthermore, they document that share repurchases follow poor stock market performance which indicates that share repurchases are preferred over dividends when the market goes down.

The flexibility related to open market share repurchases can however, according to Chan, Ikenberry, Lee and Wang (2010), be troublesome. Because of the signalling power of repurchase announcements, and the frequently abnormal returns following this announcement (Comment and Jarrel, 1991), managers can mislead investors and use repurchase announcements to boost the share price. When managers anticipate on the positive market-reaction common with open market share repurchase, they might make an announcement with no intention of actually repurchasing shares thereafter. This motivation negates the argument that open market share repurchases are informative. The argument about the cost relating to false signalling however,

makes it less likely that managers would in fact strategically use open market share repurchases to boost the stock price.

2.4 Summary

Prior research has shown that an open market share repurchase carries significant signalling power. Multiple researches discuss the positive signal related to an open market share repurchase, where an announcement in general signals the market that management perceives the shares as undervalued. On the contrary, Vermaelen (1981) considers a possible negative signal of an open market share repurchase to the market. According to Vermaelen, the market can interpret an open market share repurchase as a signal that the repurchasing firm lacks profitable investment or growth opportunities. This signal would affect the share price negatively. Furthermore, pay-out flexibility is important in the framework of open market share repurchases. Where, historically, dividends have been the preferred method of pay-out to shareholders by firm, open market share repurchases have become more popular. In general, research has shown that open market share repurchases contain information, where most research considers a postive signal related to repurchases.

3 Information content and price efficiency

This section will construct a framework surrounding the information content of prices and price efficiency. The information content of prices is defined as the amount of information incorporated into prices and price efficiency is defined as the degree to which all available information is incorporated into prices.

3.1 Information content

Collins, Kothari and Rayburn (1986) research the relationship between future earnings and the amount of information incorporated into prices. In their research they use a firm size proxy for the information content of prices. The reasoning behind this proxy is that it is more likely that the available information of relatively large firms will be processed more thoroughly as compared to smaller firms. Brown, Richardson and Schwager (1987) argue that larger firms in general have more analysts following the firm. The more analysts follow a firm, the more information will become public. The information content of prices is therefore likely to be positively related to firm size. It is expected that because of the more thoroughly processed information for large firms, the amount of available information actually incorporated into prices will be larger for

large firms. Large firms should therefore have more efficient stock prices. Huffman (1992) finds that the volume of capital traded and information content are highly correlated and that an increase in the transaction volume is associated with an increase of the information content of prices. This means that the prices will contain more information when trading volume is relatively high. According to Boehmer and Wu (2012), stocks with a high trading volume will respond more quickly to new information in the market that low turnover stocks. It stands to reason that stocks with a high trading volume will therefore increase the information content of prices and increase price efficiency. Not surprisingly, trading volume is positively related to firm size (e.g. Chan and Fong (2000) and Chordia and Swaminathan (2000)). The positive effect of firm size on the information incorporated into prices possibly works through the trading volume of a stock.

3.2 Price efficiency

Hou and Moskowitz (2005) constructed a measure which captures the price delay of a stock. The model assesses the explanatory power of the extended market model compared to the simple market model. The model captures whether lagged market returns have any added value when explaining stock returns. When prices are efficient, there should be no explanatory power in the lagged market returns and thus the delay measure should be zero. If not all available information is directly incorporated into the stock price, the delay measure will significantly deviate from zero. If there is a change in price efficiency, a change in the opposite direction should be observed in the delay measure. A related measure is based on research of Saffi and Sigurdsson (2010) and Busch and Obernberger (2017). Both researches use a price efficiency measure based on the delay measure. The measure, the coefficient-based delay measure, is constructed using the coefficients of both the simple and the extended market model. The model compares the lag-weighted sum of the lagged market return coefficients relative to all coefficients.

An alternative measure for price efficiency is proposed by Bris, Goetzmann and Zhu (2007), who use the cross-autocorrelation between lagged market returns and individual stock returns. By doing so, they aim to measure the speed of individual stock price adjustments to market movements. Saffi and Sigurdsson (2010) argue that, among other measures, this measure could be susceptible to an omitted variable bias.

3.3 Price efficiency and repurchases

Previous research done by Busch and Obernberger (2017) has distinguished two channels through which repurchases could have an effect on the price efficiency of a stock. The channels are built on the notion that open market share repurchases will increase the efficiency with which either positive or negative information is incorporated into prices. The channel relating to positive information states that prices become more efficient as a result of the active trading on positive information. An open market share repurchase signals positive information to the market, among others documented by Lie (2005). If traders observe the positive signal by the firm they will more actively trade in that stock, increasing its price efficiency (Fishman and Hagarty, 1989). The channel relating to negative information builds on the phenomenon that repurchases are conducted when the market value of a stock is low. This implies that firms will repurchase shares when prices are below fundamental values. Hong, Wang and Yu (2008) find that firms are able to keep the price from falling below its fundamental value. In doing so, firms are able to decrease downside risk. The return volatility will therefore be lower, thus making prices more efficient.

4 Hypotheses construction

In this section, several hypotheses which will structure the analysis to arrive at the conclusion will be discussed. The first and primary analysis will look into the effects of open market share repurchases on price efficiency. The secondary analysis will investigate the channels through which open market share repurchases affect the price efficiency of a stock and consider both firm size and book-to-market ratios.

4.1 Primary analysis

The primary analysis isolates the effect open market share repurchase have on price efficiency. This hypothesis is motivated by the results from Busch and Obernberger (2017). They find in their research that open market share repurchases make prices more efficient. The hypothesis of the primary analysis is:

Open market share repurchases make prices more efficient in Hong Kong.

The results of the primary analysis will capture the direct effect that open market share repurchases have on price efficiency in Hong Kong. This analysis serves as a basis on which the following analysis is built.

4.2 Secondary analysis

The secondary analysis will aim to tackle the channels through which open market share repurchases affect price efficiency and for which firms these effects are more pronounced. The research of Busch and Obernberger (2017) has distinguished two different channels through which open market share repurchases possibly increase price efficiency. The first channel is based on Hou and Moskowiztz (2005) and states that open market share repurchases increase the speed with which new positive information is incorporated into the stock price. They argue that firms trade actively on positive information. If some stocks are not actively traded in the market, they could slip the attention of investors or analysts. Firm repurchasing shares essentially act as an investor in its own stock trading on postive information which is not reflected in the stock price. This process incorporates the positive available information into the stock price thus increasing price efficiency. Busch and Obernberger (2017) conclude that open market share repurchases increase price efficiency by increasing the accuracy with which negative information is incorporated into stock prices. They argue that firms use open market share repurchases to provide price support at fundamental values, making prices more accurate and thus more efficient. The price support argument is based on Hong, Wang and Yu (2008) who claim that firms who are able to keep prices form falling below fundamental values, decrease return volatiliy. In this context, firms trade on negative information to keep the share price from overshooting and essentially maintain a lower boundary at the stock's fundamental value. This will result, according to Busch and Obernberger (2017), in more efficiently priced stocks. The second hypothesis of this research is based on the reasoning on these findings and states:

Open market share repurchases make prices more efficient by providing price support at fundamental values.

To research the effect of open market share repurchases on price efficiency in more depth, the next step in the secondary analysis takes firm size and book-to-market into account. The third hypothesis revolves around the differences in firm size. Small firms are more likely to be subject to slower information incorporation by the market compared to large firms (Hong, Lim and Stein, 2000). Larger firms are therefore priced more efficient compared to small firms which

makes the potential gain in price efficiency for small firms greater compared to large firms. The hypothesis regarding firm size is:

The effect of open market share repurchases on price efficiency is more pronounced for small firms.

The final step in the secondary analysis takes the book-to-market ratio of firms into account. The book-to-market ratio will be used to split the sample based on the median and on deciles. Following the classification of Porta, Lakonishok, Shleifer and Vishny (1997), the highest book-to-market decile will be classified as value stocks and the lowest book-to-market decile will be classified as growth stocks. High book-to-market stocks are more likely to be undervalued than low book-to-market stocks (Ikenberry, Lakonishok and Vermaelen, 1995). Comment and Jarrel (1991) argue that the positive information that is revealed to the market through an open market share repurchase is more common for a stock which is perceived to be undervalued. It stands to reason that an open market share repurchase will more significantly increase price efficiency of a stock in periods of undervaluation and a high book-to-market ratio. The final hypothesis of the secondary analysis is:

Open market share repurchases will more strongly affect price efficiency for stocks in high book-to-market periods.

5 Data

This section will elaborate on the data collection, alteration and construction process and describe the final dataset using descriptive statistics presented in table 1.

5.1 Data collection

The first step in the data collection process is to collect daily stock specific data for firms listed on the Hong Kong Stock Exchange. To end up with a sufficient large dataset, data ranging from 31-12-2003 till 31-12-2015 which are available on Datastream and Worldscope will be used. From these databases daily stock price and firm data are obtained which results in a dataset consisting of 5,825,987 daily observations spread across 1,811 firms. For the calculation of the market return, the Hang Seng price index available on datastream is used. The second step is to collect daily data on share repurchases by firms listed on the Hong Kong Stock Exchange in the same period. The repurchase data are manually obtained from HKEXnews.hk where data on repurchase activity are documented. After merging the repurchase data with the firm data and

after removing non-repurchasing firms in the chosen period, the dataset contains 1,072,578 daily observations across 473 firms.

5.2 Dataset construction

All firms which have less than one year of data available are removed. The average number of trading days, considering the weekends and the holidays on which the Hong Kong Stock Exchange is closed, is 260 trading days. This alteration results in a dataset with 1,069,297 daily observations across 446 firms. The next step is to remove firms which have faulty data available, possibly in combination with correct data for less than one year. If the firm does not have sufficient data available after controlling for these observations, the firm is removed from the dataset. After controlling for this faulty observations, 945,116 daily observations across 429 firms remain. As the analysis requires monthly data, the next step is converting the daily data into monthly data. The conversion to monthly data results in a dataset of 43,592 monthly observations across 429 firms.

The final step in constructing the dataset consists of two parts. The first part consists of the manual identification of firms which have partly faulty data concerning the stock price, but have sufficient correct data available to be used in the analysis. The months containing faulty data are removed from the dataset. The second step is remove firms which have no longer data on repurchase activity available. Some firms have only repurchase data available for months where the stock price shows faulty data. After the removal of those firms, the final dataset contains 318 firms having 38,004 monthly observations containing 2,140 repurchase months.

In order to minimize the chance of having faulty data the winsorization method is used. Prices which lay below the 2.5th percentile and above the 97.5th percentile are replaced with respectively the value of the 2.5th and 97.5th percentile value. The choice of range in order to remove outliers is subjective to the consideration between removing extreme values and having useful data. Winsorization can cause biases in the data because extreme values are no longer used in the analysis. It is common to winsorize the data using the fifth and 95th percentile. In this research the 2.5th and the 97.5th percentile are used in order to decrease the risk of using biased data.

6 Variable description

In this section, the dependent and independent variables used in the primary and secondary analysis are discussed. The construction of the variables and the models used in the primary and secondary analysis are discussed in the corresponding sections.

6.1 Dependent variables

For both the primary and secondary analysis, two variables measuring the price efficiency of a stock will serve as dependent variables. The first measure, delay, is based on the research of Hou and Moskowitz (2005) and the second measure, coefficient-based delay, is based on the research of Busch and Obernberger (2017). Both measures use the r-squared of the simple and the extended market model. The r-squared of both the simple market model and the extended market model are estimated for each firm and each month. The extended market model includes five lags of the market return. The delay measure and the coefficient-based delay measure capture the added explanatory power of the lagged market returns compared to the contemporaneous market return when explaining stock returns. These measures can be used to document changes in price efficiency. A decrease in the explanatory power of the lagged market returns will results in a decrease in the r-squared of the extended market model. This reduction in the r-squared will in turn result in a decrease in the price efficiency measure. Changes in these measures represent changes in price efficiency and thus the speed or accuracy with which information is incorporated into the price.

6.2 Independent variables

The independent variables of both the primary and secondary analysis capture the repurchase activity of a firm. In this research, two measures for repurchases activity will be used. The first measure, repurchase intensity is calculated by scaling the average monthly number of shares repurchased by the number of shares outstanding on the last trading day of the previous month. This allows one to use a measure of repurchase activity relative to the total number of outstanding shares. The second measure uses the turnover by volume of a stock to scale the number of shares repurchased in a certain month. If repurchase activity increases, the number of shares repurchased relative to the total number of shares traded will increase, which is captured by this measure.

The secondary analysis will use several variables to create subsets. Subsets concerning positive and negative information, small and large firms and low and high book-to-market ratio firms will

be constructed. The subsets capturing positive and negative information use the monthly market returns as an identification variable for splitting the sample. The data are split into months where the market goes up and months in which the market goes down. This setup essentially creates one repurchase activity measure for both months where positive and months where negative information enters the market. The same reasoning applies for the subsamples based on firm size and book-to-market ratios. The subsamples will create a repurchase activity measure for small firms, large firms, low book-to-market periods and high book-to-market periods for a firms.

7 Primary analysis

The primary analysis will research the effect of an open market share repurchase on the price efficiency of a stock. The hypothesis regarding this analysis states that open market share repurchases make prices more efficient.

7.1 Measure for open market share repurchases

In order to successfully measure the effect of an open market share repurchase on the price efficiency of a stock a measure for open market share repurchases will be constructed. For this analysis, the repurchase intensity and the repurchase turnover will be used as measures for the repurchase activity. The *repurchase intensity* is constructed by dividing the number of shares repurchased by the total number of shares outstanding at time t for firm i (equation 1). The repurchase measure will be a monthly measure, calculated using daily repurchase data, as the price efficiency measure is calculated on a monthly basis using daily data. The repurchase measure will capture the average repurchase activity scaled by the number of shares outstanding on the last trading day in the previous month. The second measure, *repurchase turnover*, captures the volume of the shares repurchased during a certain month scaled by the turnover of the stock in the previous month. The *repurchase turnover* (equation 2) denotes the average number of shares traded in the previous month scaled by the average number of shares traded in the entire market for that month. The measure has been scaled to control for periods of high turnover in the market in general.

$$Repurchase\ intensity_{t,i} = \frac{Number\ of\ shares\ repurchased_{t,i}}{Number\ of\ shares\ outstanding_{t-1,i}} \qquad (1)$$

$$Repurchase\ turnover_{t,i} = \frac{Number\ of\ shares\ repurchased_{t,i}}{Turnover\ by\ volume_{t-1,i}} \qquad (2)$$

Based on the research by Busch and Obernberger (2017), repurchase intensity is a good measure for repurchase activity. They discuss the importance of returns in this analysis. As a measure for price efficiency is constructed using stock returns, significant effects of stock returns on open market share repurchase could cause problems. According to Stephens and Weisbach (1998), open market share repurchases usually follow poor stock performance. It would therefore be expected that negative stock returns in the previous month would increase the repurchase activity of a firm in the subsequent month. To check whether repurchases are driven by returns, equation 3 is included in the analysis.

$$\begin{aligned} RI_{t,i} &= \alpha_+ \gamma RI_{t-1} + \beta_1 RetP_{t-1,i} + \beta_2 RetN_{t-1,i} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} \\ &\quad + F_i + T_t + \epsilon_i \qquad (3) \end{aligned}$$

In equation 3, *RI* is the repurchase intensity, alpha is the constant and *RetP* and *RetN* are respectively positive and negative monthly returns. *Control* captures a set of control variables. The analysis is done using panel data and therefore fixed effects estimation is appropriate. The analysis includes a firm fixed effect, which is time invariant, *F* and a time fixed effect *T*. This analysis serves a supportive purpose for the core analysis.

7.2 Measure for price efficiency

The second measure that needs to be constructed for the analysis is a measure for price efficiency. This research will include two measures for price efficiency. The first measure is the *delay* measure, suggested by Hou and Moskowitz (2005). The second measure, *coefficient-based delay* is based on research of Busch and Obernberger (2017). These measures both capture the added explanatory power of lagged market returns compared to contemporaneous market returns when explaining stock returns. For the construction of both measures, a simple and an extended market model will be estimated (respectively equation 4 and 5).

$$R_{i,t} = \alpha_i + \beta_i r_{m,t} + \epsilon_i \qquad (4)$$

$$R_{i,t} = \alpha_i + \beta_i r_{m,t} + \sum_{n=1}^{5} \beta_n r_{m,t-n} + \epsilon_i \qquad (5)$$

Both the simple and the extended market model will be estimated using daily stock return and market return data. For every month with available data the r-squared from both models will be

constructed which results in a dataset of monthly regression data. The r-squared describes the relative amount of the total variation that is explained by a model. The higher the r-squared, the better the model fits the data. The price efficiency measure proposed by Hou and Moskowitz (2005) will be constructed as described by equation 6.

$$Delay_{i,t} = 1 - \frac{r^2_{simple}}{r^2_{extended}} \qquad (6)$$

The *coefficient-based delay* (equation 7) measure describes the sum of the lag-weighted coefficients of the lagged market returns of the extended market model, relative to the sum of all the coefficients of both the simple and the extended market model. All coefficients are scaled by their standard errors.

$$Coefficient\ based\ delay_{i,t} = \frac{\sum_{n=1}^{n=5} n \frac{\beta_n}{SE_\beta}}{\frac{\beta_0}{SE_{\beta_0}} + \sum_{n=1}^{n=5} n \frac{\beta_n}{SE_{\beta_n}}} \qquad (7)$$

The higher the price efficiency of a stock, the lower (coefficient-based) delay must be. If the lagged returns have no explanatory power, (coefficient-based) delay should be zero. If the lagged returns do have explanatory power, the r-squared of the extended market model will be larger than the r-squared of the simple market model, which in turn will cause(coefficient-based) delay to be higher than zero. Hou and Moskowitz reason that if price efficiency is high, lagged market returns should have no explanatory power. If prices are efficient, there should be no observed delay when incorporating market information in stock prices. The use of both measures allows one to observe an increase or a decrease in price efficiency.

7.3 Share repurchases and price efficiency

After the construction of the measures for both repurchase activity and price efficiency, the analysis can focus on the effects of an open market share repurchase on the price efficiency of a stock. The analysis will be in the form of a fixed effect regression using the measure for price efficiency as the dependent variable and the monthly repurchase activity measure as independent variable. The regression analysis will be performed using equation 8.

$$\begin{aligned} Delay_{i,t} \;=\; & \alpha \;+\; \gamma delay_{i,t-1} \;+\; \beta_i RI_{i,t} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} \\ & + F_i \;+ T_t \;+ \epsilon_i \qquad (8) \end{aligned}$$

This panel data regression analysis includes the lagged delay measure, the contemporaneous repurchase intensity, a repurchase dummy variable, a set of control variables, a time invariant firm fixed effect and the firm invariant month fixed effect. Including a repurchase dummy, which takes value one if a firm repurchases shares in that month, next to the repurchase intensity, makes it possible to segregate the general effect of a repurchase on delay and the effect relating to the magnitude of the repurchase. The repurchase dummy will capture the effect of a repurchase month on price efficiency relative to non-repurchasing months. The repurchase intensity captures the effect an increase in repurchase activity will have on price efficiency.

7.4 Controls

Results from Hou and Moskowitz (2005) show that in general, smaller firms have lower levels of price efficiency. Therefore a control variable for firm size will be included in the price efficiency analysis. Firm size will be constructed using the market capitalization and the total asset value of the firm. Philips (2011) has found further that the stock return volatility is of importance when performing analysis on price efficiency. Repurchase activity is likely to be related to liquidity. A measure for liquidity, proposed by Amihud (2002) will be included in the analysis. In this analysis this measure will be constructed using the monthly stock return volatility. Based on the results from the analysis of lagged returns on repurchase intensity, both lagged positive and lagged negative returns will be included as control variables. Finally, several firm variables commonly used as control variables in financial research will be included.

7.5 Results

The results related to the analysis on the measure of repurchase activity are reported in table 2. As expected, the coefficient on lagged negative returns is significant and negative and the coefficient on lagged positive returns is not significant. The combination of the insignificant coefficient on positive returns and the significant negative coefficient on negative returns, indicate that an increase in stock returns will decrease repurchase activity of a firm. This effect is no longer present when stock returns are positive. The results indicate that it would be of use to control for returns in the analyses concerning price efficiency. Omitting returns in the subsequent analyses would most likely cause problems as the measure for price efficiency is constructed using analysis on stock returns. The positive and significant coefficient on lagged repurchase intensity implies that repurchase activity will be higher following previous repurchasing months. The results regarding the control variables are mostly insignificant apart from the market capitalization. The negative coefficient implies that larger firms will have relatively lower repurchase activity

compared to smaller firms. Market capitalization however, is susceptible to market mispricing. Taking into account total assets, which also captures the size of the firm, the effect on firm size no longer seems to have an effect. Total assets is not susceptible to market mispricing and the insignificant effect on repurchase intensity makes the effect of firm size doubtful. Finally, the coefficient on the measure for liquidity is negative and significant. This implies that liquidity is positively related to repurchase activity as the measure used is proxies illiquidity.

Based on the results reported in table 3, it seems that repurchase intensity significantly decreases delay. The significant negative coefficient on repurchase intensity implies that higher aggregate repurchase activity in a certain month is followed by a decrease in delay in the same month. An increase of 1 percentage point in repurchase intensity will lead to a decrease of 0.68 percent of mean delay (-0.0046/0.6730) where -0.0046 relates to the coefficient estimate on repurchase intensity and 0.6730 relates to the average delay across all firms. The coefficient on the repurchase dummy is negative and significant indicating that delay in general is decreased in months where a firm performs a repurchase. In months where a firm repurchases shares, delay is 2.76 percent lower compared to non-repurchase months (-0.0186/0.6731), where -0.0186 corresponds to the coefficient estimate on the repurchase dummy.

The results in column 2 show the effect of the lagged repurchase intensity on delay. The coefficients on the lagged repurchase intensity is negative, however far from significant. Based on these results, conclusions concerning the effect of open market share repurchases on price efficiency will need further analyzing. Conclusions based on the results of contemporaneous repurchase intensity can be susceptible to reverse causality problems.

7.6 Reverse causality

Following the results of repurchase activity on delay it is of importance to include a control analysis in order to attempt to exclude the possibility that the results are driven by reverse causality. As the results have shown that only contemporaneous repurchase activity has an significant effect on contemporaneous delay, an analysis which controls for the possible effect delay has on repurchase activity is included. To control for the possible bias the analysis will have to check whether delay affects repurchase intensity rather that the other way around. The analysis (equation 9) follows the same setup as equation 3, but the variable lagged delay is included. The variables regarding positive and negative returns, described in equation 3, are included in the set of control variables.

$$RI_{t,i} = \alpha + \gamma RI_{t-1,i} + \delta delay_{t-1,i} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (9)$$

The coefficient on lagged delay, reported in table 4, is negative but far from significant. This means that delay does not influence the repurchase activity of a firm. The conclusion is therefore that the results from the primary analysis are robust and that the results are not driven by reverse causality. The contemporaneous repurchase intensity can therefore be used as a robust measure for repurchase activity in the subsequent analyses.

7.7 Conclusion

Based on the results of the primary analysis using contemporaneous repurchase activity, it seems that open market share repurchases have a significant effect on the price efficiency of a stock. Price efficiency is increased in months where a firm performs an open market share repurchase. Furthermore, price efficiency is also significantly increased as the repurchase intensity increases. The results support the hypothesis that open market share repurchases make prices more efficient. The results from the control analysis rule out possible reverse causality issues relating to this and subsequent analysis.

8 Secondary analysis

The focus of the secondary analysis is threefold. This section will aim to explain how the results from the primary analysis come about and to which firms these results are apply. The first part of the secondary analysis looks into the effect of positive and negative information which enters the market in order to distinguish the channel through which open market share repurchases increase price efficiency. The second part looks more closely at the size of the firm and the final part takes the book-to-market ratios of firms into account.

8.1 Price efficiency in up and down months

In order to explain the effects, resulting from the primary analysis, a model to assess whether the increase in price efficiency, due to repurchase activity, is caused by the entering of either positive or negative information into the market is included. Hou and Moskowitz (2005) argue that price efficiency is increased by share repurchases if positive information enters the market.

They explain this mechanism in the way that repurchases increase the speed with which new positive information is incorporated into the stock price. They argue that this phenomenon exists through the active trading by agents on this new information. Busch and Obernberger (2017) argue that repurchases increase the accuracy with which new negative information is incorporated into the stock price by the provided price support at fundamental values by firms.

The first hypothesis of the secondary analysis suggests that the increase in price efficiency due to repurchases, is caused by the increase of the accuracy with which new negative information is incorporated into the stock price. The hypothesis follows the conclusions of Busch and Obernberger (2017), who explain the increase in price efficiency as a result of firms providing price support at fundamental values. Following their reasoning, it is expected that in this analysis the proxy used for negative information, interacting with a measure for repurchase activity significantly decreases delay. The measure used to identify whether good or bad information enters the market is the monthly market return. The monthly market return is used to split the sample into months where the market goes up and where the market goes down based on the monthly market return representing positive and negative information entering the market respectively. The hypothesis will be tested using the setup described in equation 10.

$$\begin{aligned} Delay_{i,t} &= \alpha_i + \gamma\, delay_{i,t-1} + \beta_{i,1}(RI_{i,t} * up) + \beta_{i,2}(RI_{i,t} * down) \\ &\quad + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \qquad (10) \end{aligned}$$

The setup of equation 10 is the same compared to that of the primary analysis, apart from the dummies up and down. The dummies respectively take on values one when the market goes up or when the market goes down. This setup enables it to research whether the effects of open market share repurchases on price efficiency are more pronounced when either positive or negative information enters the market.

8.1.1 Results

The results of the secondary analysis concerning positive and negative information are reported in table 5. Based on the results on this analysis, delay is significantly affected in months where the market goes up using a five percent confidence level. Judging from the results for repurchase activity in months where the market goes down, open market share repurchases significantly decrease delay, considering a one percent confidence level. Based on these results, it would imply

that price efficiency is more strongly increased by open market share repurchases when negative information enters the market. The results from the secondary analysis follow the results found by Busch and Obernberger (2017) using US data. In their research they find that price efficiency is increased in months where the market goes down. Based on the coefficient on repurchase intensity in down-months in table 5, delay is decreased with 0.0108 following an increase of 1 percentage point of repurchase intensity. This decrease per percentage point increase of repurchase intensity corresponds to a 1.57 percent decrease of mean delay (-0.0108/0.6866) where 0.0108 corresponds to the coefficient estimate on repurchase intensity and 0.6866 corresponds to the mean delay in down-months. In months where the market goes up, an one percent increase in repurchase intensity results in a 0.47 percent decrease in mean delay (-0.0031/0.6602). The results support the hypothesis that open market share repurchases increase price efficiency by providing price support at fundamental values.

8.2 Price efficiency and firm size

To further analyze the effects of open market share repurchases on the price efficiency of a stock, this section will consider size variation across firms. The data shows that the average delay across small firms is larger compared to large firms (0.7445 compared to 0.6035). This indicates that price efficiency is in general better for large firms. This would be expected as information decay is larger for small firms as information is less likely to be incorporated as accurately compared to larger firms. In terms of repurchase activity, there exist significant differences between small and large firms in this dataset. The average repurchase intensity for small firms is 3.34% where large firms average only 0.31%.

The analysis uses firms size as measure to split the sample into two groups. The first group, small, consists of firms with a market capitalization mean below the capitalization median. The second group, large, consists of firms with an above median mean. The market capitalization mean is taken for each firm for each year. The yearly mean is compared with the full sample yearly median. The setup follows the same design as the analysis with positive and negative information. There are two dummy variables indicating whether a firm qualifies as a small firm or a large firm. The size dummy interacts with the repurchase intensity to identify the effects of open market share repurchases on price efficiency across firm size. The setup for this analysis is shown in equation 11.

$$\begin{aligned} Delay_{i,t} &= \alpha + \gamma\, delay_{i,t-1} + \beta_{i,1}(RI_{i,t} * small) + \beta_{i,2}(RI_{i,t} * large) \\ &\quad + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \qquad (11) \end{aligned}$$

The hypothesis relating to this analysis states that the effect of open market share repurchases is more pronounced for small firms. The hypothesis builds on the argument that small firms are priced less efficient and the potential gain in price efficiency, due to open market share repurchases, is larger for small firms.

8.2.1 Results

The results from the analysis reported in table 6, show that the decrease in delay by repurchase intensity is more pronounced and robust for small firms compared to large firms. For small firms, a one percent increase in repurchase intensity is followed by a 0.62 percent decrease of mean delay (-0.0047/0.7445), where -0.0047 is the coefficient estimate for repurchase intensity for small firms and 0.7445 is the mean delay for small firms. The effect on delay for small firms is significant on a one percent significance level. The coefficient estimate for large firms is larger in absolute value compared to small firms. This coefficient estimate is highly insignificant however and its value is due to a singificant lower average repurchase intensity for large firms compared to small firms, rather than a stronger effect of open market share repurchases on price efficiency across large firms. The results support the hypothesis that the increase in price efficiency, due to open market share repurchases, is stronger for small firms.

8.3 Price efficiency and book to market

The last part of the secondary analysis uses the book-to-market ratio of firms in order to split the sample. There are four subsamples which are the result of classifying firms by their book-to-market ratio. The first two subsamples contain firms with either a below median book-to-market ratio for that month (low B/M) or an above median book-to-market ratio for that month (high B/M). The latter two subsamples are the result of creating deciles using the book-to-market ratio of firms. Stocks in the first decile are classified as a growth stock and firms in the highest decile are classified as a value stock for a certain month. The difference in average delay for stocks across low and high book-to-market periods is less pronounced compared to the subsamples based on firm size. Stocks in low book-to-market periods have an average delay of 0.6592 whereas stocks in high book-to-market periods average a delay of 0.6865. Growth stocks

have an average delay of 0.6870 and value stocks have an average delay of 0.6993. The data shows a negative relationship between firm size and book to market. In general, small firms qualify more frequently as a value firm whereas large firms qualify more frequently as a growth firm. In financial research, among which research done by Fama and French in 1998, small firms generally classify as a value firm. In terms of repurchase activity, firms in low book-to-market periods have a lower repurchase intensity compared to firms in higher book-to-market periods (1.07% compared to 2.58%).

The analysis follows the setup of the previous analysis aside from using the book-to-market ratio as a tool for splitting the sample (equations 12 and 13). The sample is split into the groups high and low book-to-market firms and growth and value firms for each. Firms are reclassified each month. Equation 12 incorporates an interaction variable which identifies a firm as a low or high book-to-market firm. Equation 13 incorporates an interaction variable which identifies a firm as a growth or value firm.

$$\begin{aligned} Delay_{i,t} &= \alpha + \gamma\, delay_{i,t-1} + \beta_{i,1}(RI_{i,t} * low_{B/M}) + \beta_{i,2}(RI_{i,t} * high_{B/M}) \\ &\quad + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \qquad (12) \end{aligned}$$

$$\begin{aligned} Delay_{i,t} &= \alpha + \gamma\, delay_{i,t-1} + \beta_{i,1}(rep.int_{i,t} * growth) + \beta_{i,2}(RI_{i,t} * value) \\ &\quad + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \qquad (13) \end{aligned}$$

The hypothesis relating to this analysis states that the effect of open market share repurchases is more pronounced for firms in high book-to-market periods. This hypothesis is based on the argument that a firm with a high book-to-market ratio is more likely to be undervalued. Furthermore, an open market share repurchase is more likely to contain information when stocks are undervalued.

8.3.1 Results

The reported results in table 7, show that repurchase activity only significantly decreases delay for stocks in high book-to-market periods. For those stocks, a one percent increase in repurchase activity is accompanied with a decrease in mean delay of 0.63 percent (-0.0043/0.6865) where -0.0043 corresponds to the coefficient estimate on repurchase intensity and 0.6865 corresponds to

the mean delay in periods of a high book-to-market ratio for a firm. The decrease in mean delay for firms in high book-to-market periods is significant considering a one percent confidence level. The coefficient estimate on stocks in with low book-to-market ratios is larger compared to the estimate for high book-to-market periods. However, this coefficient is highly insigificant and is most likely due to the lower repurchase acitity, in terms of repurchase intensity, for firms in low book-to-market periods. This makes the existince of an effect across firms in low book-to-market periods unlikely. The results support the hypothesis that the increase in price efficiency by open market share repurchases is stronger for firms in high book-to-market periods.

Considering the analysis on growth and value firms, repurchase intensity decreases delay for both growth and value firms, though the effect is stronger in absolute terms for growth firms and more significant for value firms. Both coefficient estimates are significant on a one percent confidence level. Although the repurchase activity, in term of repurchase intensity, is higher for value firms compared to growth firms (7.56% compared to 2.30%), the coefficient estimate is more than ten times larger (0.0386 compared to 0.0038). When using the repurchase turnover as a measure for repurchase activity, the model shows more stable results. For both measures of price efficiency, the effects of repurchase turnover for value stocks is significant whereas the effect for growth stocks is far from significant. These results are in favor of the results showing that firms in high book-to-market periods have a stronger effect on price efficiency compared to firms in low book-to-market periods. The difference between the results across both measures make it undesirable to draw definite conclusions based on this subject.

8.4 Conclusion

The first part of the secondary analysis show that open market share repurchases make prices more efficient in months where negative information enters the market. Based on the results from the analysis taking firm size into account, it seems that small firms more strongly increase price efficiency by providing price support at fundamental values than large firms. Based on the analysis concerning the book-to-market ratio of a firm, the results show that the increase in price efficiency by open market share repurchases performed by high book-to-market firms is larger compared to low book-to-market firms. When looking at deciles, the results are less conclusive. The effect of open market share repurchases tend to be more pronounced for value firms, but the results regarding different measures make this conclusion dubious. The results support the hypothesis that open market share repurchases increase price efficiency by providing price support at fundamental values. Further analysis has produced results in favor of the notion

that the effect is more strong for small firms and more strong for firms in high book-to-market periods.

9 Robustness

The results from the secondary analysis imply that open market share repurchases increase price efficiency by providing price support at fundamental values. The effect seems to be only present at small firms and firms in high book-to-market periods. In order to show the robustness of the results this section will include an analysis which assesses whether the results are not driven by firm specific information. If firms incorporate firm specific information as opposed to negative public information which enters the market, the amount of idiosyncratic risk should increase when firms perform an open market share repurchase. Hong, Wang and Yu (2008) argue that if in fact firms provide price support at fundamental values, idiosyncratic risk should decrease. If the notion of open market share repurchases providing share repurchases holds true, there should be an observed decrease in idiosyncratic risk when firms perform an open market share repurchase.

In order to research the effects of open market share repurchase on the amount of idiosyncratic risk there are three different models are included which capture this. The measures used to capture the amount of idiosyncratic information are the r-squared of the simple market model, the correlation with the market and the residual volatility. All measures are constructed on a monthly basis using daily data. The r-squared captures the amount of variation in stock returns explained by market returns. The explanatory power of the market return captures the amount of systematic risk in the stock price. An increase in idiosyncratic risk, capturing private information, should decrease as a result of open market share repurchases and there should be an observed increase in the r-squared following open market share repurchases. The reasoning using the market correlation is of the same order. If idiosyncratic risk decreases, and therefore the amount of systematic risk increases, there should be an observed increase in the market correlation in months where a firm repurchases shares. Finally, an analysis using a measure for risk, proposed by Hou and Moskowitz (2005), as independent variable will be included. They argue that residual volatility, the volatility of the residual of the simple market model, is an accurate measure for risk. The residual volatility captures the idiosyncratic risk of a firm. Following the prior reasoning it is expected that residual volatility is decreased in months where a firm repurchases shares in the open market. The setup of this analysis (equations 14, 15 and 16) follows the setup of the primary analysis, apart from a change in the dependent variable.

$$R-squaredi,t = \alpha + \gamma\, r-squared_{i,t-1} + \delta_i\, RI_{i,t} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (14)$$

$$Market\ correlation_{i,t} = \alpha + \gamma\, market\ correlation_{i,t-1} + \lambda_i\, RI_{i,t} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (15)$$

$$Residual\ volatility_{i,t} = \alpha + \gamma\, residual\ volatility_{i,t-1} + \beta_i\, RI_{i,t} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (16)$$

If open market share repurchases in fact provide price support at fundamental values, there should be an observed increase in both the r-squared and the market correlation. A decrease in residual volatility in repurchase months should also be observed.

9.1 Results

Based on the results in table 8, it is clear that open market share repurchases in fact decrease the amount of idiosyncratic information incorporated into prices and the prior results are not driven by firm specific information. The results regarding equation 14, relating to models one and two in table 8, show that repurchase intensity significantly increases the r-squared. The significant positive coefficient on the repurchase dummy shows that the r-squared in increased in months where firms repurchase shares. This implies that an open market share repurchase, regardless of its size, increases the r-squared. The magnitude of the open market share repurchase also has a significant positive effect, based on the coefficient on repurchase intensity. Both coefficients are significant on a one percent level. Resulting from equation 15, relating to models three and four in table 8, there is a significant positive effect of both repurchases in general and the magnitude of the repurchase on the correlation with the market. This effect is less pronounced compared to previous model using the r-squared. The coefficient on the repurchase intensity is significant on a ten percent level and the coefficient on the repurchase dummy is significant on a five percent level. Finally, the results on the analysis relating to models five and six in table 8, show that repurchases in general significantly decrease the residual volatility. The coefficient on the repurchase dummy is negative and significant on a one percent level. The coefficient on the

repurchase intensity is negative, but not significant. This implies that the magnitude of a open market share repurchase does not affect the residual volatility.

9.2 Summary

The results on all models do not support the notion that firms incorporate private information into the stock price by performing open market share repurchases. The relative amount of private information, captured by the idiosyncratic risk, decreases as a result of an open market share repurchase. Following these results it is clear that the results from the primary and secondary analyses are robust and open market share repurchases do increase price efficiency by providing price support at fundamental values.

10 Concluding remarks

The results of the primary analysis suggest that open market share repurchases make prices more efficient. The secondary analysis establishes that the increase in price efficiency is more pronounced when negative information enters the market. The results are more pronounced for small firms and firms experiencing high book-to-market ratios. The results are robust to the notion that open market share repurchases incorporate private information into prices.

This research has shown that for small firms and firms in high book-to-market periods in Hong Kong, open market share repurchases increase price efficiency by providing price support at fundamental values. Open market share repurchase therefore increase the accuracy with which new negative information is incorporated into prices.

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Tables

This section contains the tables providing descriptive statistics and all the results of the primary, secondary and robustness analysis. Table one describes the monthly dataset which contains the dependent, independent and the control variables. Tables two through five display the results of the core analyses of this thesis. The in-text discussion and conclusions are mostly based on the repurchase intensity as a measure for repurchase activity and delay as a measure for price efficiency. The tables contain results including repurchase turnover and coefficient-based delay. Tables six through eight correspond to the robustness or control analyses. The differences between the results regarding the different measures and the related implications will be discussed at the end of this section. The t-statistics relating to the coefficient estimates are presented between brackets below the coefficients. *, ** and *** correspond to a ten percent, five percent and one percent significance level respectively.

Table 1: Descriptive statistics

This table contains the descriptive statistics of the dependent, independent and control variables used in the analysis. It contains the mean, median, standard deviation, first and ninety-ninth percentile value and the number of observations for each variable. For the independent variables, repurchase intensity and repurchase turnover, values across small and large and low and high book-to-market periods and values for actual repurchase months are reported. All variables are presented using monthly values. The descriptives are based on the final dataset.

Descriptive Statistics	**Mean**	**Median**	**S.D.**	**1st Perc.**	**99th Perc.**	**N**
Dependent Variables						
Delay	0.6730	0.7427	0.2825	0.0601	0.9999	36,474
Coefficient-based Delay	2.2304	2.2517	0.6116	0.8192	3.5824	36,441
R-squared	14.09%	7.26%	16.89%	0.00%	71.19%	36,498
Market correlation	0.2417	0.2405	0.2870	-0.4087	0.8426	36,512
Residual volatility	0.2543	0.1503	0.4538	0.0000	2.0264	37,987
Repurchase activity						
Repurchase intensity	0.02%	0.00%	0.47%	0.00%	0.20%	38,004
Repurchase turnover	0.1742	0.0000	3.7935	0.0000	1.7200	38,004
Repurchase activity in repurchase months						
Repurchase intensity	0.33%	0.01%	1.95%	0.00%	5.54%	2,140
Repurchase turnover	3.0928	0.1222	15.7048	0.0000	61.3390	2,140
Repurchase intensity small	0.59%	0.06%	2.72%	0.00%	7.97%	1,071
Repurchase intensity large	0.06%	0.00%	0.31%	0.00	0.92%	1,069
Repurchase turnover small	5.2722	0.3707	21.6410	0.0000	82.0737	1,071
Repurchase turnover large	0.9094	0.0375	3.9027	0.0000	18.8500	1,069

Table 1 continued

Descriptive Statistics	Mean	Median	S.D.	1st Perc.	99th Perc.	N
Repurchase activity in repurchase months continued						
Repurchase intensity low B/M	0.20%	0.01%	0.74%	0.00	3.65%	1,029
Repurchase intensity high B/M	0.44%	0.02%	2.61%	0.00	7.29%	1,111
Repurchase turnover low B/M	2.0751	0.0902	9.7921	0.0000	42.1325	1,029
Repurchase turnover high B/M	4.0353	0.1585	19.6121	0.0000	76.5923	1,111
Control Variables						
Amihud	0.0211	0.0000	0.1.3206	0.0000	0.1211	36,970
Book to market	1.2533	0.8808	1.5003	-0.5399	7.2672	38,004
Cash to assets	14.92%	10.17%	16.93%	0.00%	77.37%	38,004
Market cap (mill)	17,771	1,021	107,372	26	286,762	38,004
Dividends to assets	1.70%	0.00%	9.17%	0.00%	14.54%	38,004
EBITD to assets	5.56%	5.75%	17.67%	-54.63%	100%	38,004
Leverage	0.3879	0.3658	0.2738	0.0000	0.9242	38,004
Relative spread	0.6767	0.6931	0.1056	0.0000	0.6931	38,004
Return	0.0147	0.0000	0.2171	-0.3730	0.7000	37,679
Total assets (mill)	31,156	1785	211,014	0.0000	776,675	38,004
Volatility	0.0303	0.0245	0.0276	0.0000	0.1247	37,984

Table 2: Drivers of open market share repurchases

This table contains the results corresponding to the analysis explaining the measures for repurchase activity. Model one uses the repurchase intensity and model two uses the repurchase turnover as a measure for repurchase activity.

Dependent Variable:	Repurchase Intensity	Repurchase turnover
	1	2
Repurchase intensity t-1	0.1762***	
	(6.47)	
Repurchase turnover t-1		-0.2338***
		(3.65)
Return t-1>0	-0.0013	-0.0896
	(-0.28)	(-1.60)
Return t-1<0	-0.0899***	-0.6871***
	(-2.95)	(-3.01)
Leverage t-1	-0.0414	-0.4005
	(-0.73)	(-0.97)
Relative Spread (ln) t-1	0.0140	0.2263
	(0.96)	(1.23)
Volatility t-1	-0.0510	0.6124
	(-0.68)	(0.64)
Amihud t-1	-0.0027***	-0.0159***
	(-18.61)	(-9.32)
Time fixed effect	Included	Included
Firm fixed effect	Included	Included
R-squared (within)	0.326	0.0562
Observations	33,224	33,223

Table 2 continued

Dependent Variable:	Repurchase Intensity	Repurchase turnover
Book to market t-1	0.0014	0.0481
	(0.32)	(1.29)
Market Cap (ln) t-1	-0.0094**	-0.0264
	(-2.56)	(-0.95)
Total Assets (ln) t-1	0.0012	0.0101
	(1.20)	(1.44)
Cash to assets t-12	0.0419	0.2145
	(0.85)	(0.60)
Ebitd to assets t-12	0.0270	0.3071
	(1.01)	(1.47)
Dividends to assets t-12	-0.0300	-0.2138
	(-0.89)	(-0.88)
Constant	0.1199**	0.1598
	(2.47)	(0.49)
Time fixed effect	Included	Included
Firm fixed effect	Included	Included
R-squared (within)	0.0326	0.0562
Observations	33,224	33,224

Table 3: Price efficiency

This table presents the results of the primary analysis. The dependent variable are measures for price efficiency. Model one through four use the delay measure and models five through eight use the coefficient-based delay measure. Models three, four, seven and eight use repurchase turnover as a measure for repurchase activity.

Dependent Variable:	Delay				Coefficient-based delay			
	1	2	3	4	5	6	7	8
Delay t-1	0.1058***	0.1058***	0.1058***	0.1058***				
	(14.31)	(14.28)	(14.30)	(14.28)				
Coefficient-based delay t-1					0.0458***	0.0458***	0.0458***	0.0458***
					(7.29)	(7.29)	(7.29)	(7.28)
Repurchase intensity	-0.0046***				-0.0062***			
	(-4.59)				(-3.09)			
Repurchase intensity t-1		-0.0025				-0.0047***		
		(-0.88)				(-2.67)		
Repurchase turnover			-0.0005**				-0.0008*	
			(-2.00)				(-1.69)	
Repurchase tunrover t-1				-0.0004				-0.0010***
				(-1.39)				(-2.87)
Repurchase dummy	-0.0186**	-0.0198***	-0.0185**	-0.0196***	-0.0394***	-0.0408***	-0.0387***	-0.0400***
	(-2.58)	(-2.78)	(-2.54)	(-2.75)	(-2.82)	(-2.97)	(-2.76)	(-2.91)
Time fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
R-squared (within)	0.0312	0.0311	0.0311	0.0311	0.0128	0.0127	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257	32,257	32,257	32,257	32,257

Table 3 continued

Dependent Variable:	Delay	Coefficient-based delay						
	1	2	3	4	5	6	7	8
Return t-1 >0	0.0000	0.0000	-0.0000	0.0000	0.0459**	0.0459**	0.0459**	0.0459**
	(0.00)	(0.00)	(-0.00)	(0.00)	(2.42)	(2.42)	(2.41)	(2.42)
Return t-1 <0	0.1552***	0.1554***	0.1552***	0.1551***	0.3211***	0.3213***	0.3211***	0.3206***
	(7.64)	(7.65)	(7.64)	(7.63)	(7.25)	(7.26)	(7.25)	(7.24)
Leverage t-1	0.0100	0.0101	0.0099	0.0100	0.0393	0.0394	0.0391	0.0.391
	(0.76)	(0.77)	(0.76)	(0.77)	(1.29)	(1.29)	(1.28)	(1.28)
Relative Spread (ln) t-1	0.0682	0.0683	0.0683	0.0684	0.0477	0.0478	0.0479	0.0481
	(1.34)	(1.34)	(1.34)	(1.34)	(0.49)	(0.49)	(0.49)	(0.49)
Volatility t-1	-0.5943***	-0.5943***	-0.5939***	-0.5940***	-1.0971***	-1.0970***	-1.0963***	-1.0964***
	(-6.22)	(-6.21)	(-6.22)	(-6.21)	(-6.61)	(-6.61)	(-6.61)	(-6.60)
Amihud t-1	0.0010***	0.0010***	0.0010***	0.0010***	0.0017***	0.0017***	0.0017***	0.0017***
	(5.68)	(5.75)	(5.74)	(5.76)	(5.57)	(5.57)	(5.59)	(5.54)
Market Cap (ln) t-1	-0.0323***	-0.0323***	-0.0323***	-0.0323***	-0.0485***	-0.0485***	-0.0485***	-0.0485***
	(-10.07)	(-10.06)	(-10.06)	(-10.06)	(-7.59)	(-7.59)	(-7.59)	(-7.59)
Total Assets (ln) t-1	0.0006	0.0006	0.0006	0.0006	-0.0011	-0.0012	-0.0012	-0.0012
	(1.44)	(1.43)	(1.44)	(1.43)	(-1.24)	(-1.24)	(-1.24)	(-1.24)
Time fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
R-squared (within)	0.0312	0.0311	0.0311	0.0311	0.0128	0.0127	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257	32,257	32,257	32,257	32,257

Table 3 continued

Dependent Variable:	Delay	Coefficient-based delay						
	1	2	3	4	5	6	7	8
Book to market t-1	0.0035*	0.0035*	0.0036**	0.0036**	0.0074**	0.0075**	0.0075**	0.0075**
	(1.95)	(1.96)	(1.97)	(1.97)	(2.01)	(2.02)	(2.02)	(2.04)
Cash to assets t-12	-0.0052	-0.0052	-0.0052	-0.0053	-0.0223	-0.0223	-0.0224	-0.0223
	(-0.35)	(-0.36)	(-0.36)	(-0.36)	(-0.64)	(-0.64)	(-0.64)	(-0.64)
Ebitd to assets t-12	-0.0116	-0.0117	-0.0116	-0.0116	-0.0708***	-0.0708***	-0.0707***	-0.0706***
	(-1.01)	(-1.02)	(-1.01)	(-1.01)	(-2.87)	(-2.87)	(-2.86)	(-2.86)
Dividends to assets t-12	0.0054	0.0055	0.0055	0.0055	0.0382	0.0383	0.0382	0.0382
	(0.20)	(0.20)	(0.20)	(0.20)	(0.45)	(0.45)	(0.45)	(0.45)
Constant	1.0208***	1.0204***	1.0203***	1.0203***	2.8396***	2.8394***	2.8391***	2.8263***
	(17.68)	(17.68)	(17.68)	(17.68)	(24.19)	(24.19)	(24.20)	(24.20)
Time fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
R-squared (within)	0.0312	0.0311	0.0311	0.0311	0.0128	0.0127	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257	32,257	32,257	32,257	32,257

Table 4: Reverse causality

This table incorporates the lagged delay measure in the analysis similar to the one in table two, model one. The results of the primary analysis show that the lagged repurchase intensity is not singifcant and therefore can not be used as a proxy for repurchase activity. The contemporaneous repurchase intensity shows significant results, but can be susceptible to reverse causailty. If lagged delay has no significant effect on contemporaneous repurchase intensity, there are no reverse causality problems present. This model only includes the repurchase intensity as the lagged repurchase turnover does have a significant effect on delay.

Dependent Variable:	Repurchase Intensity
	1
Repurchase intensity t-1	0.1651***
	(7.29)
Delay t-1	-0.0007
	(-0.22)
Return t-1>0	-0.0016
	(-0.35)
Return t-1<0	-0.0928***
	(-2.96)
Leverage t-1	-0.0420
	(-0.73)
Relative Spread (ln) t-1	0.0149
	(0.87)
Volatility t-1	-0.0259
	(-0.36)
Amihud t-1	-0.0028***
	(-20.74)
Time fixed effect	Included
Firm fixed effect	Included
R-squared (within)	0.0291
Observations	32,733

Table 4 continued

Dependent Variable:	Repurchase Intensity
Market Cap (ln) t-1	-0.0083**
	(-2.43)
Total Assets (ln) t-1	0.0012
	(1.29)
Book to market t-1	0.0004
	(0.09)
Cash to assets t-12	0.0408
	(0.81)
Ebitd to assets t-12	0.0302
	(1.11)
Dividends to assets t-12	-0.0319
	(-0.91)
Constant	0.1033**
	(2.24)
Time fixed effect	Included
Firm fixed effect	Included
R-squared (within)	0.0291
Observations	32,733

Table 5: Price efficiency and repurchases in up and down months

This table contains the results of the first part of the secondary analysis. This part of the secondary analysis considers months where positvie and negative information enters the market. Positive and negative months are classified on their market return. Months with a negative (positive) market return are considered months where negative (positive) information enters the market. Models one and two use delay and models three and four use the coefficient-based delay as a measure for price efficiency. Models one and three use the repurchase intensity and models two and four use repurchase turnover as a measure for repurchase activity.

Dependent Variable:	Delay		Coefficient-based delay	
	1	2	3	4
Delay t-1	0.1059***	0.1058***		
	(14.31)	(14.30)		
Coefficient-based delay t-1			0.0459***	0.0458***
			(7.29)	(7.29)
Repurchase intensity * up	-0.0031**		-0.0015	
	(-1.98)		(-0.70)	
Repurchase intensity * down	-0.0108***		-0.0210***	
	(-3.18)		(-5.58)	
Repurchase turnover * up		-0.0006*		-0.0005
		(-1.78)		(-1.03)
Repurchase turnover * down		-0.0004		-0.0012
		(-0.60)		(-1.08)
Repurchase dummy	-0.0183**	-0.0185**	-0.0387***	-0.0388***
	(-2.53)	(-2.54)	(-2.77)	(-2.76)
Return t-1>0	0.0000	-0.0000	0.0459**	0.0459**
	(-0.00)	(-0.00)	(2.41)	(2.41)
Return t-1<0	0.1552***	0.1552***	0.3213***	0.3211***
	(7.65)	(7.64)	(7.25)	(7.25)
Time fixed effect	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included
R-squared (within)	0.0312	0.0311	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257

Table 5 continued

Dependent Variable:	Delay		Coefficient-based delay	
	1	2	3	4
Leverage t-1	0.0099	0.0099	0.0392	0.0392
	(0.76)	(0.76)	(1.29)	(1.29)
Relative Spread (ln) t-1	0.0682	0.0683	0.0478	0.0479
	(1.34)	(1.34)	(0.49)	(0.49)
Volatility t-1	-0.5941***	-0.5939***	-1.0965***	-1.0961***
	(-6.22)	(-6.21)	(-6.61)	(-6.60)
Amihud t-1	0.0010***	0.0010***	0.0017***	0.0017***
	(5.66)	(5.74)	(5.51)	(5.59)
Market Cap (ln) t-1	-0.0323***	-0.0323***	-0.0486***	-0.0485***
	(-10.07)	(-10.06)	(-7.60)	(-7.59)
Total Assets (ln) t-1	0.0006	0.0006	-0.0012	-0.0012
	(1.44)	(1.44)	(-1.24)	(-1.24)
Book to market t-1	0.0036*	0.0036*	0.0075**	0.0075**
	(1.96)	(1.97)	(2.02)	(2.02)
Cash to assets t-12	-0.0051	-0.0053	-0.0223	-0.0224
	(-0.35)	(-0.36)	(-0.64)	(-0.64)
Ebitd to assets t-12	-0.0116	-0.0116	-0.0707***	-0.0710***
	(-1.01)	(-1.01)	(-2.86)	(-2.86)
Dividends to assets t-12	0.0054	0.0055	0.0381	0.0382
	(0.20)	(0.20)	(0.45)	(0.45)
Constant	1.0209***	1.0204***	2.8397***	2.8390***
	(17.68)	(17.68)	(24.20)	(24.20)
Time fixed effect	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included
R-squared (within)	0.0312	0.0311	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257

Table 6: Price efficiency and firm size

This table contains the results of the second part of the secondary analysis. This part of the secondary analysis considers two groups of firms based on their market capitalization. Firms with a below (an above) median market capitalization mean are classified as small (large). Models one and two use delay and models three and four use the coefficient-based delay as a measure for price efficiency. Models one and three use the repurchase intensity and models two and four use repurchase turnover as a measure for repurchase activity.

Dependent Variable:	Delay		Coefficient-based delay	
	1	2	3	4
Delay t-1	0.1058***	0.1058***		
	(14.30)	(14.30)		
Coefficient-based delay t-1			0.0458***	0.0458***
			(7.29)	(7.29)
Repurchase intensity * small	-0.0047***		-0.0062***	
	(-4.68)		(-3.11)	
Repurchase intensity * large	0.0081		-0.0022	
	(0.22)		(-0.06)	
Repurchase turnover * small		-0.0005**		-0.0008*
		(-2.17)		(-1.75)
Repurchase turnover * large		0.0012		0.0008
		(0.54)		(0.21)
Repurchase dummy	-0.0190**	-0.0192**	-0.0395***	-0.0394***
	(-2.57)	(-2.59)	(-2.82)	(-2.77)
Return t-1>0	0.0000	0.0000	0.0459**	0.0459**
	(0.00)	(0.030)	(2.42)	(2.41)
Return t-1<0	0.1552***	0.1553***	0.3211***	0.3211***
	(7.64)	(7.65)	(7.25)	(7.24)
Time fixed effect	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included
R-squared (within)	0.0312	0.0312	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257

Table 6 continued

Dependent Variable:	Delay		Coefficient-based delay	
	1	2	3	4
Leverage t-1	0.0099	0.0099	0.0393	0.0391
	(0.76)	(0.76)	(1.29)	(1.28)
Relative Spread (ln) t-1	0.0682	0.0683	0.0477	0.0479
	(1.34)	(1.34)	(0.49)	(0.49)
Volatility t-1	-0.5944***	-0.5938***	-1.0971***	-1.0963***
	(-6.22)	(-6.21)	(-6.61)	(-6.60)
Amihud t-1	0.0010***	0.0010***	0.0017***	0.0017***
	(5.68)	(5.75)	(5.52)	(5.59)
Market Cap (ln) t-1	-0.0323***	-0.0323***	-0.0486***	-0.0485***
	(-10.07)	(-10.07)	(-7.59)	(-7.59)
Total Assets (ln) t-1	0.0006	0.0006	-0.0012	-0.0012
	(1.44)	(1.44)	(-1.24)	(-1.24)
Book to market t-1	0.0035*	0.0036**	0.0074**	0.0075**
	(1.95)	(1.97)	(2.01)	(2.02)
Cash to assets t-12	-0.0051	-0.0052	-0.0223	-0.0223
	(-0.35)	(-0.35)	(-0.64)	(-0.64)
Ebitd to assets t-12	-0.0116	-0.0116	-0.0708***	-0.0706***
	(-1.01)	(-1.00)	(-2.87)	(-2.86)
Dividends to assets t-12	-0.0054	-0.0054	0.0381	0.0381
	(0.20)	(0.20)	(0.45)	(0.45)
Constant	1.0207***	1.0204***	2.8396***	2.8392***
	(17.68)	(17.69)	(24.19)	(24.20)
Time fixed effect	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included
R-squared (within)	0.0312	0.0312	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257

Table 7: Price efficiency and book-to-market

This table contains the results of the third part of the secondary analysis. Firms with a below (an above) median book-to-market mean are classified as low B/M (high B/M). Firms in the first and tenth book-to-market decile are classified as a growth and value firm respectively. Models one, two, five and six use delay and models three, four, seven and eight use the coefficient-based delay as a measure for price efficiency. Models one, three, five and seven use the repurchase intensity and models two, four, six and eight use repurchase turnover as a measure for repurchase activity. Models one through four consider low B/M and high B/M stocks and models five through eight consider growth and value stocks.

Dependent Variable:	Delay		Coefficient-based delay		Delay		Coefficient-based delay	
	1	2	3	4	5	6	7	8
Delay t-1	0.1058***	0.1057***			0.1058***	0.1058***		
	(14.30)	(14.30)			(14.29)	(14.30)		
Coefficient-based delay t-1			0.0458***	0.0458***			0.0459***	0.0459***
			(7.29)	(7.29)			(7.30)	(7.30)
Repurchase intensity * low BM	-0.0116		-0.0287					
	(-0.82)		(-1.33)					
Repurchase intensity * high BM	-0.0043***		-0.0054***					
	(-5.74)		(-2.79)					
Repurchase turnover * low BM		0.0002		-0.0001				
		(0.37)		(-0.10)				
Repurchase turnover * high BM		-0.0006***		-0.0010***				
		(-4.07)		(-2.95)				
Time fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
R-squared (within)	0.0312	0.0312	0.0128	0.0128	0.0312	0.0312	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257	32,257	32,257	32,257	32,257

Table 7 continued

Dependent Variable:	Delay		Coefficient-based delay		Delay		Coefficient-based delay	
	1	2	3	4	5	6	7	8
Repurchase intensity * growth					-0.0386**		-0.0764**	
					(-2.21)		(-2.28)	
Repurchase intensity * value					-0.0038***		-0.0048**	
					(-7.04)		(-2.26)	
Repurchase turnover * growth						-0.0006		-0.0006
						(-0.67)		(-0.48)
Repurchase tunrover * value						-0.0007***		-0.0011***
						(-7.43)		(-5.31)
Repurchase dummy	-0.0181**	-0189**	-0.0377***	-0.0391***	-0.0183**	-0.0190***	-0.0382***	-0.0398***
	(-2.43)	(-2.59)	(-2.63)	(-2.78)	(-2.53)	(-2.64)	(-2.74)	(-2.87)
Return t-1>0	-0.0000	0.0000	0.0458**	0.0459**	0.0001	-0.0000	0.0457**	0.0459**
	(-0.00)	(0.00)	(2.41)	(2.41)	(-0.01)	(-0.00)	(2.41)	(2.41)
Return t-1<0	0.1552	0.1550***	0.3213***	0.3209***	0.1557***	0.1553***	0.3219***	0.3212***
	(7.64)	(7.62)	(7.25)	(7.24)	(7.68)	(7.64)	(7.27)	(7.25)
Leverage t-1	0.0101	0.0099	0.0397	0.0391	0.0103	0.0099	0.0400	0.0390
	(0.77)	(0.76)	(1.29)	(1.28)	(0.79)	(0.76)	(1.31)	(1.28)
Relative Spread (ln) t-1	0.0682	0.0681	0.0480	0.0477	0.0686	0.0682	0.0485	0.0477
	(1.34)	(1.34)	(0.49)	(0.49)	(1.35)	(1.34)	(0.50)	(0.49)
Time fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
R-squared (within)	0.0312	0.0312	0.0128	0.0128	0.0312	0.0312	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257	32,257	32,257	32,257	32,257

Table 7 continued

Dependent Variable:	Delay		Coefficient-based delay		Delay		Coefficient-based delay	
	1	2	3	4	5	6	7	8
Volatility t-1	-0.5940***	-0.5945***	-1.0961***	-1.0970***	-0.5932***	-0.5937***	-1.0947***	-1.0965***
	(-6.21)	(-6.22)	(-6.61)	(-6.61)	(-6.21)	(-6.22)	(-6.60)	(-6.61)
Amihud t-1	0.0010***	0.0010***	0.0017***	0.0017***	0.0010***	0.0010***	0.0017***	0.0017***
	(5.67)	(5.73)	(5.48)	(5.58)	(5.67)	(5.70)	(5.47)	(5.54)
Market Cap (ln) t-1	-0.0323***	-0.0323***	-0.0486***	-0.0485***	-0.0324***	-0.0323***	-0.0486***	-0.0485***
	(-10.08)	(-10.06)	(-7.60)	(-7.59)	(-10.09)	(-10.06)	(-7.62)	(-7.59)
Total Assets (ln) t-1	0.0006	0.0006	-0.0012	-0.0012	0.0006	0.0006	-0.0012	-0.0012
	(1.43)	(1.44)	(1.25)	(-1.24)	(1.40)	(1.43)	(-1.27)	(-1.24)
Book to market t-1	0.0035*	0.0036**	0.0073**	0.0075**	0.0035*	0.0036**	0.0073**	0.0075**
	(1.93)	(1.98)	(1.98)	(2.03)	(1.91)	(1.97)	(1.97)	(2.03)
Cash to assets t-12	-0.0052	-0.0051	-0.0225	-0.0222	-0.0052	-0.0052	-0.0217	-0.0222
	(-0.36)	(-0.35)	(-0.65)	(-0.64)	(-0.36)	(-0.35)	(-0.63)	(-0.64)
Ebitd to assets t-12	-0.0116	-0.0117	-0.0706***	-0.0707***	-0.0115	-0.0116	-0.0704***	-0.0707***
	(-1.01)	(-1.01)	(-2.86)	(2.86)	(-1.00)	(-1.01)	(-2.85)	(-2.86)
Dividends to assets t-12	0.0054	0.0055	0.0381	0.0382	0.0054	0.0054	0.0373	0.0381
	(0.20)	(0.20)	(0.45)	(0.45)	(0.20)	(0.20)	(0.45)	(0.45)
Constant	1.0209***	1.0203***	2.8401***	2.8391***	1.0214***	1.0204***	2.8409***	2.8391***
	(17.69)	(17.68)	(24.19)	(24.20)	(17.69)	(17.69)	(24.20)	(24.20)
Time fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included	Included	Included	Included	Included
R-squared (within)	0.0312	0.0312	0.0128	0.0128	0.0312	0.0312	0.0128	0.0128
Observations	32,257	32,257	32,257	32,257	32,257	32,257	32,257	32,257

Table 8: Private information and idiosyncratic risk

This table contains the results of the robustness analysis. Models one and two, models three and four and models five and six use the r-squared, the market correlation and the residual volatility as a measure for private information respectively. Models one, three and five and models two, four and six use the repurchase intensity and the repurchase turnover as a measure for repurchase acitivity.

Dependent Variable:	R-squared		Market correlation		Residual volatility	
	1	2	3	4	5	6
R-squared t-1	0.1931***	0.1931***				
	(21.60)	(21.59)				
Market correlation t-1			0.1409***	0.1408***		
			(20.59)	(20.58)		
Residual volatility t-1					0.0973***	0.0973***
					(5.10)	(5.10)
Repurchase intensity	0.0027***		0.0017*		-0.0038	
	(3.79)		(1.90)		(-1.21)	
Repurchase turnover		0.0003*		0.0004**		-0.0006
		(1.77)		(2.21)		(-1.42)
Repurchase dummy	0.0120***	0.0119***	0.0160**	0.01514**	-0.0331***	-0.0323***
	(2.83)	(2.77)	(2.38)	(2.24)	(-3.49)	(-3.39)
Return t-1>0	0.0007	0.0007	-0.0222*	-0.0221*	0.0513	0.0512
	(0.13)	(0.14)	(-1.70)	(-1.70)	(1.25)	(1.25)
Return t-1<0	-0.0984***	-0.0918***	-0.1792***	-0.1790***	0.2161***	0.2160***
	(-7.67)	(-7.79)	(-8.90)	(-8.90)	(4.81)	(4.80)
Leverage t-1	-0.0080	-0.0080*	-0.0155	-0.0154	0.1654***	0.1653***
	(-1.02)	(-1.05)	(-1.03)	(-0.95)	(3.95)	(3.94)
Relative Spread (ln) t-1	-0.0391*	-0.0391*	0.0683	0.0682	0.1820***	0.1821***
	(-1.82)	(-1.83)	(0.80)	(0.80)	(3.41)	(3.41)
Time fixed effect	Included	Included	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included	Included	Included
R-squared (within)	0.0669	0.0669	0.0445	0.0445	0.0235	0.0236
Observations	32,257	32,257	32,266	32,266	33,224	33,224

Table 8 continued

Dependent Variable:	R-squared		Market correlation		Residual volatility	
	1	2	3	4	5	6
Volatility t-1	0.3626***	0.3622***	0.4596***	0.4593***	0.5608**	0.5613**
	(6.32)	(6.32)	(4.50)	(4.49)	(2.36)	(2.36)
Amihud t-1	-0.0004***	-0.0004***	-0.0018***	-0.0018***	0.0033**	0.0033**
	(-5.79)	(-5.86)	(-6.38)	(-6.38)	(2.34)	(2.34)
Market Cap (ln) t-1	0.0204***	0.0203***	0.0363***	0.0363***	0.0205***	0.0205***
	(11.36)	(11.35)	(11.20)	(11.20)	(2.74)	(2.74)
Total Assets (ln) t-1	-0.0003	-0.0003	-0.0005	-0.0005	-0.0031***	-0.0031***
	(-1.22)	(-1.22)	(-1.01)	(-1.01)	(-3.18)	(-3.18)
Book to market t-1	-0.0026**	-0.0026**	-0.0019	-0.0020	0.0076	0.0076
	(-2.58)	(-2.59)	(-1.06)	(-1.08)	(1.62)	(1.63)
Cash to assets t-12	-0.0008	-0.0007	0.0036	0.0036	0.0157	0.0157
	(-0.10)	(-0.10)	(0.22)	(0.22)	(0.41)	(0.41)
Ebitd to assets t-12	0.0029	0.0029	0.0055	0.0054	-0.1194***	-0.1193***
	(0.52)	(0.51)	(0.51)	(0.50)	(-3.55)	(-3.54)
Dividends to assets t-12	-0.0120	-0.0121	0.0002	0.0003	-0.0666***	0.0667***
	(-1.37)	(-1.37)	(0.03)	(0.04)	(-2.65)	(-2.66)
Constant	-0.1516***	-0.1514***	-0.3597***	-0.3597***	-0.1856*	-0.1859*
	(-5.21)	(-5.20)	(-4.72)	(-4.72)	(-1.79)	(-1.79)
Time fixed effect	Included	Included	Included	Included	Included	Included
Firm fixed effect	Included	Included	Included	Included	Included	Included
R-squared (within)	0.0669	0.0669	0.0445	0.0445	0.0235	0.0236
Observations	32,257	32,257	32,266	32,266	33,224	33,224

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Alternative measures

Both the primary and secondary analyses are performed using two measures for both repurchase activity and price efficiency. The in-text discussion of the results relates to the repurchase intensity as a measure for repurchase activity and to delay as a measure for price efficiency. This section will briefly address the differences in the results using the alternative measures and the implications relating to those differences.

Primary analysis

Comparing the results relating to repurchase intensity and repurchase turnover, there are differences in significance and coefficient size. The sign of the effect has not changed. Repurchase activity increases price efficiency in all models, though the results are more pronounced for the models using repurchase intensity. The same conclusion applies for using the coefficient-based delay as a measure for price efficiency in terms of coefficient sign. The general effect that repurchase activity increases price efficiency remains present. Th main difference here is that when using the coefficient-based delay measure, the lagged repurchase activity measures show significant results. This would be helpful in order to exclude possible reverse causaility problems in advance.

Secondary analysis

Relating to the analysis where proxies for positive and negative information are used, the models using the coefficent-based delay measure show more explicit differences between up and down markets. The sign of the effect remain roughly unchanged and the implication that repurchase make prices more efficient by providing price support at fundamental values remains valid. Using the repurchase turnover measure, the results become less conclusive. Only the coefficient on repurchase turnover in up markets using delay is marginally significant. The results using this measures neither negate or support the conclusions based on positive and negative information using repurchase intensity.

Relating to the analysis regarding firm size, there are no significant changes in the interpretation of the results across the different measures. Using the coefficient-based delay measure, the models show results in the same direction, though slightly less significant. Using the repurchase turnover measure, the results are less significant compared to the models using the repurchase intensity. The results do show opposing signs and the conclusions based on the repurchase intensity altered. Explaining the results in the light of high and low book-to-market stocks,

there are no significant differences in results between the measures. The models using the repurchase intensity as a measure show more significant results compared to the repurchase turnover measure. All models, however, show results in the same direction. The difference between the measures is more interesting when analyzing growth and value stocks. The models using repurchase intensity show a large differnce in significance if delay is used as a measure for price efficiency. The model using coefficient-based delay shows no difference in terms of significance between growth and value stocks. The models using repurchase turnover show clear differences between growth and value stocks. For both delay and coefficient-based delay as a measure for price efficiency, the results show significant results for value stocks and no significant results for growth stocks. However, considering all the results, it would be premature to conclude that there is a difference across growth and value stocks.

General

The r-squared is smaller for models which use the coefficient-based delay as a measure for price efficiency compared to models who use delay as a measure for price efficiency. This means that the variation in delay is more effectively explained by the model compared to the variation in coefficient-based delay. This difference, however, does not affect the conclusion.

Considering the results on all different measures, the results seem to be the most stable when using repurchase intensity and delay as relevant measures. Especially the results regarding repurchase turnover seem to be less persistent compared to repurchase intensity. Conclusions in this research are therefore merely based on the results on repurchase intensity. The analysis using the repurchase turnover serve a more complementary purpose. In this thesis, repurchase intensity is considered to be the most efficient measure for repurchase activity.

Equations

This section contains all equations used in the models, excluding the in-text equations. The equations are listed tablewise and numbered modelwise. For example, equation 4.3 corresponds to table four, model three. The models include the lagged repurchase intensity (table 3), the contemporaneous and lagged repurchase turnover (table 3-8) as measures for repurchase activity and coefficient-based delay (table 3-8) as a measure for price efficiency.In the models, *RI* corresponds to repurchase intensity and *RT* corresponds to repurchase turnover.

Table 2, model two. This model corresponds to the analysis explaining repurchase turnover.

$$\begin{aligned} RI_{t,i} &= \alpha_+ \gamma RI_{t-1} + \beta_1 RetP_{t-1,i} + \beta_2 RetN_{t-1,i} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} \\ &\quad + F_i + T_t + \epsilon_i \qquad (2.2) \end{aligned}$$

Table 3, models two through eight. These models corresponds to the primary analysis.

$$\begin{aligned} Delay_{i,t} &= \alpha + \gamma\, delay_{i,t-1} + \beta_i\, RI_{i,t-1} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i \\ &\quad + T_t + \epsilon_i \qquad (3.2) \end{aligned}$$

$$\begin{aligned} Delay_{i,t} &= \alpha + \gamma\, delay_{i,t-1} + \beta_i\, RT_{i,t} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i \\ &\quad + T_t + \epsilon_i \qquad (3.3) \end{aligned}$$

$$\begin{aligned} Delay_{i,t} &= \alpha + \gamma\, delay_{i,t-1} + \beta_i\, RT_{i,t-1} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i \\ &\quad + T_t + \epsilon_i \qquad (3.4) \end{aligned}$$

$$\begin{aligned} Coeff.delay_{i,t} &= \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_i\, RI_{i,t} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} \\ &\quad + F_i + T_t + \epsilon_i \qquad (3.5) \end{aligned}$$

$$\begin{aligned} Coeff.delay_{i,t} &= \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_i\, RI_{i,t-1} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} \\ &\quad + F_i + T_t + \epsilon_i \qquad (3.6) \end{aligned}$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_i\, RT_{i,t} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (3.7)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_i\, RT_{i,t-1} + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (3.8)$$

Table 5, models two through four. These models correspond to the secondary analysis regarding positive and negative information.

$$Delay_{i,t} = \alpha + \gamma\, delay_{i,t-1} + \beta_{i,1}\,(RT_{i,t} * up) + \beta_{i,2}\,(RT_{i,t} * down) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (5.2)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_{i,1}\,(RI_{i,t} * up) + \beta_{i,2}\,(RI_{i,t} * down) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (5.3)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_{i,1}\,(RT_{i,t} * up) + \beta_{i,2}\,(RT_{i,t} * down) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (5.4)$$

Table 6, models two through four. These models correspond to the secondary analysis regarding small and large firms.

$$Delay_{i,t} = \alpha + \gamma\, delay_{i,t-1} + \beta_{i,1}\,(RT_{i,t} * small) + \beta_{i,2}\,(RT_{i,t} * large) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (6.2)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_{i,1}\,(RI_{i,t} * small) + \beta_{i,2}\,(RI_{i,t} * large) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (6.3)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_{i,1}\,(RT_{i,t} * small) + \beta_{i,2}\,(RT_{i,t} * large) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (6.4)$$

Table 7, models two through four and six through eight. These models correspond to the secondary analysis regarding firms with low and high book-to-market ratios.

$$Delay_{i,t} = \alpha + \gamma\, delay_{i,t-1} + \beta_{i,1}\,(RT_{i,t} * low_{B/M}) + \beta_{i,2}\,(RT_{i,t} * high_{B/M}) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (7.2)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_{i,1}\,(RI_{i,t} * low_{B/M}) + \beta_{i,2}\,(RI_{i,t} * high_{B/M}) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (7.3)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_{i,1}\,(RT_{i,t} * low_{B/M}) + \beta_{i,2}\,(RT_{i,t} * high_{B/M}) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (7.4)$$

$$Delay_{i,t} = \alpha + \gamma\, delay_{i,t-1} + \beta_{i,1}\,(RT_{i,t} * value) + \beta_{i,2}\,(RT_{i,t} * growth) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (7.6)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_{i,1}\,(RI_{i,t} * value) + \beta_{i,2}\,(RI_{i,t} * growth) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (7.7)$$

$$Coeff.delay_{i,t} = \alpha + \gamma\, coeff.delay_{i,t-1} + \beta_{i,1}\,(RT_{i,t} * value) + \beta_{i,2}\,(RT_{i,t} * growth) + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \quad (7.8)$$

Table 8, models two, four and six. These models corresponds to the robustness analysis.

$$\begin{aligned} R-squared_{i,t} &= \alpha + \gamma\, r-squared_{i,t-1} + \delta_i\, RT_{i,t} \\ &\quad + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \end{aligned} \tag{8.2}$$

$$\begin{aligned} Market\ correlation_{i,t} &= \alpha + \gamma\, market\ correlation_{i,t-1} + \lambda_i\, RT_{i,t} \\ &\quad + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \end{aligned} \tag{8.4}$$

$$\begin{aligned} Residual\ volatility_{i,t} &= \alpha + \gamma\, residual\ volatility_{i,t-1} + \gamma_i\, RT_{i,t} \\ &\quad + \sum_{n=1}^{n=N} \beta_{i,n} Control_{i,n,t} + F_i + T_t + \epsilon_i \end{aligned} \tag{8.6}$$