Actual Market Share Repurchases

The determinants of a firm's buy back activity during a crisis: Empirical evidence from the COVID-19 pandemic

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Abstract

This paper attempts to investigate the influence specific firm characteristics have on the repurchasing activity of U.S. listed firms. More specifically, the extent to which firm characteristics change during a global health crisis. Through a combination of a newly collected dataset of monthly actual share repurchases, stock prices and a dataset of firm characteristics, empirical evidence is provided. Furthermore, the market timing ability of firms during the COVID-19 pandemic is investigated. The methodology used in this thesis comprises of a standard Ordinary Least Squares (OLS) method, extended with additive and multiplicative dummies to show the difference between two time periods. Due to heteroscedasticity in the OLS estimator a Generalized Least Squares modification is made to improve efficiency in the estimation. To conclude on the market timing ability of managers the relative repurchasing price (REP) is constructed. Resulting in the ability to compare the two time periods, indicating that managers can time the market and the magnitude increase significantly during the COVID-19 period. In closing, this thesis provides empirical evidence on how specific firm characteristics change during a global health crisis. Subsequently, showing that a share buyback can be more profitable when the economy is in recession.

Key Words: Share Repurchase, Repurchase Volume, Firm Characteristics, COVID-19, OLS

JEL Classifications: G35, G12, G32, G01, C39

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1. Introduction

From the 1980's onward the focus on rewarding stockholders by paying dividends moved partly to share repurchases. A share repurchases became a common corporate event where managers decide to use the excess internal funds to distribute cash back to the shareholders by repurchasing an amount of the firm's equity. Such a buyback of shares increased in popularity not only in the business world but also in academic literature. A share repurchase results in a lower amount of outstanding shares and therefore a higher earnings-per-share ratio. Over the past decade a significant amount of academic research has been conducted about the actual repurchases that companies do and what motives they have for them. The academic world has provided multiple motives for conducting a share repurchase, this thesis will touch upon the most popular phenomena that have been researched over de past decades. An example of such a popular explanation for a share repurchase is the distribution of excess cash to the shareholders (Guay and Harford, 2000), (Jensen, 1986). The selling shareholders end up with more cash and less shares, whereas the shareholders that hold on to their shares end up with a bigger part of the total outstanding shares. An example of classic economic theory, the efficient market hypothesis, would not expect any share price reaction to a share repurchase. This hypothesis states that all public information is incorporated in the price, therefore with no change in fundamental value, there should not be a change in the price. However, prior studies have shown a positive price reaction when a firm buys back their stock (e.g., Liu and Swanson, 2016). Multiple studies have shown that firms are able to repurchase shares at a lower price than the average market price (Obernberger, 2014). A recent example of such a study is one of Dittmar and Field (2015). They also find that managers can, on average, time the market.

The outbreak of the coronavirus, COVID-19, has influenced our day-to-day life in many ways. It still influences our consumption, travel behavior and working habits. As of February 2020, the COVID-19 pandemic disrupted the entire world and by doing so all economic activity. In the United States (U.S.) alone, the unemployment rate reached 14.7%, highest unemployment rate since 1939. The first reaction of the S&P500 was similar, it lost over one third of its value from February the 19th and March 23rd, 2020 (Cox, Greenwald, Ludvigson, 2020). However, over the following month the market recovered, gaining 29% and it was back at the level of August 2019, when the United States' economy was flourishing, and the unemployment rate was 3.7% (Cox, Greenwald, Ludvigson, 2020). A lot of literature focusses on the impact that COVID-19 has on macroeconomic factors (Eichenbaum, Rebelo, Trabandt, 2020) or the

epidemiological, demographic, and clinical issues of the virus (Callaway, Cyranoski, Mallapaty, Stoye, 2020). This thesis will address the problem of repurchasing stocks in the volatile environment that the COVID-19 pandemic created. As just described, the market in the U.S. showed a V-shaped trajectory. When a firm would have had a lot of reserves, no leverage or still a lot of income during the crisis it could be profitable to buy back its own shares. The firm specific characters that drive share repurchasing activity during the COVID-19 pandemic has not yet been widely researched. Therefore, the main objective of this thesis is to exhaustively address the following research question:

How do specific firm characteristics influence the actual share repurchase activity of firms during the COVID-19 pandemic in comparison to the pre-COVID-19 period?

To find an answer to this question, this thesis will address multiple hypotheses regarding several firm characteristics to explain variation in firms' decisions on repurchasing stock. The most commonly used accounting measures, firm size, leverage, cash holdings, profitability and return performance are expected to be strongly correlated to the repurchase decision of firms. After analyzing the firm specific measures and their relation to the repurchasing activity, the difference between the "corona year" and the fifteen years before will be laid out. Subsequently, a last hypothesis is tested to see whether managers can time the market during a global crisis.

The structure of this paper is as follows. The first section introduces share repurchases and the COVID-19 pandemic, connects them and thereby showing the relevance of this research. Hereafter, the research question of this thesis is stated. Section 2 presents an overview of relevant literature on the COVID-19 pandemic, and it also explains the most important publications on share repurchases. Subsequently section 2 divides the research question into five hypotheses. Section 3 provides details about how the data is gathered, modified and explains why the latter is relevant. The methodology is laid out in the fourth section, this part presents how the hypotheses from section 2 are tested. Section 5 discusses and elaborates on the empirical results that are discovered by the different analyses. Section 6 concludes on the results and describes the limitations of this research. The objective of this thesis is to examine what factors influence a share repurchase. Whereas a lot is known from previous literature, this thesis extends the current literature in the following way; determining the influence firm specific factors have on the repurchasing activity of a firm. Moreover, showing the influence of a global health crisis on these factors.

2. Literature Review

The purpose of this section is to provide an overview of the current literature that is available on the COVID-19 pandemic and share repurchases. Section 2.1 will discuss the literature concerning the pandemic. Subsequently, in section 2.2, this thesis will touch upon the most popular motives firms have to repurchase their shares. Section 2.3 focusses on the literature regarding the firm characteristics that explain or have a correlation with the repurchasing activity of firms. In combination with this literature, the hypotheses are developed to address the research question stated previously.

2.1 The COVID-19 pandemic

The virus emerged in the fourth quarter of 2019. During this period the Chinese office of the World Health Organization (WHO) firstly picked up a media report from the Wuhan Municipal Health Commission on a "viral pneumonia", now known as COVID-19. How did a health crisis turn into an economic crisis? The pandemic has forced countries to lock-down borders, and people to start social distancing, resulting in de-globalization. Lockdowns prevented goods, people, and capital to go its natural cause, businesses and production facilities had to temporarily shut down. The economic implications of the outbreak is widely known as 'Coronanomics' (Barua, 2020). The rapid rate at which the virus spread and the increased uncertainty on what would happen caused a flight to safety in consumption and investment among consumers, investors and international trade partners (Ozili, Peterson, Arun, 2020). Firms were struggling to make ends meet as the lockdown had huge impact on their cash flows, cash reserves and balance sheets (Pettenuzzo, Sabbatucci and Timmermann, 2021). As the liquidity shock affected the world economy by triggering a descent in firms' cash flow, leaving those firms with high debts and little cash reserve vulnerable to default (Liu, Qiu, Wang, 2021). Firms, under these circumstances, were forced to decrease their number of employees to remain financially healthy. The unemployment rate skyrocketed to 14.7 % within a few weeks' time after the crisis hit the U.S., creating huge economic uncertainty.

The relation of the determinants of share repurchasing activity and COVID-19 has not been widely researched. Some researchers try to investigate how firms change their dividend payout policy during the COVID-19 period (Mazur, Dang & Vo, 2020). Others try and find out how stock returns relate to corporate characteristics during a pandemic (Ding, Levine, Lin and Xie, 2021). Pettenuzzo, Sabbatucci and Timmermann (2021) try to explain how the coronavirus has

been affecting the dividend payout decisions of firms. They find that a lot of firms suspend their dividend payments or share repurchase programs. One of the most important conclusions they draw is that the market reacts negatively to the suspension of dividend payments. On the contrary, investors perceive a reduction in dividend as a sign of strong financial policy.

Pettenuzzo, Sabbatucci and Timmermann (2021) show that during 2020 the dividend payout programs, and share repurchase programs of firms are often suspended. Not every company had to suspend their dividend payments or share repurchase program. Section 2.3 will elaborate on the firm characteristics that could be the drivers, have a causal effect or be correlated to the suspensions and reductions in payout programs. Existing research suggests that repurchases and dividends can be seen as substitutes (Skinner, 2008). Firms can manage cash distribution to shareholders through dividend payments, repurchases, or a combination of both. Whereas Mazur, Dang and Vo (2020) find that the earnings available to shareholders, measured in earnings per share, is negatively related to dividend payments. Although dividend and stock repurchase are both forms of distributing excess cash to current shareholders, they are not perfect substitutes. As most of the recent literature focusses on the dividend payout policies this thesis will investigate how several firm characteristics are related to stock repurchases and how they change during a crisis.

2.2 Motives for share repurchases

Why do firms choose for a share repurchase if they could also distribute cash by paying out dividends? Guay and Harford (2000), Jensen (1986) show that firms use share repurchases to distribute excess cash. More recent research by Dittmar and Field (2015) presents evidence that firms successfully try to time the market, resulting in arbitrage due to undervaluation by the market. Another well-known theory is the market timing theory of capital structure by Baker and Wurgler (2002). This theory states that the current capital structure is the cumulative outcome of past attempts to time the market. Market timing implies that firms issue new shares when they seem to be overvalued and that they repurchase their shares when the firm thinks they are undervalued. The idea whether companies are able to time the market remains controversial. Jung, Kim, and Stulz (1996) find evidence inconsistent with market timing. DeAngelo, DeAngelo, and Stulz (2010) show only a limited effect of market timing, whereas other papers show that firms time the market with equity issues (Baker and Wurgler, 2002)

The theory that companies time the market has led to the market-timing hypothesis; firms anticipate returns and thus buy back before stock price increases. During a crisis the volatility in the market increases which causes the peaks and bottoms to be higher and lower than usual, which leaves more room for arbitrage. Not mutually exclusive is the contrarian-trading hypothesis proposes that firms buy back more at lower stock prices simply because repurchases are negatively related to realized returns. The results of the empirical analysis by Obernberger (2014) provide strong support for the contrarian-trading hypothesis. This means that repurchases are driven by negative returns in the past, and that firms buy back at below average market prices. While the contrarian-trading hypothesis is supported in the research of Obernberger (2014), the empirical evidence does not support the market-timing hypothesis. The difference between market prices and repurchase prices is in this research not positively correlated with abnormal returns. Where Baker and Wurgler (2002) find evidence that firms can time the market when they issue equity, Obernberger (2014) does not find support for the market timing hypothesis.

Cash distribution to the shareholders in the form of a share buyback, can be used by managers as an information signal. According to the information signalling hypothesis managers use share buybacks to signal the undervaluation of the firm's stock, because management believes that the market price is below the intrinsic value of the share (Vermaelen, 1981). Due to information asymmetry the market can believe that the management has superior information that is not publicly known. Small firms are less likely to be analyzed by analysts and more often suffer from a mispricing (Bakke and Whited, 2010). A high book-to-market ratio is associated with an undervaluation because of the low market value of equity in comparison with the book value. Simultaneously, a firms' management could undervalue their stock even though they have poor past performance. As a response to this perceived undervaluation the management can buy back shares to signal information about the particular stock. Zhang (2005) finds evidence for signaling on the short-term with regard to the size and book-to-market factors. Next to that, Peyer and Vermaelen (2009) find evidence for long-term mispricing with regard to size, book-to-market and past returns.

While a firms' equity might be correctly valued or even overvalued, the repurchase of shares signals the undervaluation of a firm's equity (Vermaelen, 1981). Signaling and price support are closely related. Liu and Swanson (2016) show that an increase in repurchases is followed by eight periods of positive abnormal returns, even though there is a decline in return on assets

over this period. Successful price support indicates that even though the profitability declines the abnormal returns are positive (Liu and Swanson, 2016). Where signaling is focused on the short-term impact, price support seems to be effective over a longer period (Liu and Swanson, 2016). The authors show that price support comes from two sources. Firstly, repurchases reduce shares outstanding sufficiently to mute the effect of reduced profitability on reported earnings per share. Secondly, higher repurchases increase demand for the company's stock while decreasing the supply of shares in circulation.

2.3 Firm characteristics, hypotheses development and empirical predictions

In the previous section the most popular phenomena that firms' have for buying back shares are touched upon. This is the rationale for why firms repurchase their shares and these motives are very important for firms, but the actual share repurchase is also influenced by the characteristics of the different firms. This section will bring up the firm characteristics that influence the share repurchasing activity of a firm.

Ding, Levine, Lin and Xie (2021) show that the drop in stock returns due to the pandemic was less among firms that had strong financials (e.g., more cash and less debt) before the crisis hit. An advantage for buying back shares is that it is a flexible form of cash distribution. Since the market penalizes firms that reduce or omit their dividend payment, a share repurchase is not a commitment, whereas dividend is (Allen and Michaely, 2003). As motives for share repurchases are widely researched, the expectation is that there are no new motives for firms to repurchase shares during a crisis. Therefore, the main research question is not about the motives for share repurchases but about the influence of firm characteristics:

How do specific firm characteristics influence the actual share repurchase activity of firms during the COVID-19 pandemic in comparison to the pre-COVID-19 period?

Many researchers have been looking at the influence of firm characteristics and the relation they have to the repurchasing activity of firms and how these firms perform. Ben-Rephael, Oded and Wohl (2013) find that small firms repurchase stocks at a discount in the month of the repurchase and large firms do not. Similarly, Dittmar and Field (2015) observe a higher discount for small firms and firms with a lower market-to-book value. This indicates that firm size is negatively related to the timing of actual share repurchases. The rationale behind these findings is that small firms more strategically repurchase stocks and time their decision depending on

the overall market sentiment. On the contrary, larger firms repurchase more often and regularly. They do this because they have large repurchase programs and focus less on favorable prices. However, larger firms have more liquid resources which gives them the ability to buy back shares when the market is unfavorable. Firms are more likely to repurchase shares when they hold high levels of excess cash (Dittmar, 2000). As mentioned in the previous section, similar results from; Guay and Harford (2000), Jensen (1986) their results indicate that firms use share repurchases to distribute transitory excess cash. Therefore, the first hypothesis is constructed as follows:

H1a: *Cash holdings are positively correlated with repurchasing activity.*
H1b: *The magnitude of the positive relation will increase during the COVID-19 period.*

This thesis will further touch upon other firm characteristics that have proven to be of influence on a firms' repurchasing activity. The profitability of a company should be positively related to the cash available for shareholders. The following variable is valuable because in previous research (e.g., Lintner, 1956) it is shown that net earnings is a very important factor for determining existing dividend policy. During the research of Lintner (1956) there were no repurchase programs. However, more recent findings of Skinner (2008) show that earnings do a good job of explaining corporate payouts. In his research Skinner (2008) divides the sample in different groups as they payout in different forms. Whereas the research of Skinner (2008) is focused on the dividend and repurchase programs, this thesis will solely focus on the effect of firm characteristics being determinants for repurchasing activity. The expectation is that the return on equity determines a large part of the repurchasing activity, with an increasing magnitude during the COVID-19 pandemic. This is mainly due to the fact that if a firm has a relatively high profitability per share, the firm has a strong market position and should be able to distribute cash back to his shareholders. Following this reasoning the next hypothesis is determined:

H2a: *Return on equity is positively related to repurchasing quantities.*
H2b: *The coefficient of the return on equity will increase in the COVID-19 period.*

If a firm has a lot of outstanding debt, a substantial part of the cash flow has to go to rent payments or to repayments of the loans. This leaves less money on the table to repurchase shares. Previous studies have shown evidence that companies tend to repurchase stock when

their leverage ratio is below their target (e.g., Dittmar, 2000), this is in line with the motive of the optimal capital structure suggested by Baker and Wurgler (2002). Jagannathan and Stephens (2003) find that firms with a low debt-to-equity ratio are more likely to make a repurchase. Moreover, Davison (2020) finds that the main effect of leverage is negatively related to the performance of a firm. During the COVID-19 crisis many firms underperformed or had to shut down their entire operation. This could have had multiple reasons, but one of the most obvious reasons is the inability to repay debt (Liu, Qiu and Wang, 2021) Therefore, this thesis will examine the effect leverage has on repurchasing activity in general and show the effect a global health crisis has on this relation. To do so the following hypothesis is put together:

H3a: *Leverage is negatively related to repurchasing volume.*
H3b: *The effect of leverage increases during the COVID-19 pandemic.*

The payout policy of a firm can change over time, if firms have abundant cash that they want to distribute among their shareholders they can do so in different ways. Firms have different motives as previously discussed. To extend the literature on share repurchases, the influence of a crisis has on the payout activities and the determinants of the repurchasing activity is examined. Firms have different preferences on how to payout their returns to the shareholders, some firms use dividends, others use a share repurchase or a combination of both. Moreover, the payout preference of a firm could differ when they suffer from the economic downturn of a crisis. Paying dividend and buying back shares are considered as (imperfect) substitutes (Skinner, 2008). To show the relation of dividends and repurchasing activity the following hypothesis is constructed:

H4a: *Dividends can be seen as a (imperfect) substitute for a share repurchase, the effect is expected to be negatively related to repurchasing activity.*
H4b: *The magnitude will increase during the COVID-19 period.*

Several researchers examined stock repurchases while relying on actual repurchasing data and they present evidence that is consistent with the market timing hypothesis. (e.g., Dittmar and Field, 2015). Dittmar and Field (2015) measure this discount with the relative repurchase price. They draw a comparison between the average monthly repurchase price to the average of the CRSP closing price and find that the average firm repurchases stock at a price significantly lower than the average closing price over the month of the repurchase and over the months

subsequent to the repurchase. The results of Dittmar and Field (2015) are quite recent, and this research does not want to replicate their results for another time period but rather demonstrate if there is a difference during times of crisis. As explained in section 2.1 the COVID-19 pandemic influenced our day-to-day life in many ways. One of the most important difference is the increased uncertainty, this has influenced the investor sentiment and as shown by Pettenuzzo, Sabbatucci and Timmermann (2021) forced a lot of firms to suspend their share repurchase programs. In line with this reasoning the following hypothesis is established:

H5: *In 2020 the average relative repurchase price differs significantly from the period 2004-2019.*

The expectation from the fifth hypothesis is that the magnitude of the coefficient increases. Because the volatility and the uncertainty during a crisis is higher, there are more opportunities for firms to take advantage of this sentiment (Bolton, Chen and Wang, 2013). Examining the first four hypotheses provides an insight into the firm characteristics that influence the repurchasing activity and shows if firm characteristics change with respect to the repurchasing activity. These general insights are necessary to get a clear overview of what the most influential factors are for a firms' payout decision. The fifth hypothesis is addressed to show the market timing ability of managers during the COVID-19 pandemic. After testing these hypotheses, the research question will be addressed, and this thesis will provide new insights for the existing literature on share repurchases. This thesis contributes to current literature by focusing solely on share repurchasing activity and the relation the net income to shareholders equity, cash holdings, leverage and dividends have to repurchasing activity. Moreover, it is expected that firms that conduct a share repurchase during the COVID-19 period do so with more discount than in the period before the pandemic.

3. Data

To answer the hypotheses and the main research question of this thesis a quantitative analysis is needed. The purpose of this research is to create understanding on how firms behave and how their characteristics change during a global crisis. Quantitative research is a way to learn about a group of people, by examining the sample population (Allen, 2017). Therefore, data is collected, this section elaborates on the process. First by addressing the data collection process thereafter the modification of the data is described. This has several advantages such as an increase of the robustness of this research.

3.1 Data collection

This thesis focuses on the firm characteristics that influence the actual share repurchase activity of listed U.S. companies from 2004-2020. The dataset of monthly actual U.S. repurchase that is used was constructed by PhD Candidate Y. Li from the Erasmus School of Economics. The Securities and Exchange Commission's (SEC) Electronic Data Gathering, Analysis and Retrieval (EDGAR) system provided the 10-K and 10-Q filings, those were downloaded over the period 2004-2020. The data was extracted and put into a Stata file. However, not all data could be extracted automatically. Some data had to be manually collected from the SEC EDGAR system. The output was not directly observable in an Excel or Stata file, therefore the data on the repurchasing activity of firms in 2020 had to be manually put into an Excel file. After this step it is converted into a Stata file. The data contains the number of repurchased shares per month, the average price paid per share, the number of shares firms repurchased as part of share buy-back programs and the remainder, the amount of shares the firms still can buy back as a part of these programs. For the firm characteristics the financial ratios from the Wharton Research Data Services- is utilized. This is a web-based engine that delivers more than 70 financial ratios for all U.S. companies in multiple categories. This is a sophisticated tool for researchers that want to conduct a firm or industry level analysis. A selection is made based on the literature review and the expectations of the variables that have most impact on the repurchasing activity of firms. Subsequently, the data on stock prices is gathered via Wharton Research Data Services from Compustat Monthly Security Data. To match the data on monthly share repurchases, monthly data is used instead of daily data. To address the fifth hypothesis the monthly stock price data is used to create the relative repurchase price.

3.2 Data modification

Before the methodology can be implemented, the data is gathered and analyzed. As the dataset on the repurchasing data is a raw dataset it is exposed to outliers. These outliers cause the data to be skewed and give a false representation of the reality. Thus, modification is necessary. With the winsorization technique the exposure to outliers is reduced (Dixon, 1960). The advantage of the winsorization technique is that it does not delete outliers, but it gives the outlier less weight. This technique works as follows; if a dataset is winsorized at a 1% level for both tails, the outliers in the 1st and 99th percentile are changed to the same value as those at the end of the new tail, 1st and 99th percentile. The use of this winsorization technique enables this research to lessen the weight of outliers for all research variables. This is necessary as multiple variables contain extremely high or extremely low values. By way of example, the maximum of the dividend yield variable was 1.7. The dividend yield is calculated as the dividend paid, divided by the price of the particular share. This value is not realistic, a firm would not pay 1.7 times their shareholder value in dividends. Therefore, the dividend yield is winsorized at the 1st and the 99th percentile. For every variable the cut-off level is determined, one, five or ten percent, and that depends on which level of winsorization keeps the variance sufficient and smoothens extreme values. The same modification is made for the debt-to-equity ratio, the cash ratio and the return on equity measures. Besides that, the growth variable, is also winsorized at the 1st and 99th percentile. The difference in extreme values and standard deviations for all winsorized variables is shown in Figure 2 in the Appendix, this provides an overview of the rationale for the winsorizing of the research variables. For the size of a firm this is not necessary as it is subject to a logarithmic transformation. With this modified dataset proper research is possible, the methodology section will elaborate on how the research is conducted.

4. Methodology

In this section the methodology that is used to test the hypotheses is presented. Section 4.1 will explain how the general model is constructed to show how the firm characteristics relate to repurchasing activity of firms. Thereafter, section 4.2 describes the modifications needed to show the same relation but for different time periods. This is possible by utilizing additive and multiplicative dummies. Section 4.3 shows how to test for the market timing ability of managers during the COVID-19 pandemic.

4.1 Multiple linear regression model

To test the effects of these different firm characteristics this thesis will show a multiple linear regression (MLR) analysis. With such an analysis the correlation between the dependent and independent variables is shown. Where the dependent variable is the repurchase volume and the other factors are the independent variables. The general model to compare the influence of the independent variables on the dependent variable is shown below.

$$LNRepurchase\ volume_{i,t} = \beta_0 + \beta_1 Cash_{i,t} + \beta_2 Income_{i,t} + \beta_3 Leverage_{i,t} + \beta_4 Dividend_{i,t} + \beta_5 LNSize_{i,t} + \beta_6 Growth_{i,t} + f_{i,t} + \varepsilon_{i,t} \quad (1)$$

Repurchase volume is the dependent variable and is calculated as the shares repurchased by firm *i* in period *t* multiplied with the price paid for that share in the same period. This measure shows how much a firm bought back in a certain period. To show the percentual change in repurchasing activity and to make this variable less skewed a logarithmic transformation is conducted. The repurchase volume is transformed to the natural logarithm of the repurchase volume. The interpretation of a linear regression analysis is when a unit changes in X will coincide a change of β_x change in Y. Taking the log of Y, repurchasing volume in this case, will change the interpretation from a unit change to a percentual change.

Cash is defined as the cash ratio of firm *i* in period *t* and is constructed as; the cash and cash equivalents divided by the current liabilities. This measure shows how much liquid resources a company has in comparison with its short-term liabilities. If this ratio is high the particular firm has a lot of short-term flexibility.

Income is defined as the return on equity, the net income of a company relative to the shareholders equity. The return is a percentage of the total equity, this makes it more difficult

to interpret the coefficient in a log-linear model and therefore the factor is multiplied by 100 to be able to directly interpret the coefficient in the regression analysis. Following Lintner (1956), the expectation is that a higher net income increases the willingness of a firm to pay out dividends or repurchase shares. Companies focus on the generation of profit and maximization of shareholders' equity. Brigham and Ehrhardt (2011) argue that: "maximizing the market value of a firm offers the most essential objective function which is necessary for the efficient management of a firm".

Leverage is defined as the debt-to-equity ratio. With this measure a firm shows how dependent they are of debt and equity. With a high debt-to-equity ratio the cost of capital increases, equity providers will demand a higher return and debt providers will demand more interest. Due to the higher cost of capital if the debt-to-equity ratio is high, the expectation is that this measure is negatively related to the repurchase volume.

Dividend is measured as the dividend yield. The calculation of this yield is the dividend divided by the price of the particular stock. As the dividend is given as a percentage of the stock price, this variable is multiplied by 100 to be able to directly interpret the percentual change in repurchasing volume. The advantage is that it is no absolute number but a relative measure so that it does not matter if a stock has a high or low absolute value.

The beta coefficients show how influential the various variables are on the repurchasing volume. If these beta coefficients are significant a conclusion can be drawn about the effect of the independent variables on the dependent variable. A positive beta coefficient can be interpreted as a one unit increase in the particular variable increases the dependent by the value of the beta. If the coefficient is negative the interpretation is the same but then with a decrease in value. Included in the model are some control variables. This is the interpretation for a linear model. For this research a log-linear model is used, interpreting the coefficients becomes different, a one-unit change in the independent variable changes the dependent variable by 100 * β as a percentage. For example if β_x = .06, and X changes one unit the expected increase in Y is 6% (Benoit, 2011).

As share repurchases mitigate information asymmetry and agency cost (Brailsford, Marchesi, Simon, Tutticci, 2008), it is expected that the size of a firm is positively related to share repurchase activity. However, larger firms are subject to more external control in comparison to smaller firms. Moreover, investment analysts follow larger companies more closely and institutional investors have more exposure to large companies. This puts these companies under

external scrutiny and pressures large firms to be more transparent (Allen, Bernardo, Welch, 2000). Because of this scrutiny, the information asymmetry and agency costs are likely to reduce relative to small firms. On the other hand, outside investors of small firms are likely to suffer from adverse selection as they have less information then inside equity holders. These outside investors require a high premium due to the chance of adverse selection. The repurchase mechanism can be used to reduce adverse selection costs for small firms. This gives the empirical prediction that size is negatively related to the repurchasing activity of a firm, contradicting the expectation mentioned previously. Therefore, no prediction on the sign of the size variable in relation to share repurchase activity is made.

Size is measured as the natural logarithm of the book value of total assets. The transformation to a natural logarithm is made as the size of a firm is a highly skewed variable and due to this transformation, the variable has a more normalized distribution. Due to this logarithmic transformation, the interpretation changes. Whereas the interpretation of a log-linear coefficient shows how a unit change relates to a percentual change in the dependent variable, the log-log coefficient represents the elasticity of the Y variable to the X variable, *Repurchasing volume*, and *Size* respectively. Elasticity is the estimated percent change in the Y variable for a percentual change in the X variable.

The second control variable implemented in this regression analysis is *Growth*. The rationale is as follows: when a company has run out of growth opportunities and thus cannot find an exceptional utilization for its funds, the firm could use the unused funds to repurchase shares. Following this reasoning it is expected that firms with many growth opportunities buy-back less shares compared to firms lacking growth opportunities. The growth prospect of a firm is, at least in theory, negatively related to the repurchasing activity of companies. To account for the growth options in this regression analysis a proxy needs to be used as there is no variable available that will tell how much firm specific growth options are available. The results from Adam and Goyale (2008) show that the market-to-book assets ratio has the most information content regarding investment opportunities. The book value is a proxy for the assets in place and the market value of assets is a proxy for assets and investments possibilities. The data available has provided the book-to-market ratio, this is the reverse of the market-to-book ratio. Therefore, this ratio should have the same information content but a reversed interpretation. Whereas a high market-to-book ratio shows a lot of growth opportunities, the market values growth opportunities while they are before they are implemented, a low book-to-market ratio

also shows that a firm has numerous possibilities to invest relative to its assets in place. Therefore, the proxy used to address the growth opportunities of a firm is the book-to-market ratio.

The multiple linear regression method is an extension of the ordinary least squares (OLS) method and provides a comprehensive rationale for the best fit of a line considering the data points that are being researched. This method creates a straight line that, as the name of the OLS method states, aims to minimize the sum of squares of the errors. These errors occur as a result of squared residuals which in their turn cause differences in the observed value. This method is widely used since Carl Friedrich Gauss discovered the method in 1795 (Stigler, 1981). The line with the best fit could also explain the potential relationship between the independent and dependent variables. With the multiple linear regression, it can be shown how multiple independent variables are related to a single dependent variable. Each of the independent has some predictive value to the dependent variable. The information that multiple variables give, cash, earnings, leverage, and dividends, can be used to generate an accurate prediction on the effect they have on the repurchasing activity.

The last two terms in the regression equation, $f_{i,t} + \varepsilon_{i,t}$, denote the firm fixed effects and the error term, respectively. The firm fixed effects (FFE) are omnipresent in financial economics research as a control for correlated omitted variables (deHaan, 2020). Fixed effects are often used for high-frequency groups, firms in this case. Including these firm fixed effects discard all the between-firm variation, meaning that the regressors explain more accurately the variation in repurchasing volume. Moreover, firm fixed effects reduce the possibility of that omitted variables drive any associations between dependent and independent variables. All in all it reduces the variance in the independent variables and narrows the scope by a decrease of the overall variation in the data set (Mummolo and Peterson, 2018). The error term represents the margin of error in the model. It is conducted as the sum of deviations within the linear regression line. The error term provides a clarification for the difference between the theoretical values and the actual results.

4.2 Differences during the COVID-19 pandemic

In this section the methodology used to address the extension and the essence of the first four hypotheses is presented. As described in section 2.1, the COVID-19 virus had a lot of impact on the way we do business. This impact is expected to influence the repurchasing activity of firms globally. To test the empirical predictions made earlier the model in section 3.1 is constructed for the period 2004-2020. To show the effect of the COVID-19 year this thesis will extend the model mentioned previously. To do so a similar model is used for the period 2004-2020, the difference is that a dummy variable is added for the year 2020. This variable takes the value of one if the observation is in the year 2020 and zero otherwise. Subsequently, an interaction term is added for every independent variable. The value of the interaction term is the dummy variable multiplied by the independent variable. In this case the interaction term is helpful as it shows how the different variables change in 2020 relative to the prior period. The model looks like this:

$$LNRepurchase\ volume_{i,t} = \beta_0 + \beta_1 Cash_{i,t} + \beta_2 Income_{i,t} + \beta_3 Leverage_{i,t} + \beta_4 Dividend_{i,t} + \beta_5 LNSize_{i,t} + \beta_6 Growth_{i,t} + \beta_7 Dum2020_{i,t} + \beta_8 Cash * Dum2020_{i,t} + \beta_9 Income * Dum2020_{i,t} + \beta_{10} Leverage * Dum2020_{i,t} + \beta_{11} Dividend * Dum2020_{i,t} + \beta_{12}\ LNSize * Dum2020_{i,t} + \beta_{13} Growth *\ Dum2020_{i,t} +\ f_{i,t} + \varepsilon_{i,t} \quad (2)$$

The interpretation of the equation changes, a dummy variable is used to categorize the two different time periods. The general model shows how the relation is for the whole sample period, the dummy variable splits this into two periods. For instance, if the dummy variable takes a negative value, the repurchase volume in 2020 is lower than in the previous period, 2004-2019. The interaction terms show how the independent variables relate to the repurchasing volume in 2020 whereas the $\beta_1,\ \beta_2,\ \beta_3,\ \beta_4, \beta_5\ and\ \beta_6$ coefficients show how the variables relate to repurchasing volume in the period 2004-2019. This methodology directly points out the source of difference if there is any. The additive dummy will show if the intercepts are equal, and the multiplicative dummies will show if the slopes are equal (Gujarati, 1970). A multiplicative dummy is the same as an interaction term and thus will show how the slope, the beta coefficient differs during the COVID-19 pandemic. The additive dummy is the $\beta_5 Dum2020$ factor in this regression and shows if and how the intercept, starting point of the linear regression line, changes.

4.3 Market timing

The methodology to test whether managers are able to time the market during the COVID-19 pandemic is presented in this section. The relative repurchase price is the method to show at what price managers buy back their stock relative to the average price in the same month. It is a measure to capture possible discounts or premia paid by firms relative to the average market price in windows surrounding the actual repurchase. In the study from Dittmar and Field (2015) this measure is also applied to study the market timing ability of managers. The relative repurchase price is calculated as the percentage difference between the average price of the shares that are repurchased and the average daily closing price. This is shown with the following equation:

$$Relative\ repurchase\ price_{i,t} = (RP_{i,t} / StockP_{i,t}) - 1 \quad (3)$$

Where the RP is the repurchase price in the transaction month *t* for firm *i* and StockP is the average stock price for that particular share in the transaction month. To show the relation between the relative repurchase price and the possibility of firms to time the market, the interpretation of the measure will be explained. The relative repurchase price measure is used to examine if there exists a significant difference between the average price a stock is sold for and the price that firms pay when they buy back the particular stock (Dittmar and Field, 2015). As mentioned in section 2.3 the research by Dittmar and Field (2015) shows a significant negative relative repurchase price. This means that in their research period, 2004-2011, managers were, on average, able to time the market as they bought stocks at a lower price than the market. This thesis will focus on the timing ability of managers during the COVID-19 pandemic. If the average relative repurchase price is significantly higher or lower than the average stock price managers buy at a premium or discount respectively, ($RP_{t=0} \neq StockP_{t=0}$).

The expectation is that, in contradiction with Dittmar and Field (2015), managers are not able to time the market as the markets are very volatile and uncertain during the COVID-19 pandemic. Moreover, the crisis created a liquidity shock, firms' cashflows decreased drastically which left less cash on the table for repurchase programs. Due to this uncertain environment in combination with the decrease in liquidity the timing of the market is more difficult. On the one hand because managers do not know what will happen next (i.e., another lockdown) and on the other when markets become favorable again there might not be enough funding to time the market. This thesis will show if there is a significant difference in the price firms pay for their

stock in comparison with the closing price on the market in the particular repurchase month. The method used for this is the relative repurchase price method of Dittmar and Field (2015). This measure shows what the average relative repurchase price is. Thereafter, a two-sample t-test is conducted, this test is used to see whether the average relative repurchase price in 2020 differs significantly from the mean of the 2004-2019 period.

5. Results

The following section elaborates on the empirical results obtained after the methodology is implemented. Hereby answering the research question presented in the first section. To give some insight in each of the research variables, section 5.1 shall summarize these variables and will identify the number of firms that repurchase shares and the aggregate repurchase activity. The base model is presented in section 5.2, showing how repurchasing activity of firms relates to the different research variables. Subsequently, the additive and multiplicative dummies are added to the model and these results will show how repurchasing activity differs during the COVID-19 period. These results provide evidence for the research question that this thesis has raised in the first section. The market timing ability of managers is elaborated on in section 5.3. As mentioned previously the results of Dittmar and Field (2015) will not be replicated but their method is used to see if managers are able to time the market during the COVID-19 pandemic.

5.1 Summary statistics

This paper studies the effect that specifically selected variables have on repurchasing activity, the sample period reaches from 2004 up to and including 2020, and covers actual share repurchases of listed U.S. firms. The monthly repurchase dataset obtained from PhD candidate Y. Li with the 10-K and 10-Q filings is matched with the closing stock prices from the CRSP database. Moreover, the firm specific characteristics are added and matched on the firms' Ticker, which is a stock symbol representing publicly traded securities on an exchange. After merging the dataset on the stock prices and research variables together with the monthly actual repurchase dataset, 4,505 companies that repurchased shares at least once during the sample period are identified. Firms are identified if they made a repurchase in a specific year, this is denoted as firm-years in Table 1. This illustrates how many firms are responsible for the aggregate repurchasing activity in a year, also referred to as firm-years. The entire sample of actual share repurchases consists of 4,505 U.S. companies that ever made a repurchase and 13,321 repurchasing firm-years.

In Table 1 the average relative repurchase price per year and an average over the whole sample period is presented. This is a measure of the market timing ability of firms and their managers. The price for which an average firm repurchases stock is 0.5% lower in comparison to its average market price within the same month, which implies that managers time the buyback of shares in periods when the stock price seems to be undervalued.

Table 1
Summary statistics of the repurchasing activity per year

Year	*Aggregate Repurchase Volume (in billion dollars)*	*Firm years*	*Average Relative Repurchase Price*
2004	219.99	628	-1.4%
2005	971.47	759	-0.6%
2006	470.54	831	-1.0%
2007	535.91	909	0.2%
2008	350.56	940	0.6%
2009	120.87	685	-0.4%
2010	230.51	699	0.1%
2011	410.64	840	-1.1%
2012	308.19	871	-0.7%
2013	287.35	716	-1.5%
2014	391.02	917	-0.5%
2015	374.30	909	0.6%
2016	365.89	877	-1.4%
2017	372.38	861	-0.8%
2018	518.24	902	0.7%
2019	386.79	899	-0.7%
2020	15.24	78	-1.1%
Cumulative/ Average	6,443.39	13,321	-0.5%

The sample shows 13,321 firm years. These firm years are constructed as follows, when a firm conducts a share repurchase in a certain year between 2004-2020 one firm year is added to the specific year the repurchase was in. This shows how many firms are responsible for the aggregate repurchasing activity in that specific year. The average relative repurchase price is shown per year, this indicator shows how firms on average performed when conducting a share repurchase.

5.2 The determinants of repurchasing volume

In this section the results of the multiple linear regression analysis are presented. Firstly, the interpretation of the regression of the base model over the whole sample period is elaborated on. Subsequently, in the following subsection the effect of the additive and multiplicative dummies is analyzed and explained. Both results are shown in Table 2 and provide evidence for the various hypotheses formulated in section 2.

The log-linear model is useful in this case because the percentual change in repurchase volume can be shown when changing one independent variable and holding the others constant. The results from the different log-linear regressions are shown in Table 2 on the left-hand side. Where *Repurchase volume* is the dependent variable and is calculated as the shares repurchased by firm *i* in period *t* multiplied with the price paid for that share in the same period. As mentioned previously the dependent variable is transformed into a logarithmic variable.

In the absence of firm fixed effects, the influence of *Cash* on the repurchase volume over the whole sample period is -9.75%. This coefficient can be interpreted as a one-unit change of the cash ratio decreases the repurchasing volume by almost 10 percent. This outcome is unexpected as cash holdings should give a company the possibility to invest and buy back shares. However, when the firm fixed effects are included in the model, the coefficient shows a sign reversal. Because of the previously stated improvements the fixed effects have for this model, this will be the leading result of this research. The influence of *Cash* on the repurchase volume is 32.1% Since this coefficient has such a large positive impact on the dependent variable and is significant at a 1% level there is no clear reason to reject the first hypothesis (H1a). This implies that over the whole sample period, firms with a high cash ratio, repurchase more in comparison to firms that have a low cash ratio.

The *Income* variable has a positive marginal effect on the repurchasing volume of U.S. listed firms. A one percent increase in the return on equity lead to a 4.85% percent increase in the repurchasing volume, without the control of firm fixed effects. The magnitude of this coefficient increases significantly when controlling for FFE's, to 226.8%. This seems to be large but not unrealistic. The result is in line with the expectation beforehand. Due to this positive effect and the significance at a one percent level the second hypothesis (H2a) cannot be rejected. These results indicate that a higher net income relative to the total shareholder equity increases the actual share repurchase activity. On the other hand, the *Leverage* a firm

has, measured as the debt-to-equity ratio, has a negative effect on the repurchasing activity of firms in the U.S. A one unit increase in the debt-to-equity ratio means that a firm takes on one time their own equity in debt. This will increase the measure by one percent and decreases the repurchasing volume by 14.7% and by 17.6% when controlling for FFE's. As expected, the relation between the repurchasing activity and the leverage of firms is negative and significant at a one percent level, gives no reason to reject the third hypothesis (H3a). For the fourth hypothesis the *Dividend* variable is analyzed. Dividend is, similar to return on equity, measured as a percentage. Thus, a one percent increase in dividend yield will decrease the repurchase volume by 10.6% and by 2632% when controlling for FFE's. These results display similarities with the findings of Skinner (2008), where in his research in the Journal of Financial Economics he argues that share repurchases, and dividends are substitutes. The results from the regression analysis in Table 2 show a negative relation between the repurchasing activity and the dividend yield of a company. Hence the fourth hypothesis (H4a) cannot be rejected. However, this gives reason to assume that when a company increases their dividend, they will repurchase less shares.

Whereas the interpretation of a log-linear coefficient shows how a unit change relates to a percentual change in the dependent variable, the log-log coefficient represents the elasticity of *Size* variable relative to the *Repurchasing volume* variable. Elasticity denotes the estimated percentual change in the dependent variable for a percentual change in the independent variable. Therefore, the beta coefficient of *Size* can be directly interpreted as a one percent change in the book value of a firms' assets increases the repurchasing volume by 1.128% and 0.578% when controlling for FFE's. The *Growth* variable has a regular log-linear interpretation. A one unit change the book-to market ratio of a firm decreases the repurchasing volume of the firm by 165.1% and 99.1% when controlling for FFE's. The magnitude of this coefficient is so large because a one-unit increase in the book-to-market ratio is a very unusual change. This would mean that a firm doubles their book value relative to the market value. Moreover, these results are inconsistent with the argument that a firm with a low book-to-market ratio has more investment opportunities and will repurchase less shares relative to firms with a high book-to-market ratio. These results show that a higher book-to-market ratio decreases the repurchasing volume of U.S. listed firms.

5.3 Findings on the COVID-19 period

Prior analysis has been conducted over the whole sample period from 2004 up to and including 2020 for U.S. listed firms. To show how the determinants of the repurchasing activity change over time, the base model is extended to a model that includes two types of dummies. The first one is to distinguish two different time periods, the additive dummy. It takes the value of one if the observation is in the year 2020 and zero otherwise. The additive dummy in this regression shows how the intercept, starting point of the linear regression line, changes. As this model is still a log-linear model the interpretation of the coefficient is that the starting point of the regression, the intercept, is 141.1% higher in 2020 than in the period 2004-2019. However, this coefficient is not significant and therefore no conclusion can be drawn on the difference in starting point of the linear regression model. From here on the multiplicative dummies, also referred to as interaction terms, are generated. The multiplicative dummies are shown in Table 2 in the column on the right-hand side. A multiplicative dummy shows how the slope, the beta coefficient differs during the COVID-19 pandemic. In Table 2 it is shown that the coefficients from the extended model differ from the base model. This is due to the difference in sample period. On the left-hand side and the middle column, the average coefficients are shown over 2004-2020 period. Whereas the regression output on the right-hand side splits the two periods using dummy variables. The interpretation of the base model coefficients is the same as described in the previous section. However, these coefficients represent the 2004-2019 period, and the dummy variables show the difference between 2020 and the previously mentioned period.

During the COVID-19 pandemic *Cash* is more positively related to the repurchase volume of firms. The 2020 coefficient is .275 higher relative to the average over the 2004-2019 period. This means that for one unit change in the cash ratio the repurchase volume is 27.5% higher than in the period prior to the global health crisis. This is a significant coefficient with a large magnitude, therefore the first hypothesis regarding the difference in the COVID-19 period (H1b) cannot be rejected. These results do indicate that a more positive relation between the cash ratio and the repurchasing volume exists. For the *Income* variable in 2020 the results are similar. Whereas the beta coefficient is positive in the period before COVID-19, the slope changes drastically by -3.415 and the coefficient decreases from 2.450 in the 2004-2019 to -0.965 in 2020. The expectation was that the magnitude of the beta coefficient would increase

during the COVID-19 period, this is not true for this sample. Therefore, the second hypothesis (H2b) can be rejected. The magnitude does not increase during 2020 but it decreases.

Where the debt-to-equity ratio in the period prior to COVID-19 was negatively related to the repurchase volume, during the pandemic the coefficient changes from negative to positive. This result can be interpreted that listed firms in the U.S. with high leverage bought back more shares during the pandemic compared to firms that have low leverage. Due to this result the third hypothesis (H3b), concerning the determinants of repurchasing activity during a global health crisis, can be rejected. Such significant differences in the determinants for share repurchasing activity implicate a reversal effect, firm specific characteristics that usually drive share repurchasing activity do not do so during a crisis. The *Dividend 2020* variable is in line with the fourth hypothesis (H4b), and the beta coefficient is significant at a five percent level. Thus, the effect of the dividend on repurchasing activity in 2020 has, as expected, a more negative relation than in the previous period. The two control variables display similar behavior as the *Leverage* variable, the sign of the coefficient is the opposite as it was in the period before the pandemic. The beta coefficient of the *Size* variable decreases from 1.262 to 0.292 and the *Growth* variable increases from -1.188 during 2004-2019 to 0.646 in 2020. As the *Growth* variable is measured as the book-to-market ratio this leads to the following conclusion; in 2020 the increase in a book-to-market ratio leads to increased repurchasing activity. This is in line with the expectations as a low book-to-market ratio represents a lot of growth opportunities. However, this measure is highly negative over the period 2004-2019 which is surprising as the firms with the most growth opportunities buy back the most shares. Lastly the R-squared measure; this coefficient evaluates the scatter of the data points around the fitted regression line. Due to this "goodness of fit", the R-squared is also called the coefficient of determination. A higher R-squared value represents a smaller difference between the observed data and the fitted values of the regression line. R-squared is the percentage of the variation in the repurchase volume that is explained by the regressors, research variables in the model.

Table 2

Multiple linear regression analysis

	Natural logarithm of the repurchasing volume	***Natural logarithm of the repurchasing volume***	***Natural logarithm of the repurchasing volume***	***Natural logarithm of the repurchasing volume***
Cash	-0.0975***	0.321***	-0.101***	0.236***
	(0.0255)	(0.0449)	(0.0260)	(0.0444)
Income	0.0485***	2.268***	0.0503***	2.450***
	(0.00213)	(0.232)	(0.00218)	(0.234)
Leverage	-0.147***	-0.176***	-0.143***	-0.149***
	(0.0135)	(0.0159)	(0.0138)	(0.0161)
Dividend	-0.106***	-26.32***	-0.0695***	-12.34***
	(0.0201)	(2.881)	(0.0207)	(2.953)
Size	1.128***	0.578***	1.206***	1.262***
	(0.0186)	(0.0823)	(0.0187)	(0.0828)
Growth	-1.651***	-0.991***	-1.813***	-1.188***
	(0.103)	(0.135)	(0.106)	(0.137)
Additive Dummy			1.252*	1.141
			(0.739)	(0.709)
Cash 2020			0.230**	0.275***
			(0.109)	(0.0999)
Income 2020			-0.0410***	-3.415***
			(0.00841)	(0.782)
Leverage 2020			0.176***	0.150***
			(0.0524)	(0.0482)
Dividend 2020			-0.0497	-16.27**
			(0.0757)	(7.050)
Size 2020			-0.989***	-0.970***
			(0.0897)	(0.0854)
Growth 2020			1.838***	1.834***
			(0.374)	(0.353)
Constant	-1.257***	2.533***	-1.564***	-2.007***
	(0.157)	(0.559)	(0.159)	(0.561)
Observations	48,785	48,785	48,785	48,785
R-squared	0.113	0.361	0.139	0.384
Firm fixed effects	No	Yes	No	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.3.2 Test for robustness

Robustness tests are needed as a check whether the assumptions that have been made in the model are correct. The Gauss Markov assumptions for modelling ordinary least squares (OLS) regression and the validity of the regression coefficients:

1. Linearity: the parameters used for the OLS method must be linear.
2. Random: the data must be randomly sampled from the population.
3. Non-collinearity: the regressors are not perfectly correlated with each other.
4. Exogeneity: the research variables are not correlated with the error term.
5. Homoscedasticity: the error term of the variance is constant.

All variables are linear, the data is randomly selected and there are no omitted variables due to collinearity. Therefore, the three first conditions seem to be true and the fourth and fifth are tested for. Exogeneity tells whether or not the independent variables, the regressors, are dependent on the dependent variable. The test used for this is the Durbin Wu Hausman test shown in the column on the left in Table 3, the 2SLS regression. The results of this test have shown that there are no endogenous regressors which means that they do not depend on the independent variable. Several precautions have been made to reduce the chance of heteroscedasticity. Heteroscedasticity is mainly caused by outliers in the data and omitted variables. The winsorization of the research variables is one of the most important things to prevent a skewed distribution. The same goes for the logarithmic transformation performed on the *Repurchase volume* and the *Size* variables. This transformation also ensures a less skewed distribution of these variables.

To test for the heteroscedasticity the Breusch-Pagen test is performed. This assesment has the following null hypothesis; homoscedasticity, the alternative is that the model is subject to heteroscedasticity. The regular ordinary least squares regression shown in Table 2 and the corresponding Breusch-Pagen test is conducted and shown in Figure 1 in the Appendix. This tests whether the variance of the errors from the regression is dependent on the values of the independent variables. The results do report heteroscedasticity in the residuals of the model. This has serious consequences for the OLS estimator, although the estimation is still unbiased the estimated standard error is wrong. The OLS regression is no longer the best linear unbiased estimator (BLUE). Subsequently, a new regression model and analysis needs to be implemented. Whenever there is a form of heteroscedasticity the generalized least squares

(GLS) is the best linear unbiased estimator (Politis, Poulis, 2014). Under the assumption that the error variance is unknown but a smooth function of the regressors the GLS estimation is possible. This method first estimates the residuals, squares these and then transforms it to a logarithmic function of the squared residuals. The second step is regressing the logarithmic function as a dependent variable on the independent variables used in the original OLS regression. From this regression the fitted values are obtained and exponentiated. The last step is running the corrected regression with the weights of one over the exponentiated fitted values. The results are shown in the middle column in Table 3.

The results of the generalized least squared method differ from the regular OLS regression. The difference between OLS and GLS is the assumption made about the error term in the model. As shown in the OLS model the error term is heteroscedastic. The GLS model that is presented in Table 3 eliminates heteroscedasticity, as far as possible. In the middle column the GLS regression is shown for the extended model and on the right-hand side it is shown for the base model. With GLS an asymptotic efficiency is gained over the OLS model. Both models are unbiased, but the OLS coefficients are inefficient. The GLS estimators have smaller standard errors and are more efficient estimators as the OLS model is suffering from heteroscedasticity.

The interpretation of the coefficients is the same as explained previously, a one-unit change in an independent variable X causes the dependent variable Y, or in this case repurchasing volume, to change by the β_x multiplied by 100 measured as a percentage. The interpretation of the *Size* variable still is the elasticity as it is shown as a log-log relation to the repurchasing volume. The main difference in the GLS model is that these results show that most coefficients and their standard errors are smaller due to the modification from OLS to GLS. In comparison the OLS regression with robust standard errors is added. As there still seems to be a form of heteroskedasticity the GLS estimator is the most efficient estimator. Moreover, the magnitudes of the coefficients decrease, as does their standard deviation. Hence, the GLS is the best linear unbiased estimator.

Table 3
Differences in regression analyses

	2SLS	***GLS***	***GLS***	***OLS with robust standard errors***
Cash	-0.101***	0.411***	0.294***	0.236***
	(0.0259)	(0.0411)	(0.0410)	(0.0395)
Income	0.0503***	-0.341***	0.0291	2.450***
	(0.00217)	(0.114)	(0.119)	(0.241)
Leverage	-0.143***	-0.0110	-0.0860***	-0.149***
	(0.0138)	(0.0101)	(0.0117)	(0.0176)
Dividend	-0.0695***	-18.69***	-8.401***	-12.34***
	(0.0207)	(1.308)	(1.468)	(2.716)
Size	1.206***	0.239***	1.230***	1.262***
	(0.0187)	(0.0550)	(0.0594)	(0.0831)
Growth	-1.813***	-0.0413	-0.404***	-1.188***
	(0.106)	(0.0654)	(0.0685)	(0.127)
Additive Dummy	1.252*		0.167	1.141*
	(0.739)		(0.305)	(0.642)
Cash 2020	0.230**		0.315***	0.275***
	(0.109)		(0.0837)	(0.0921)
Inc 2020	-0.0410***		-1.031***	-3.415***
	(0.00841)		(0.354)	(0.763)
Lev 2020	0.176***		0.176***	0.150***
	(0.0524)		(0.0199)	(0.0508)
Div 2020	-0.0497		-6.978***	-16.27***
	(0.0757)		(2.410)	(5.730)
Size 2020	-0.989***		-0.724***	-0.970***
	(0.0897)		(0.0463)	(0.0819)
Growth 2020	1.838***		0.585***	1.834***
	(0.374)		(0.130)	(0.277)
Constant	-1.564***	1.231***	-1.662***	-2.007***
	(0.159)	(0.255)	(0.265)	(0.563)
Observations	48,785	48,785	48,785	48,785
R-squared	0.139	0.240	0.270	0.384
	(No endogenous regressors)			
Firm fixed effects	No	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.4 Relative repurchase price

In this section the results on the market timing ability of firms and their managers are presented. Whereas the main goal of this thesis is to show what firm specific characters determine share repurchasing activity during the COVID-19 period, the market timing ability has been used as an argument for share repurchases. Multiple researchers have shown that managers are, on average, able to time the market (Obernberger, 2014). Therefore, the only focus is to show whether or not managers are still able to time the market when they have to make a repurchase decision in times of a global health crisis. To be able to make a comparison the relative repurchase price over the two sample periods is constructed, see Table 4. The test constructed in Table 4 compares the means of the period 2004-2019 with the mean of the 2020 relative repurchase price. There is a significant difference in the means of the two sample periods. As shown in Table 4, the difference between the two means is tested. The alternative hypotheses are shown below the table. The alternative hypothesis on the left and the one in the middle are significant at a one percent level. From these results it is quite obvious that the means are different from each other, and the difference is below zero.

Recalling the fifth hypothesis, the relative repurchase price in 2020 differs significantly from the average relative repurchase price during the period 2004-2019, the results give no clear reason to reject this hypothesis. However, it indicates that there is a significant improvement in the market timing ability of managers. Pettenuzzo, Sabbatucci and Timmermann (2021) show that during 2020 dividend payout programs, and share repurchase programs are often suspended. However, not every company had to suspend their dividend payments or share repurchase program. The firms that did still continue their share repurchase program or incidentally bought back some shares, did so with a greater discount then in the years previous to the COVID-19 pandemic.

Table 4
Two-sample t test with unequal variances

Variable	*Obs*	*Mean*	*Std. Err.*	*Std. Dev*	*[99% Conf.*	*Interval]*
REP2020	2,205	-.011	.00114	.054	-.014	-.008
REP04-19	156,319	-.005	.00018	.071	-.005	-.004
combined	158,524	-.005	.00018	.071	-.005	-.004
difference		-.006	.00116		-.009	-.003
Diff = mean(REP2020) – mean(REP04-19)	*H0: Diff* = 0	*t* = -5.46	*Satterthwaite's*	*degrees*	*of freedom =*	2313.88
	Ha: Diff < 0		*Ha: Diff !=0*		*Ha: Diff > 0*	
	Pr(T<t) = 0.0000		*Pr(T>t) = 0.0000*		*Pr(T>t) = 1.0000*	

6. Conclusion, limitations and implications

In this section this thesis is summarized and there are some limitations of the study which will lead to implications for further research. These topics will be discussed in section 6.1 and 6.2, respectively.

6.1 Conclusion

This thesis provides evidence on the determinants of share repurchases. The effect of these specifically selected firm characteristics change when firms are subject to the global health crisis we know as COVID-19. During the pandemic the firms that have conducted share repurchases show different characteristics in comparison with the period prior to the crisis. The *Cash* variable had a positive effect on the share repurchasing volume before the crisis, this effect during 2020 is increased significantly. A reversed sign effect is seen in the *Income, Leverage* and *Growth* variables. On the other hand, the *Size* variable show a positive relation at first and this positive relation decreases during the COVID-19 period. The only variables that have an increased magnitude during the pandemic are the *Cash* and *Dividend* variables, this result is as expected, shown by hypotheses 1b and 4b, respectively. Moreover, there is no clear evidence to reject hypothesis 1b, but the impact is positive, and the magnitude increases during the COVID-19 pandemic. Although there is no reason to reject hypothesis 4b this result indicates that dividend yield is negatively related to the repurchasing volume and this effect increases in strength during a crisis.

Even though the OLS regression is subject to heteroscedasticity it is still an unbiased estimator. To improve efficiency the GLS regression, which also is a linear estimator, has been implemented. Due to this modification of the model the standard errors and the beta coefficients decreased. This has resulted in a decrease in the R-squared measure, which is the "goodness of fit". However, the coefficients in the OLS regression were inefficient and should not be interpreted. Due to the improved efficiency the GLS regression provides the results to conclude on.

All in all, this thesis does not find evidence to reject the first hypothesis (H1a), due to a significant positive relation between the cash ratio of a firm and the repurchasing volume. For the second, third and fourth hypothesis (H2a, H3a, H4a) there is no clear reason to reject the hypotheses. Moreover, the evidence found for the *Income, Leverage* and *Dividend* variables

support these hypotheses. For the COVID-19 period the results are different as there is reason to reject the second and third hypothesis (H2b, H3b). The impact of the *Income* and *Leverage* variables was expected to increase in magnitude. However, these variables show a decreased effect during 2020. For *Cash* and *Dividend* there is no clear reason to reject the hypotheses, H1b and H4b respectively. The *Cash* variable displayed a positive relation prior to COVID-19 and increased the positive relation during 2020. Therefore, this seems to be an indication of a positive effect during the pandemic and thus supportive for H1b. The *Dividend* variable increased in magnitude and therefore gives no reason to reject the hypothesis. Thus, the results for H4b seem to be supportive as well.

The results of the fifth hypothesis give no clear reason to reject the hypothesis. The repurchase volume during the COVID-19 pandemic dropped drastically. Firms that were able to keep their share repurchase programs going or incidentally bought back shares did so with a larger discount than in the period before the pandemic. Where the within the month average relative repurchase price was -0.5% over the 2004-2019 period, in 2020 the same average was -1.1%. This evidence gives reason to support the fifth hypothesis. Although this hypothesis is not on the determinants of share repurchases it does give a rationale for companies to try and buy back stock at the most opportune moment. This thesis contributes to current literature by focusing solely on share repurchasing activity and the relation with the return on equity, cash ratio, debt-to-equity ratio, and dividend yield. Moreover, this research shows that managers conduct less repurchases during a crisis, but the ones that make repurchases do significantly better than in other years.

To conclude, the results of this thesis indicate that specifically chosen determinants explain some of the fluctuations in the repurchasing volume over time. The repurchase volume drastically decreased in 2020 due to the suspension of a lot of repurchasing programs. Moreover, these factors behave significantly different during the COVID-19 pandemic. The most influential, negatively related, variable is the dividend yield. These results are consistent with the idea that dividends can be substitutes for share repurchases (Skinner, 2008). Similar to the *Dividend* variable the *Cash* variable followed the expectation and increased in magnitude. *Income* and *Leverage* were expected to increase in magnitude did not follow the expectation, the reversal of the signs from 2004-2019 period to 2020 could have multiple explanations.

6.2 Limitations and further research

The empirical research is subject to some limitations. The U.S. repurchase data comes from a raw dataset. This dataset is constructed by extracting the repurchase table of the 10-K and 10-Q filings from the SEC EDGAR database. Some codes used in this program could not be identified and did not add to the dataset. Due to the rawness of the data, it was exposed to outliers. The CRSP and Compustat datasets were also subject to spurious outliers, as explained in section 3.2 the winsorization technique is used to not delete but give less weight to these spurious outliers. Another limitation is the heteroscedasticity in the first OLS regression, this inefficiency is partially fixed with the modification to the GLS model. However, the R-squared measures and coefficients should be interpreted with caution. The R-squared measure ranges from 13.9% to 38.4%, this means that other factors also have a substantial part in explaining the variance of the repurchasing activity.

The question as to how the different determinants relate to share repurchasing activity has been partially answered. So, a suggestion for further research is to examine what other factors influence the share repurchasing activity and how they change during the COVID-19 pandemic. If this hypothetical model does explain a lot of variation in the repurchase volume, investors could anticipate which firms will buy back stock by analyzing their financials. This would be another interesting field of research for the future and would be a valuable addition to the extensive literature on actual market share repurchases. Overall, this thesis contributes by the usage of the most recent dataset on actual share repurchases, showing how specific firm characteristics change during a global health crisis and with some interesting opportunities for further research on the determinants of share repurchasing activity.

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8. Appendix

8.1 Breusch-Pagan test

Figure 1

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of lnrep_volume

chi2(1) = 5333.08
Prob > chi2 = 0.0000

8.2 Difference in distribution due to winsorization

Figure 2

This figure shows the rationale of the winsorization technique.

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Cash	388,438	1.44	3.56	0	290.37

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Cash winsor	388,438	1.34	2.12	.0072	12.90

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Income	485,659	.0124	4.85	-1436.67	834.76

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Income winsor	485,659	.038	.321	-1.75	.86

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Leverage	501,032	2.91	158.69	-40289.82	26020.17

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Leverage winsor	501,032	2.80	4.46	-11.59	22.31

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Dividend	237,817	.025	.021	.000165	1.73

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Dividend winsor	237,817	.024	.017	.00153	.094

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Growth	488,296	.68	.74	**.**0000019	57.08

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
Growth winsor	488,296	.66	.51	.039	3.05