Share buybacks in the United States and the United Kingdom

Master Thesis Financial Economics

Abstract:
By analyzing the firm characteristics of 7.607 instances of share repurchases over the last 14 years (2004 up and until 2018), it is found that only the cashflow theory has effect using an OLS regression. No effect of other control variables or theories like the signaling hypothesis, optimal capital structure and the hostile take-over defense have been observed. To investigate whether the same results hold over time, a probit analysis has been performed. It is found that UK firms are 11,9% less likely to announce a share repurchase. Also in this case, the excess cash hypothesis is confirmed based on the results. The hostile takeover hypothesis can also be confirmed, meaning that firms are more likely to announce a share repurchase program in order to prevent a hostile takeover. In addition, evidence is also found for the optimal capital structure theory and the signalling hypothesis.

Finally, a prediction is made on the chance of a share repurchase to be announced given the data (firm characteristics and control variables) of the sample. It is found that share repurchases are correctly classified (predicted) with an 83,21% probability.

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1. Introduction

With US listed companies Adobe, Apple, Bank of America, Boeing, Google and Pfizer all announcing to buy back their own shares in 2018, the appetite to repurchase shares is as big as it has even been according to the Financial Times (Samson, 2018). Estimated spending for buyback programs in 2018 is over $1 trillion, for US based companies alone, with Apple buying back shares worth of $100 billion (MarketBeat, 2018). Share buybacks are estimated to be up 46% compared to 2017 and surpassing pre-financial crisis amounts. This is not just the case of US listed firms, but also holds for UK listed companies (on the FTSE 100) like Shell, Lloyds, BP and Aviva (Cornish, 2018).

A share repurchase is an event where a firm is repurchasing its own shares. Doing so, the firm distributes cash to its shareholders in return for a fraction of the outstanding equity. A share repurchase distributes cash to the shareholders that are willing to sell their shares (De Cesari, Susanne, Khurshed, & Simkovic, 2012). After the share buyback, the number of outstanding shares in the market has decreased.

With share repurchases being higher than amounts prior to the financial crisis, it raises questions on the rationale behind this phenomenon. A lot of literature is available on share repurchases, and the reason why firms tend to shift to repurchasing their own shares instead of (increased) dividend pay-out. It has been shown that a lot of firms tend to repurchase shares to take advantage of their (potential) undervaluation. If investors believe that the company may be undervalued (and thus repurchases its own shares), the stock will rise shortly after a share repurchase announcement. Other factors that may influence a company's decision to buy back shares are tax driven (dividend tax or capital gains tax) or by increasing the Earnings Per Share (EPS).

On the other hand, some firms tend to repurchase their own stock to compensate for low earnings. In order to still meet the Earnings Per Share forecast and to reduce the negative reaction of the market on the company's shortcomings.

The literature discussed in the previous paragraph is mainly based on data from the United States. On top of this, the theories discussed in the literature already exist for several decades. This research paper will therefore endeavour to test whether these theories also hold in the present day. In addition, the difference will be examined in share repurchase announcement between the US and the UK. No similar literature was found that provides a link between US and UK share repurchases. This paper will shed light on whether the same theories and effects can be observed across the Atlantic Ocean.

1.1 Research question

The research question is as follows: What reasons motivates firms to repurchase their own shares, is there a difference between the United States and the United Kingdom, and can these share repurchases be predicted over the period 2004 up and until 2018?

1.2 Findings & Structure

Based on data from the S&P 500 and FTSE All Shared Index (provided by DataStream), an OLS regression and probit regression were performed. The OLS regression showed that the excess cash hypothesis is still relevant to date. It implies that cash rich firms tend to be more inclined to repurchase their own shares. This makes sense because shareholders expect this cash to be returned to them either through dividend or a share repurchase (agency theory). In addition, to preserve the debt to equity ratio, cash is most commonly used in a share buyback instead of (bank) debt. This is also in line with the results.

By performing the probit regression, it is investigated whether the different hypotheses also hold over time and if a share buyback could be predicted. Like in the OLS regression, the excess cash hypothesis was confirmed. In addition, evidence is found for the hostile takeover hypothesis, the optimal capital structure theory and the signalling hypothesis. For the prediction, a correct classification of 83,21% is found. Meaning that over 83% of the observations are correctly predicted that these firms announce a share repurchase in that given year.

The remaining parts of this research is split into four chapters. First of all, the different existing theories will be explained and discussed in the Literature review. In the Methodology chapter, the research methods will be discussed and the variables used will be explained. In the chapter: Data, the data collection methods and descriptive statistics will be discussed. Thereafter, focus will be laid upon the executed research and the accompanying results in the Results chapter. This does also include a link with the existing literature. In the last chapter, the Conclusion, a summary of this paper will be given including recommendations for further research.

2. Literature review

This section provides a review of the extensive academic literature on share repurchases, emphasizing those theoretical frameworks and papers most relevant to this study. First of all, the difference between dividends and share repurchases will be discussed. Subsequently, the motives behind share repurchases will be investigated. Lastly, a link will be made with the present day.

For much of the last century, firms were not allowed to buy back their own shares. From the 1980s and onward, US and UK based firms were allowed to do so, with France and Germany following in 1998 (Stonham, 2002). Over $2.550 billion worth of shares has been repurchased in the US over the period 2010-2013. The aggregate share repurchases and dividends of US based companies from 1980 to 2013 can be seen in the graph below.

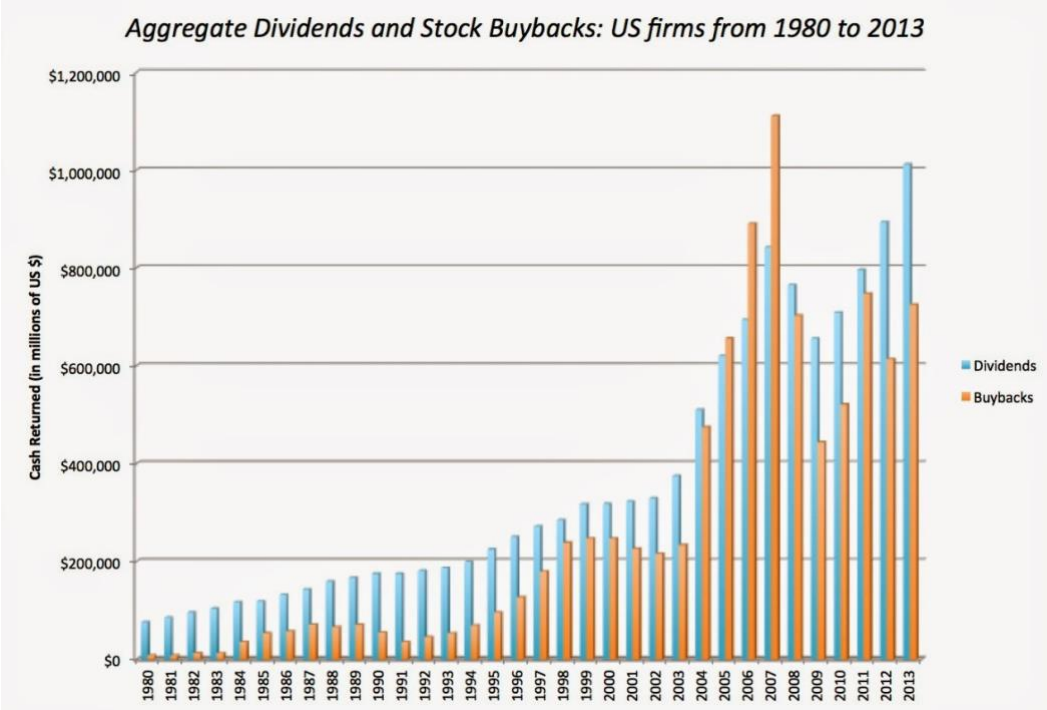

Figure 2. Aggregate Dividends and Stock Buybacks of US firms (Damodaran, 2014).

While most companies prefer to pay out dividends in the 1980s, a clear shift to share buybacks can be observed in the 1990s. The aggregate number of buybacks has even exceeded the amount of dividends paid over the last ten years in Graph 1 (2004-2013). In 2007, the aggregate number of buybacks was over 30% larger than the dividends paid in that year. To understand what caused this shift in pay-out policy, first one needs to understand what makes share repurchases different than dividends since both accomplish the same basic goal: transfer wealth to shareholders.

With dividend, there is a phenomenon called sticky dividends. This is a tradition to maintain or increase the dividends when first initiated. Investors expect these dividends to continue, or else the company's share price may face a drop in value. Share buybacks don't carry this phenomenon, and firms can buy back shares one year and not the other without facing the same market reaction.

When firms pay dividends, all shareholders get paid related to the number of shares they own, whether they want to or not. In a share repurchase, only shareholders who offer their

shares back to the firm receive cash. The remaining shareholders get a larger stake in the company.

Another distinct difference is that share repurchases effect the total outstanding shares, while dividends do not. The number of shares decreases by the number of shares bought back. An investor who chooses not to sell his/her shares in a buy back, ends up with a larger share in a smaller company. Consequently, this changes the ownership structure of the firm.

The last difference is that buybacks and dividends are treated differently in terms of tax consequences. This is the case in most countries. A different tax rate applies to dividends and capital gains. Since dividends are paid out to all shareholders, it is treated as income in the year in which it is paid out by the company. On the other hand, when a share repurchase occurs, shareholders who offer their shares have to pay taxes on capital gains. If the remaining shares go up in price, shareholders who didn't offer their shares can defer their capital gains taxes until they actually sell their shares (Damodaran, 2014).

Now that the differences between share repurchases and dividends is clear, on what base do firms choose to pay dividends or repurchase their shares in order to return wealth to their shareholders? In order to find the answer to this question, a review of the existing theoretical literature is necessary. In the next few paragraphs, the different motivations for share repurchases will be discussed, as well as the hypotheses will be formed.

2.1 Signalling hypothesis

Over the past several decades, there has been a lot of research into why companies exercise a share repurchase. There are many different reasons for a company to buy back its shares. One of the most common theories is the signalling hypothesis, also known as the undervaluation theory. Undervaluation means that the market underestimates the firm's performance in the months after the share repurchase (D'mello & Shroff, 2002). This phenomenon arises from information asymmetry. Outside investors don't possess the same information as management does about the value of the company's stock, this may cause its shares to be either under- or overvalued. When firms decide to announce a share repurchase, this may signal that their respective stock is undervalued, especially when a firm decides to repurchase its shares at a substantial premium above the market price (Vermaelen, 1981).

The announcement effect is positively correlated with the level of information asymmetry, as Chari, Jagannathan & Ofer (1988) pointed out. Their theory predicts a negative correlation between the announcement return and the size of a firm. So, a smaller company has a higher probability that its stock is being undervalued. Therefore, it is highly likely that an announcement to buy back its own shares will result in higher (abnormal) returns. The hypothesis accompanying the signalling theory, can be found in the sub-chapter: Hypotheses

2.2 Excess cash hypothesis

In addition to the signalling hypothesis, a share repurchase can also be a mechanism to distribute excess cash to the firm's current shareholders. This does, however, depend on the growth stage of the firm. According to Grullon and Michaely (2004), firms in the growing phase are expected to have higher capital expenditures, many positive NPV projects, higher earnings growth and lower levels of free cash flow than in comparison to mature firms. At some point the firm's growth will decline, and the value of the firm will be more heavily determined based on its assets. A decrease in growth (and return on investment) will increase the excess cash since less money can be invested with a decent return. This brings the agency theory into play. According to the agency theory; it is more likely that firms with excess cash spend it on value destroying projects (or investments) (Nohel & Tarhan, 1998). The theory states that the company's value increases as the excess cash decreases, since this suggests a reduction in agency costs. By following the research papers mentioned in this paragraph, Grullon and Michaely (2004) and Nohel and Tarhan (1998), a proxy can be used to determine overinvestment; Tobin's Q. More information regarding the calculation and test for this variable will be provided in the Data section. The hypothesis accompanying the excess cash theory, can be found in the sub-chapter: Hypotheses

2.3 Optimal Capital Structure

Another important factor that could impact the decision to repurchase the company's own shares, is based on a target capital structure ratio of the firm. This target capital structure optimizes the trade-off between the costs (and potential benefits) related to debt and equity (Hovakimian, Opler, & Titman, 2009). When the debt to equity ratio is not in an optimal position for the firm, one of the potential mechanisms to bring this back to the optimal ratio is to repurchase shares and thereby decreasing the outstanding equity. In a survey conducted by Graham and Harvey (2001), 81% of the 392 Chief Financial Officers (CFO's) indicated using a target debt to equity ratio. Fifty percent of these targets are flexible, while the other half are strict target ratios. A firm is more likely to repurchase its own shares if its debt to equity ratio is below its target ratio. Thus, a firm's capital structure will affect its decision to repurchase (Bagwell & Shoven, 1988). The hypothesis accompanying the optimal capital structure theory, can be found in the sub-chapter: Hypotheses

2.4 Stock options

Managers might prefer to repurchase shares over dividends, especially when they own (a lot of) stock options. The fair value of the option is determined by the current share price. In order to get the options (even more) 'in the money', managers might be incentivised to execute a share buyback program in order to increase their personal gain (Dittmar, 2000). In the United Kingdom, however, it is not allowed for firms to buy back their own shares in order to facilitate a compensation plan for manager or employees. Therefor managers might be willing to buy back shares in order to (try to) raise the price of the shares, but the company is not allowed to do so. Since the theory cannot be tested in the United Kingdom, no comparison can be made to the US. Therefore, this theory will not be part of the hypotheses.

2.5 Takeover protection

All of the previous discussed theories relate the decision to repurchase a company's own shares to an internal company decision and its shareholders. A share repurchase, however, may also affect other stakeholders outside the firm. A potential (unwilling) target in an acquisition may increase the cost of the acquisition by repurchasing its own stock (Dittmar, 2000). Share repurchases increase the acquisition price, because shareholders selling in a share repurchase are those with the lowest reservation value(s). So, a share buyback can be used as a takeover defence, because a repurchase can increase the lowest price for which a stock is available on the market (Bagwell, 1991). Thus, making it more expensive for the acquirer to purchase the target's stock. The hypothesis accompanying this theory can be found in the next paragraph: Hypotheses.

2.6 Hypotheses

Based on the amount of different theories discussed above, it is important to perform more research to the exact cause (or causes) of share repurchases. On top of this, a lot of these theories exist for more than several decades. It is worth checking whether these theories still hold today. Also, each of these theories explain one reason why firms repurchase stock. Firms may repurchase shares for any of these reasons, or they may only repurchase if several criteria are met. The aim of this study is to test whether the signalling, excess cash, hostile takeover and optimal capital structure can still predict the share repurchase effects in modern finance. The theories discussed above will be tested using several hypotheses.

The existence of the signalling theory will be tested first. This will be done with the following hypothesis:

1) The effects predicted by the signalling theory can be observed in the study's sample.

It is expected that the signalling theory can be tested using a proxy for information asymmetry. As small firms have a higher level of information asymmetry than larger firms, the signalling theory predicts a negative correlation between the announcement return and the firm's size (Chari, Jagannathan, & Ofer, 1988). The proxy used will thus be size, more information on this variable can be found in the data section, including the definition and use of a natural logarithm.

Another variable that may explain the undervaluation (signalling) theory, is the Book-To-Market Ratio (B/M Ratio). A firm with a relative high B/M Ratio may be undervalued, because its market value is low relative to the book value of its assets.

The next theory that will be tested is the excess cash theory. This will be done using the following hypothesis:

2) The effects predicted by the excess cash theory can be observed in the study's sample.

As mentioned in the Literature review, Tobin's Q will be used as proxy for overinvestment to test the excess cash hypothesis. The level of cash depends of the amount of investment opportunities. Firms who repurchase their own shares are expected to have fewer investment opportunities and thus are more likely to overinvest. Both Nohel and Tarhan

(1998) and Grullon and Michaely (2004) used Tobin's Q as proxy for overinvestment. A value less than one indicates an overinvesting firm. Apart from Tobin's Q, the level of cash a company has may also explain the excess cash hypothesis. It is expected that companies with a relative high amount of cash are more likely to explain this phenomenon.

The third theory that will be tested is the optimal capital structure theory. This will be done using the following hypothesis:

3) The effects predicted by the optimal capital structure theory can be observed in the study's sample.

To determine whether this theory also holds with the data sample used for the United Kingdom, leverage levels (debt-to-equity) in the period prior and post a share repurchase will be observed as did Hovakimian, Opler & Titman (2009). A relatively large increase of the Debt-To-Equity ratio may explain a relatively large announcement return.

The fourth theory that will be analysed is the takeover protection hypothesis. The will be done using the following hypothesis:

4) The effects predicted by the takeover protection hypothesis can be observed in the study's sample.

To see whether this hypothesis can be confirmed, a dummy variable will be introduced. This dummy variable: Deal Attitude. This variable is true (1) when the takeover was considered hostile, and false (0) when the takeover was not considered hostile. Following Billet and Xue (2007), the firm's size will be taken into account. Since the size of a firm impacts the agency theory (information asymmetry). Billet and Xue (2007) found an inverse relationship with size and the takeover protection theory, as is expected in this sample. A positive relationship is expected with hostile takeover, meaning a hostile takeover has a higher chance of the firms causing to repurchase its own shares.

At the same time, a comparison will be made with the United States. The same calculations and regressions (OLS and probit) will be performed with an extra dummy variable for the United Kingdom. This variable: UK is true (1) when a firm is from the United Kingdom and false (1) when a firm is from the United States. This will be done using the following hypothesis:

5) The effects predicted by the theories differ from the United States compared to the United Kingdom

In order to determine this, the results will be compared and analysed. It will be interesting to see whether the same theories hold (or not) during the same period of time, across the Atlantic Ocean.

Now that the hypotheses are defined, the next chapter: Methodology will highlight the methodology used and the reasoning behind it.

3 Methodology

This chapter will provide an overview of the methodology used in this paper. At first, the event study will be discussed. In addition, the OLS regression will be talked about including defining the variables. Subsequently, the probit model will be discussed. Lastly, the different assumptions that have been made will be analysed.

3.1 Event study

The first thing to be calculated are the Abnormal Returns, this is the dependent variable in the OLS regression. It will be done using an Event Study, which also means calculating the beta by using the appropriate index of the firm. The index for UK based firms will be the FTSE All Shares index, while the index for US based firms will be the S&P 500.

To calculate the Abnormal Return, the Beta per observation first has to be calculated. The beta of a share illustrates the sensitivity of that share relative to the market. If a share is more volatile than the market itself, the value of the beta is greater than one. When the market is more volatile than the share, the value of the beta is lower than one (Rosenberg & Guy, 1976). When the value of the beta is lower than one, a negative effect between the return on the shares and the return of the market exists. Meaning, when the market return is positive, the return of the share will be negative. The same goes the other way around with a negative market return resulting in a positive return on the shares. The beta for each individual share is calculated using the following formula:

$$(1)\ \beta_\alpha = \frac{Cov(r_\alpha, r_\beta)}{Var(r_\beta)}$$

Where β_α is equal to the beta of share α. r_a and r_β respectfully hold for the return of the share and the relative return of the market. With Cov, the covariance between two variables is displayed. Lastly, Var stands for the variance. The beta is the first independent variable in the regression.
The relative period to calculate the beta will be from -60 to -5 days before the announcement date. This is equal to the period on which the relative returns will be calculated, both for the shares as the market, in found in formula (4) and (5).

To calculate the abnormal returns, many different equations or models can be used (amongst others: Market Model; CAPM; Market Model with GARCH & EGARCH; Fama-French 3 Factor Model). This paper has chosen to use the Market Model to calculate the abnormal returns at the date of the share repurchase announcement. The normal return first has to be estimated using an OLS regression. The formula to calculate the Return will be as follows (Strong, 1992):

$$(2)\ R_{it} = a_i + \beta_i * R_{mt} + \varepsilon_{it}$$

Where R_{it} is the return of the stock of observation i (a firm), on day t. R_{mt} stands for the return of the reference market (FTSE All Shares or S&P 500) on day t. Both R_{it} and R_{mt} are calculated as follows:

$$(3)\ R_{it} = \frac{P_1 - P_0}{P_0}$$

$$(4)\ R_{mt} = \frac{M_1 - M_0}{M_0}$$

Where P_1 is equal to the price of the stock at day 1, and P_0 is equal to the price of the stock at day 0. M_1 stands for the value of the respective market index at day 1, while M_0 stands f or the value of the respective market index at day 0.

To continue with explaining equation (2), the Beta (as calculated above with formula (1)) of observation i is equal to β_i. a_i is equal to the intercept of the observation. ε_{it} is the error term at time t. When the Return is calculated, the Abnormal Return can be determined. The formula to calculate the Abnormal Return is as follows:

$$(5)\ Abnormal\ Return_{it} = R_{it} - (a_i + \beta_i * R_{mt})$$

In line with Masulis (1980) the event window to calculate the Abnormal Returns are Day 0 (announcement date) and Day 1. The reason for this is to capture the announcement effects on Day 1 that may have been done on Day 0 after closing of trading on that day. So, the announcement effects would in that case move onto the next trading day (Day 1).

Now that the event study has been discussed. The OLS regression equation so far will look as follows, with more variables still to be added:

$$(6)\ Abnormal\ Return = \alpha_o + \beta_1(Beta_i) + \varepsilon$$

By calculating the Abnormal Returns, this concludes the Event study. In the next paragraphs more x-variables, belonging to the OLS regression and probit model, will be discussed.

3.2 Signalling hypothesis

The Market-to-book ratio (M/B ratio) variable is widely used in the field of finance as measure of perceived value. A company with a relative low M/B ratio may be undervalued, as its market value is low relative to the book value of its assets. On the other hand, growth firms often have a high market-to-book ratio since this is in line with its growth prospects. In that case, the market value is higher to compensate for the expected increase in value that will be capitalised in the future. However, it is also expected that growth firms don't exercise share repurchases as often as mature firms, because this contradicts the excess cash hypothesis: growth firms need the cash they possess to invest in their own activities rather than to buy back their own shares. The formula for the market-to-book ratio is as follows:

$$(7)\ \frac{M}{B}ratio_i = \frac{Market\ capitalisation_i}{Book\ value\ of\ assets_i}$$

Since the signalling (or undervaluation) theory means that the market underestimates the firm's performance, an increase in share price is expected in the months or years after the repurchase. Grullon and Michaely (2004), however, didn't find such evidence. Contradictory, they found a decrease in profitability following an exercised share buyback. In order to test for the undervaluation theory, the M/B ratio variable will be used. A positive relation is expected since a higher market capitalization compared to its assets may indicate overvaluation and therefore increase the incentive to repurchase its own shares.

The second reason that may explain the abnormal returns of share repurchase announcements, is the size of company itself. The size can be interpreted in different ways, however, this paper will use Market Capitalisation instead of Assets. Since the cash of a company is taken into account in the Assets, a high correlation will be expected with another variable: Cash. In addition, some firms may have a very large number of assets for their size (such as banks) while others may have few assets in respect to their actual size. Therefore, the market capitalization of a firm is considered more accurate and thus preferred over the use of its total assets. The formula to calculate the market capitalisation of a firm is as follows:

$$(8)\quad Market\ Capitalisation_i = Number\ of\ outstanding\ shares_{i,t-1} * Price\ per\ share_{i,t-1}$$

The number of outstanding shares and the price per share are measured at year end in the year prior to the share repurchase announcement of a company. A positive relation with the Abnormal Return is expected since larger companies have more to gain by repurchasing their own shares. Both x-variables (M/B ratio and the Market Capitalisation) are used in the OLS regression and the probit model.

3.3 Excess Cash hypothesis

In order to test the excess cash hypothesis, the agency costs will be examined (Boudry, Kallberg, & Crocker, 2013). By repurchasing stock, the firm reduces Jensen's (1986) free cash flow agency problems. Five different x-variables will be used as to determine whether the excess cash hypothesis also holds in this sample. The first variable, Free Cash Flow, is the firm's funds from operations (FFO) divided by total assets. The funds from operations is calculated as:

$$(9)\quad FFO = Net\ income + Depreciation + Amortisation - Gains\ on\ Sales\ of\ property$$

Free cash flow can then be calculated accordingly:

$$(10)\quad Free\ Cash\ Flow = \frac{FFO}{Total\ Assets_i}$$

The second variable, following Dittmar (2000), is Free Cash. This is the amount of cash at hand and marketable securities divided by the total assets. For both variables (Free Cash Flow and Free Cash), a positive relationship with repurchases is expected. The formula to calculate Free Cash is as follows:

$$(11)\quad Free\ Cash_i = \frac{Cash_{i,t-1} + Marketable\ securities_{i,t-1}}{Total\ Assets_{i,t-1}}$$

In this formula the Cash variable will be explained in the next paragraph. The marketable securities are assets (+) or debt (-) that are to be sold or redeemed within one year. It is another form of cash, like government bonds or (liquid) common stock.

Tobin's Q will also be used to test the excess cash hypothesis. The formula to determine Tobin's Q is as follows:

$$(12)\ \ Tobin's\ Q_i = \frac{Total\ market\ value\ of\ the\ firm_i}{Total\ Assets_i}$$

A low Tobin's Q indicates that the firm has relatively few investment opportunities and a relative high probability of overinvestment. These characteristics mean that more agency costs may be generated using excess cash, so a positive relation is expected regarding a share repurchase.

The fourth x-variable to test the excess cash hypothesis is the Cash variable. Cash is equal to the total cash on balance sheet of firm i at year-end in the year before the repurchase announcement. The year-end before the announcement is used since the Cash at this time is the largest and may influence the decision to announce a share repurchase. Cash after an announcement and execution has been returned to the shareholders and has therefore decreased. Instead, a change in Cash from one year to another can be used as a proxy. However, this may not solely explain share repurchases since the cash could have been used for many other purposes.

It can be observed in the data statistics in the chapter: Data, that the absolute differences between observations (companies) can be large in terms of cash. In order to better distribute the data and to decrease the amount of extreme values, a natural logarithm is used for Cash. A new variable is created: LnCash. This is in line with the research paper of Beatty and Ritter (1986), who observed the same phenomenon.

With these variables (Cash and LnCash), also a positive relationship is expected. To test the excess cash hypothesis, a probit model will also be used with the variables described above.

3.4 Optimal Capital Structure hypothesis

As mentioned, the firms' debt-to-equity (D/E) ratio may influence a share repurchase decision. Since repurchasing stock may increase the firm's leverage, companies with a relative high amount of leverage are less likely to repurchase their stock since higher leverage will potentially increase expected bankruptcy costs. In addition, leverage can also affect repurchase decisions since it reduces free cash flow levels (Jensen, 1986). Therefore, a negative relationship between the abnormal return and the debt-to-equity ratio is expected. The variable used will be the debt-to-equity ratio. The formula used for the D/E ratio is as follows:

$$(13)\ \ \frac{D}{E}ratio_i = \frac{Total\ debt\ of\ the\ firm_i}{Total\ equity\ value\ of\ the\ firm_i}$$

3.5 Takeover protection hypothesis

In an effort to stop a potential (hostile) takeover of the firm, a company may repurchase its own shares, to increase the minimal bid price per share. To test this hypothesis, a variable will be computed with the independent dummy variable: Deal Attitude. The variable will be used in the OLS regression as well as the probit model in order to also determine its effect over time. The Deal Attitude variable has a value of 1 when a company decides to repurchase its own shares to prevent a hostile takeover. A value of 0 can be observed when this is not the case. To determine when a share repurchase is caused by a (hostile) takeover,

the data supplied by the database: ThomsonOne will be used. More information regarding this variable can be found in the next chapter: Data. The execution and results of the assumptions and variables explained above can be found in the chapter: Results.

3.6 Predicting repurchases

In order to predict share repurchase announcements, a probit or logit model has to be used. In this case, a probit model analysis is preferred over a logit model. First of all, the difference in a binomial model between probit and logit is very small. A difference, however, may appear in the tails of the underlying distributions (Cox, 1967). If the binary data that is being modelled is unbalanced (there is no 50-50 split between 0 and 1), as is the case in this research, a preferred choice can be made between the models based on whether the unbalanced binary data (the dependent variable) is generated by a leptokurtic or platykurtic distribution. With a kurtosis of the dependent variable (repurchase yes (1) / no (0)) of 1,16, a platykurtic distribution is present. This is because a leptokurtic distribution is only present with a kurtosis of greater than 3. In the case of a platykurtic distribution, a probit model is preferred over a logit model (Chen & Tsurumi, 2010). Therefore this paper chooses to execute the probit analysis.

3.7 Regression Assumptions

In order to perform a reliable OLS regression, multiple assumptions have to be met regarding the data. It is important to comply with these assumptions to get the most reliable results as possible. A total of five assumptions have to be met;

1. Linear relation between the dependent and independent variables;
2. Normal distribution of the error terms;
3. Multicollinearity;
4. Autocorrelation;
5. Homoscedasticity.

First of all, there has to be a linear relationship between the dependent and the independent variables. This can be read from a scatter chart. The results of this chart can be found in the chapter: Results.
Subsequently, one of the most important assumptions regarding a regression model is that the error terms of the multivariate regression are normally distributed. To test whether this holds, a multivariate regression will be performed will all variables. The regression equation will look as follows:

$$(14)\quad Abnormal\ return = \alpha_o + \beta_1(UK_i) + \beta_2(Beta_i) + \beta_3(Deal\ Attitute_i) + \beta_4\left(\frac{M}{B}ratio_i\right) + \beta_5(Market\ Cap_i) + \beta_6(Cash_i) + \beta_7(LnCash_i) + \beta_8(Free\ Cash_i) + \varepsilon$$

By creating a histogram of the error terms of the regression, it can be determined whether the error terms are normally distributed. This histogram will be made using a normal Kernel density. Thereafter, a Shapiro-Wilk test will be performed to statistically prove whether the error terms are normally distributed or not. The hypothesis regarding the Shapiro-Wilk test

is as follows: H_0: $The\ error\ terms\ are\ normally\ distributed$. Both the histogram and the results of the test will be discussed in the chapter: Results.
The third assumption that will be tested is the assumption that no multicollinearity exists. Multicollinearity means that the independent variables are not independent from each other. To see whether this is the case, three tests will be performed.
The first test to be looked at is the Tolerance level. This measures the influence of an independent variable on the other independent variables. Calculating this Tolerance level can be done using the following formula:

$$(15)\ \ Tolerance\ level = 1 - R^2$$

Where R^2 equals the R-squared value of the multivariate regression. When the Tolerance level is lower than 0,2, there could be multicollinearity. When the Tolerance level is lower than 0,1, however, with certainty can be said that multicollinearity exists in the sample.

In addition, multicollinearity can also be found by using a correlation table. When the correlation between two independent variables is higher than 0,8, there could be multicollinearity.

The last factor to be looked at is the Variance Inflation Factor (VIF). When this value is higher than 10, there could be multicollinearity in play. Whenever this value is higher than 100, multicollinearity exists for sure. The results of all the three test just mentioned will be considered in order to give a definitive conclusion whether multicollinearity is present in the sample. The results of will be discussed in the chapter: Results.

The next assumption by exercising a regression, is that no autocorrelation may be present. Autocorrelation means that the residuals are not independent of each other. In other words, de value of $y(x+1)$ is not independent of the value of $y(x)$.

The test to determine if autocorrelation is present can either be a Breusch-Godfrey test or a Durbin-Watson test. The advantage of a Breusch-Godfrey test compared to the Durbin-Watson test, is that the Breusch-Godfrey test is more flexible regarding the assumption of the normal distribution of the error-terms. This means that the error-terms don't need to be strictly normally distributed, as is the case with the Durbin-Watson test.
Apart from this, the Breusch-Godfrey test is also able to test for autocorrelation over several periods in time. This is not possible with the Durbin-Watson test. Due to the several reasons just mentioned, this paper will use the Breusch-Godfrey test. The null hypothesis belonging to this test is as follows: H_0: $There\ is\ no\ autocorrelation$. Also in this case, a significance level of 5% ($\alpha = 0{,}05$) will be applied.

Two different periods will be tested on the existence of autocorrelation. The first period will be to test whether first order autocorrelation exists. With this, it will be tested if the previous period ($x-1$) influences the current period (x). The second period to be tested for autocorrelation is relative to the ten observations. This is to see if a trend can be identified over multiple observations, and to determine if the regression assumption won't be violated over a larger number of periods. The results of this test can be found in the Results chapter.

Homoscedasticity means that the variance of the residuals is independent and constant in relation to the value of the dependent variable. This is important, because the residuals influence the standard errors of the variables and thus also influence the significance tests. Dependent residuals could therefore cause an unjustified positive significance result, while this is not the case (Type 2 error). To test whether homoscedasticity exists, a Breusch-Pagan / Cook-Weisberg test will be performed. The hypothesis accompanied by this test is:

H_0: $Constant\ variance$. While executing this test, a significance level of 5% ($\alpha = 0{,}05$) will be maintained in line with the other tests. Like the other tests, the results regarding this assumption will be presented in the chapter: Results.

4 Data

Now that the methodology has been discussed and the variables are quantified, all that remains to execute the research is the data. In this chapter, the data retrieval methods will be explained. In addition, the modifications to the data and the data statistics will be discussed.

4.1 Data collection

The data is collected from the Securities Data Company (SDC) database and WRDS. Part of the SDC database are Thomson One and DataStream. Both are used to collect the required data.

First of all, Thomson One is used. In this database the repurchases with at least a value of $1million US Dollars will be examined for the period of January 1st 2004 up and until the 1st of January 2018. A minimum share repurchase amount of $1million US Dollars is used in order to eliminate all very small share repurchases that may interfere with the data. The market for the United Kingdom will be approximated by using the FTSE all-shares index. For performing the United States analysis, the S&P 500 is used as this captures the US' 500 biggest firms and gives a good grip on the economic climate of the country. In all data queries, US Dollars are used in terms of currency. The reason for this is because most data is expressed in Dollars instead of Pounds Sterling or Euro's for both Thomson One, DataStream and WRDS. So in order to preserve the most amount of observations as possible, US Dollars are used as currency. The following data has been retrieved from Thomson One:

- The announcement date;
- Company name;
- The unique DataStream code per company
- CUSIP code per company
- Value of the transaction;
- Hostile takeover;

This led to a total of 391 observations for the UK and 9738 for the US. Based on these observations, three DataStream queries have been executed for both the UK and the US. The first query will gather the closing price of the shares per company one day prior to the announcement date. The second query will gather the closing price of the shares on the date of announcement per company and the day after the announcement. Now that the announcement date, closing price prior and the closing price after the announcement are known, the third and final query in DataStream can be performed.

This last query is executing an event study. This will be done to retrieve the last information needed to calculate the Abnormal Returns. This is the return of the market (either FTSE all-shares for UK or S&P 500 for US based firms) on the announcement date per company. To do this, the 'DataStream Even Study Matching Tool', offered by the Erasmus Data Service Centre (EDSC), will be used. The tool is based on the DataStream code in combination with the announcement date, both retrieved from ThomsonOne. For the event period, day -1 and day +1 are used around the announcement date (day 0). This captures a 3-day event period. The day +1 was included to include the effects of announcements made after the close of trading on day 0 (Masulis, 1980). Day -1 is included to calculate the returns on day 0, since previous values are required for this calculation. The estimation window before the announcement date is from -60 business days to -5 business days. So an

estimation period of just over 29 weeks. The event study is executed where for each company the relative returns of the shares and the market are calculated. Subsequently, the abnormal return is calculated according to the Market Model (Strong, 1992). The link between the Datastream Code from ThomsonOne and Datastream did not seem to be 100% fail proof. Some values in the Datastream Code are unknown, which causes blank values in the Datastream output. On the other hand, some Datastream Codes are not correct when retrieving data in Datastream. This causes error values for that particular company (observation). All in all, these inconsistencies reduce the total amount of observations slightly. A total of 372 UK observations and 9516 US observations of share repurchase announcements remain over the period 1-1-2004 until 1-1-2018. This corresponds to a total of 266 unique UK firms and 3734 unique US based firms.

In order to retrieve the data for the independent variables, the WRDS database is used. Part of the WRDS database is Capital IQ. By using the CUSIP code per company, retrieved from Thomson One, information per company per year can be acquired. This has been done for the year 2004 up and until the end of 2017. A total of just over 44.000 observations are retrieved.

With all the data collected from the various searches and query's, a list in Excel is made where for each observation a total of 21 variables are known. The full list of the available variables per observation can be found in the Appendix, Table A.
With all this data retrieved, the variables are calculated following the equations discussed in the Methodology chapter, paragraph 2.6 up and until 2.8.

4.2 Data mutations

In order to make the data as reliable as possible outliers, errors and blank values will be removed. Table B, found in the appendix, highlights the amount of observations removed for each variable. This table captures the variables in the OLS as well as the probit regression for both UK and US based firms. A detailed description per variable with reason of removal can also be found in the Appendix accompanying Table B.

All in all, quite a few observations are removed duo to outliers or error values. For both the UK and US OLS regressions, a total of 7.607 observations remain. For the UK and US probit model, a total of 42.419 observations remain.

The probit observations are not simply the amount of years' times the observations from the OLS regression. This is due to the fact that a specific company can announce multiple share repurchases over the period 1/1/2004 until 1/1/2018. Also, some companies have gone private or bankrupt in this period. This also reduces the amount of observations.
Now that all the Data mutations are performed. The descriptive statistics can be calculated and discussed.

4.3 Descriptive statistics

Since both an OLS regression and a probit model will be executed, two tables of descriptive statistics are made. One for each analysis. Table 1 regarding the descriptive statistics of the OLS regression can be found below. This tables captures both the US and UK data for the OLS regression.

Var. Name	Average	Median	Std.Dev	Maximum	Minimum	#Obs.
Abnormal return	1,63%	1,15%	6,02%	63,14%	-49,34%	7.607
UK*	0,01	0,00	0,09	1,00	0,00	7.607
Beta	0,99	0,98	0,62	9,53	-3,37	7.607
Deal Attitude*	0,00	0,00	0,02	1,00	0,00	7.607
M/B ratio	3,44	2,10	15,95	591,48	-156,00	7.607
Market Cap.	11.958,22	1758,53	36.425,75	614.590,20	0,00	7.607
Cash	874,04	119,60	4.348,47	159.353,00	0,00	7.607
LnCash	4,72	4,78	2,12	11,98	-6,91	7.607
Free Cash	0,17	0,10	0,18	1,00	0,00	7.607

*Table 1. Descriptive statistics of the variables for the OLS regression. For each variable the average, median, standard deviation, maximum, minimum and the total amount of observations is given. Variables with * are dummy variables and have a value of 0 or 1. The Market Capitalisation and Cash are in million US Dollars.*

What immediately catches the eye, is that an Abnormal Return of 1,63% is found over the period 1/1/2004 until 1/1/2018. Meaning that a share repurchase announcement has, on average, a positive Abnormal Return of 1,63%. The dummy variable Deal Attitude has an average of 0,00. This means that a very low amount of share repurchases are executed to prevent a hostile takeover. In fact, only 5 observations are regarding a hostile takeover. For the M/B ratio, the average is 3,44 and the median 2,10. This indicates that there are a few high observations for this variable. With a standard deviation of 15,95 and a maximum of 591,48, this reinforces the indication. A negative value for the M/B ratio is obtained by having a negative equity book value of the firm. Both the Market Cap. and Cash have a relative high average compared to their median. Also the standard deviation of both variables can be considered very large and the variables are therefore volatile. This also justifies the use of LnCash to reduce the absolute differences in Cash. The negative minimum of LnCash is due to the Cash of a particular company being lower than 1. This results in a negative value.

Table 2 can be found below. This table captures the data for both the US and UK probit models.

Var. Name	Average	Median	Std.Dev	Maximum	Minimum	#Obs.
Repurchase*	0,17	0,00	0,37	1,00	0,00	42.419
UK*	0,02	0,00	0,14	1,00	0,00	42.419
M/B ratio	2,18	1,43	15,29	759,62	-682,53	42.419
Market Cap	9.698,69	396,58	89.296,22	3.778.514,00	0,00	42.419
Cash	624,53	59,33	3.767,61	159.353,00	0,00	42.419
LnCash	4,11	4,08	2,16	11,98	-6,91	42.419
D/E ratio	0,83	0,34	9,91	429,32	-374,11	42.419
Tobin's Q	1,33	0,84	2,57	79,05	0,00	42.419
Free Cash Flow	0,04	0,04	0,21	5,76	-8,09	42.419

*Table 2. Descriptive statistics of the variables for the probit model. For each variable the average, median, standard deviation, maximum, minimum and the total amount of observations is given. Variables with * are dummy variables and have a value of 0 or 1. The Assets and Cash are in US Dollars.*

A total of 42.419 observations are used in this model. This is based on the 7.607 observations from the OLS regression. The increase in the amount of observations is due to data retrieval over several years (2004-2018). With roughly 17% of the observations being a share repurchase announcement, it is accompanied by a standard deviation of 0,37. It is interesting to note that the variable: Cash has the same maximum as in Table 1. This means that for this large observation, a share repurchase announcement took place. The Debt to Equity ratio (D/E ratio) has an average of 0,83. With a standard deviation of 9,91 this variable can be considered volatile. The minimum for Tobin's Q is 0,00 which means that there is no observation with a negative asset value or market capitalisation of a specific firm[1]. With an average of 0,04 for Free Cash Flow, the average is very close to 0.

In this chapter the data retrieval, the modifications to the data and the data statistics have been discussed. In the next chapter: Results, the results from the OLS assumptions will be discussed as well as the results from the OLS regression itself and the probit model results.

[1] Note that a company with a negative market capitalization and negative assets results in a positive (> 0) Tobin's Q. However, after analyzing the data this case was not present in the sample.

5 Results

This chapter will give an overview of all the results of this research. First off, the different regressions (OLS & probit) will be executed as described in the chapter: Methodology. Subsequently, the variables and outcomes will be interpreted and a conclusion is given. Afterwards, the results of the OLS regression assumptions will be discussed.

5.1 OLS Regression

As mentioned in the chapter: Methodology, at first the univariate regressions will be executed for each variable to see whether the variable is significantly different from 0,00. Doing so, a regression will be executed, for each variable, with the Abnormal Return as dependent variable and just one other variable as independent variable. The null-hypothesis is equal to: H_0: $Coefficient\ of\ the\ variable\ is\ equal\ to\ zero$. When the accompanying P-value of a variable is lower than its significance level of 5% ($\alpha = 0{,}05$), the null-hypothesis will be rejected. Each variable that has its null-hypothesis rejected (and thus is not equal to zero) will also be used in the multivariate regression. The results of the univariate regression can be found in the table below, Table 5.

Var. Name	Coefficient	Std. Error	t-value
UK	-0,01	0,01	-1,51
Beta	0,00	0,00	1,37
Attitude	0,03	0,02	1,47
M/B	0,00	0,00	0,81
Market Cap.	0,00**	0,00	-5,64
LnCash	-0,00**	0,00	-8,06
Free Cash	0,01*	0,01	2,78

*Table 5. Univariate regression results statistics per variable. Coefficients noted with * and ** are significantly different from zero at the one five percent and one percent levels, respectively.*

Of the initial six different variables only three variables are significantly different from 0,00, and thus will have their null-hypothesis rejected. This is the case for the variables: Market Cap., LnCash and Free Cash.
Since the variable Market Cap is also not significantly different from 0,00, the theory that the level of information asymmetry has a positive effect on the announcement return from Chari, Jagannathan & Ofer (1988) cannot be observed in the sample.

The dummy variable UK has a P-value of 0,13 and is not significantly different from 0,00. This means that a firm from the United Kingdom does not have significant influence on the Abnormal Return which can be realized at a share repurchase announcement. With a P-value of 0,14 the deal-attitude variable also does not statistically differ from zero.

The multivariate regression will be performed with the variables: Market Cap., LnCash and FreeCash. The regression equation will look as follows:

$$(14) \qquad Abnormal\ Return = \alpha_o + \beta_1(Market\ Cap_i) + \beta_2(LnCash_i) + \beta_3(FreeCash_i) + \varepsilon$$

The execution of the multivariate regression is done to determine whether some variables together may explain the effect of the Abnormal Return. Also in this case, the same conditions apply with the univariate regressions. The null-hypothesis is: H_0: $Coefficient\ of\ the\ variable\ is\ equal\ to\ zero$, and the significance level is 5% ($\alpha = 0{,}05$). The results of the multivariate regression can be found below, in Table 6.

R-squared		0,01	
Joint significance		26,21	
Var. Name	**Coefficient**	**Std. Error**	**t-value**
Market Cap.	0,00	0,00	1,35
LnCash	-0,00**	0,00	-7,45
Free Cash	0,02**	0,01	3,46

*Table 6. Result of the multivariate regression. Coefficients noted with * and ** are significantly different from zero at the one five percent and one percent levels, respectively.*

In the results of the multivariate regression, found in Table 6, it immediately stands out that both the variables: LnCash and FreeCash have a P-value lower than the significance level of 5%. Their respective null-hypothesis has to be rejected. This means that LnCash and Free Cash both have a significant effect on explaining the Abnormal Return that is generated shortly after a share repurchase announcement of a company. The excess cash hypothesis can therefore not be rejected. The Market Capitalisation has no significant effect on explaining the Abnormal Return since its P-value is with 0,18 higher than α (0,05). Because this is the proxy for the size of a firm, size does not seem to matter in explaining the Abnormal Return. All in all, no evidence is found in this model that the Abnormal Return can be explained by the signalling hypothesis since both the M/B ratio and the Market Capitalisation variables are not significant. Also, no evidence for the Hostile Takeover hypothesis is found because the variable Hostile Attitude is not significant. On the other hand, the Excess Cash hypothesis can be confirmed. Both the LnCash and Free Cash variables are significant in the univariate and multivariate regressions.

The R^2 of this model is 0,01. The R-squared indicates to what extend the independent variables explain the dependent variable. It does not indicate whether variables are significant or not or whether this model is a good explaining model. With a value of 0,01 the R-squared is relatively low. On one side this can be expected, since other theories may also affect the Abnormal Returns but this is not investigated in this OLS regressions. On the other side, with the addition of more variables and more observations the model may be improved in explaining the dependent variable and thus increasing the R-squared. The F-score for joint significance is equal to 26,21 in the multivariate regression. In total, four degrees of freedom are used with a significance level of 5%. Since this coefficient of larger than the critical value of 4,53, the null-hypothesis has to be rejected that all variables are equal to 0. The full multivariate linear regression can be found in Table C in the Appendix.

5.2 Probit model

To test the remaining hypothesis, the Optimal Capital Structure hypothesis, a probit model analysis will be performed. In this analysis the variables Attitude, LnCash and Free Cash will also be considered. This is to check whether the Hostile Attitude and Excess cash hypotheses also holds over time. The dependent variable is whether a share repurchase announcement

was made (1 for Yes, 0 for No). At first, the probit regression will be performed. The results of this regression ca be observed in the table below, Table 7. The original statistical output can also be found in Table D located in the Appendix.

Pseudo R2	0,0195		
LR Chi2	750,32		
Var. Name	**Coefficient**	**Std. Error**	**z-value**
UK	-0,48**	0,08	-6,00
Attitude	1,32*	0,60	2,21
MB ratio	0,00*	0,00	2,17
Market Cap.	0,00	0,00	1,81
LnCash	0,08**	0,00	22,57
DE ratio	-0,00*	0,00	-3,03
Tobin's Q	-0,01*	0,00	-2,69
Free Cash	0,40**	0,05	8,07

*Table 7. Result of the probit regression. Coefficients noted with * and ** are significantly different from zero at the one five percent and one percent levels, respectively.*

The Pseudo R2 of this probit regression is 0,02, which is considered quite low. What immediately catches the eye is that all variables are statistically significant, with the exception of the Market Capitalisation variable. The magnitude of the coefficient cannot be interpreted just yet. Only the sign of the coefficient can be interpreted in this probit analysis. Size, however, does not seem to matter in this probit analysis. In this case, companies based in the United Kingdom are less likely to announce a share repurchase than companies based in the United States. Also, a higher Debt over Equity ratio decreases the probability a firm will repurchase its shares. The same goes for the Tobin's Q of a firm. To interpret the magnitude of the coefficients in a probit analysis, the average marginal effects have to be calculated. The average marginal effect measures how much the probability of the outcome variable changes when one changes the value of the regressor, while holding all other regressors constant (ceteris paribus). The average marginal effect can also be calculated at the mean of the variable (marginal effect of the means). However, since the difference between the average marginal effect and the marginal effect at the mean is negligible (difference is less than 0,001), the average marginal effect is used for simplicity. The average marginal effect of the variables can be observed below in Table 8.

The McFadden R^2 (Pseudo R2) in this model is equal to 0,0195. As mentioned by McFadden himself, a value between 0,2 and 0,4 represents excellent fit of the model. The value in this model is lower and could be improved by increasing the number of firm characteristics or control variables (McFadden, 1979).

The Likelihood Ratio (LR) Chi-squared test that at least one of the regression coefficients is not equal to zero in the model, has a score of 750,32. In other words, the null-equals H_0: $All\ regression\ coefficients\ are\ equal\ to\ zero$. The probability that at least one of the regression coefficients is not equal to zero is 0,00 (see Appendix Table D). Meaning that the null-hypothesis has to be rejected and that at least one of the coefficients is not equal to zero.

Var. Name	Coefficient	Std. Error	z-value
UK	-0,119**	0,020	-6,00
Attitude	0,326*	0,15	2,21
MB ratio	0,00*	0,00	2,17
Market Cap.	0,00	0,00	1,81
LnCash	0,020**	0,00	22,57
DE ratio	-0,001**	0,00	-3,03
Tobin's Q	-0,003*	0,00	-2,69
Free Cash	0,098**	0,05	8,07

*Table 8. Average marginal effect of the probit analysis. Coefficients are given in thousands since the coefficients have to be multiplied by 100 to get a percentage. Coefficients noted with * and ** are significantly different from zero at the one five percent and one percent levels, respectively.*

What immediately stands out is that all variables except Market Capitalisation are significant at a 5% significant level. A variable could be statistically irrelevant in the sense that its coefficient estimate is statistically insignificant but at the same time its marginal effect might be statistically significant. The first does not mean that this variable does not matter because it also affects the marginal effects of all the other covariates. In other words, including it may still improve the fit of the overall model (Dowd, Greene, & Norton, 2014).

A UK based firm is 11.9% less likely to announce a share repurchase than a firm based in the US. The hostile attitude of a potential takeover increases the share repurchase announcement by 32.6%. This confirms the hostile takeover hypothesis. Even though the Market to book ratio is significant in this analysis, the coefficient is 0,0%. This implies that it has a very low effect on the actual share repurchase decision. On the other hand, the (large) amount of cash a firm holds increases the likelihood of a share repurchase announcement by 2% (see LnCash). The relative high debt to equity ratio decreases the chance of a repurchase decision. This also makes sense in the light of the Optimal Capital Structure theory. A firm which is relatively highly levered is less likely to repurchase its own shares, thereby increasing the debt to equity ratio even further. Even though the coefficient is 0.1%, the variable is statistically significant. The Optimal Capital Structure theory can therefore be confirmed in this sample. Another interesting result for the Excess cash hypothesis is the Tobin's Q. A firm with a relatively high Tobin's Q is relatively overinvested and may have a relatively large amount of cash at hand. As is observed in the sample, a negative relation is found. The coefficient is just 0,3% but contradicts the LnCash variable and the excess cash hypothesis. Lastly, the Free Cash variable has a coefficient of 9,8%, meaning that a firm with a relatively large amount of cash over assets in that year is 9,8% more likely to announce a share repurchase. Given the fact that the marginal effect of LnCash is also significant, together (with Free Cash) this indicates a confirmation of the excess cash hypothesis even though the Tobin's Q variable says otherwise.

Last but not least, a new variable will predict on the basis of the probit model, in order to check whether this model can correctly classify share repurchase announcement based on the variables used. This new variable correctly classified 83,21% of the observations. In other words, this model can correctly predict a share repurchase announcement to happen with 83,21% probability given the set of variables. The results can also be observed in the Appendix, Table E: Correct classification.

5.3 OLS Assumptions

The Linear relation is the first assumption that is going to be tested. To test whether this relation holds, a scatterplot of the dependent variable with each of the independent variables will be made. For all variables, a linear relation can be observed in a strong or weaker form. The strongest linear relation is found with the Abnormal Return and the Market-to-Book ratio. For a dummy variable (UK and Hostile Attitude) it is very hard to observe, since a dummy variable can only take the value of either zero or one.

The next assumption to be tested is the normal distribution of the error terms. To determine whether the error terms are normally distributed, a histogram will be made. In addition, a Shapiro-Wilk test will be performed. The reason for this statistical test is to prove if the results of the histogram are statistically significant. The histogram can be observed below in Figure 3.

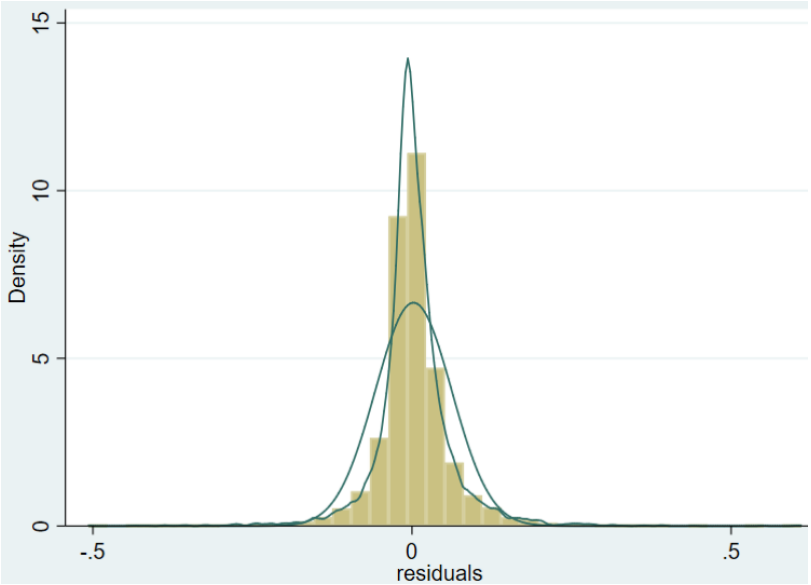

Figure 3. Distribution of the residuals with a normal kernel density line.

The histogram seems to have the same shape as the normal-distribution line accompanied with it, although the bars are much larger than the normal kernel density line. The null-hypothesis of the Shapiro-Wilk test is: H_0: $Residuals\ are\ normally\ distributed$. With a P-value of 0.00 and a significance level of 5% the null-hypothesis has to be rejected. This means that the residuals are not normally distributed in the model. Despite the fact that the residuals are not normally distributed, this does not have to be a concern for the reliability of the model. Since there is a large amount of observations, and as long as no prediction intervals are calculated there should be no problem.

There is no way to immediately rule out the presence of multicollinearity. However, using three different methods a good estimate can be given whether the model is subject to multicollinearity, as mentioned in the chapter: Methodology. Two of the three methods (Variance Inflation Factor and the correlation) will be discussed in this paragraph while the last one (Tolerance) will be discussed with the multivariate regression results. First, the Variance Inflation Factor. The VIF has been calculated and can be observed in Table 3 just below.

Var. Name	VIF	1/VIF
LnCash	1,41	0,71
MarketCap	1,32	0,75
Beta	1,07	0,94
Free Cash	1,03	0,97
UK	1,01	0,99
M/B ratio	1,00	1,00
Attitude	1,00	1,00

Table 3. Per variable the Variance Inflation Factor and 1 divided by the Variance Inflation Factor.

A general rule of thumb is that multicollinearity may arise when the VIF of a particular variable is higher than 4,00. As can be observed in Table 3, this is not the case for any variable. This method therefore does not give evidence reason to be believe in the presence of multicollinearity.

A high correlation, higher than 0,8, may also indicate multicollinearity. The entire correlation matrix can be found just below in Table 4.

Var. Name	Abnor. Return	UK	Beta	Attitude	M/B	Market Cap.	LnCash	Free Cash
Abnor. Return	1,00							
UK	-0,02	1,00						
Beta	0,02	-0,02	1,00					
Attitude	0,01	-0,00	0,01	1,00				
M/B	0,01	-0,00	0,01	-0,00	1,00			
Market Cap.	-0,04	0,06	0,02	-0,01	0,04	1,00		
LnCash	-0,08	0,04	0,23	0,01	0,03	0,48	1,00	
Free Cash	0,04	-0,03	0,06	0,01	0,04	-0,03	0,12	1,00

Table 4. The pairwise correlation of each variable.

The largest correlation that can be observed is between LnCash and Market Capitalisation and has a value of 0,48. This can be partly explained by the fact that companies with a lot of cash able to return (a part of) this cash to stockholders in the near future causing the market capitalisation of this particular firm to rise. On the other hand, a high market capitalisation may indicate that the firm is expected to generate, or is currently holding, a lot of cash that is going to be distributed to the equity holders. This reasoning may only be part of the explanation since other information may also influence the market capitalisation of a company (growth prospects, share repurchases, M&A activity, macro-economic outlook, etc.). The highest correlation of 0,48 is lower than 0,8 and thus does not indicate the presence of multicollinearity.

Tot test for the presence of autocorrelation, a Breusch-Godfrey test will be performed. The null-hypothesis of this test is: H_0: $No\ serial\ correlation$, and the significance level used is equal to 5% ($\alpha = 0{,}05$). The first analysis will be on first-order autocorrelation. The result of this test is a P-value of 0,95. This means the null-hypothesis cannot be rejected and no

first-order serial correlation is present. The next test will be on serial correlation of the past ten observations. Using the same null-hypothesis and significance level, a P-value of 0,22 results for this test. Since this P-value is larger than the significance level the null-hypothesis can't be rejected. This means that also for a larger period no serial correlation is present.
A Breusch-Pagan / Cook-Weisberg test will be performed to see if this model is subject to heteroscedasticity. The outcome results in a P-value of 0,00, with a significance level of 5% ($\alpha = 0{,}05$), this means that the null-hypothesis: H_0: $Constant\ variance$ has to be rejected. This means that heteroscedasticity is present. One way to correct for heteroscedasticity is by using robust (Huber-White) standard errors while executing the regression. This has been applied when executing the regressions.

6 Conclusion

In this research paper an analysis was performed on the share repurchase announcements of companies based in the USA and UK from January 2004 up and until December 2018. It sheds light on the possible reasons for a company to decide to repurchase its own shares. In addition, it was examined whether a difference could be observed between US and UK based firms and whether it is possible to predict that a share repurchase may be announced.

The main contribution of this paper is that most existing hypotheses can be confirmed in this sample, in addition with some interesting remarks. The paper provides evidence that Abnormal Returns (with an average return of 1,63%) following a share repurchase announcement still exist to date by performing an event study. In addition, it is proven that the excess cash hypothesis in the OLS analysis sample still persists. The other hypotheses in the OLS regression (regarding hostile takeover and signalling) have to be rejected.

Apart from the OLS regression, a probit analysis has also been performed to analyse the data over time and to predict a share repurchase announcement. UK firms are 11,9% less likely to announce a share repurchase program. Also in this case, the excess cash hypothesis is confirmed based on the results. The hostile takeover hypothesis can also be confirmed, meaning that firms are more likely to announce a share repurchase program in order to prevent a hostile takeover. In addition, evidence is also found for the optimal capital structure theory and the signalling hypothesis.

Finally, a prediction was made on the chance of a share repurchase to be announced given the data in the sample. With an 83,21% chance to correctly classify a share repurchase announcement, the prediction of the model can be interpreted as quite reliable.

In summary, the excess cash hypothesis is confirmed in both regressions, while the hostile takeover, signalling hypothesis and the optimal capital structure theory are only confirmed in the probit analysis. A difference between US and UK based firms can only be observed in the probit sample, with UK firms being far less likely to repurchase their own shares than their United States based counterparts.

In order to add extra force to this research, more variables could be incorporated or calculated differently. For example, defining the size of a firm differently or adding another variable like whether a company is backed by private equity (or venture capital) investors. Subsequently, a larger period can be examined in order to retrieve more observations based on UK companies, since they tend to be less likely to announce a share repurchase. As for the probit model, a correct classification of 83,21% is found. It is unclear, however, whether this is a good quantitative estimation. Meaning, the correct classified percentage is relatively good but it may indicate that the model could not correctly classify a certain group of observations. More research is required in order to give a definitive conclusion, for example a Hosmer-Lemeshow approach could be used to tackle this potential problem. Lastly, the contradicting results (in the OLS regression and Probit analysis) of the size proxy could be worth investigating further.

Appendix

Table A, Number of variables per observation

- The announcement date;
- Company name;
- DataStream code;
- CUSIP code;
- Value of the transaction;
- Hostile takeover;
- Relative return of the shares per company over the period -60 to -5 days
- Relative return of the market per company over the period -60 to -5 days
- Opening and closing price per share on announcement date

Since the data from WRDS is based on 14 years per company, the following data is known per company per year:

- Cash;
- Total market value;
- Total Assets;
- Total Debt;
- Total Equity;
- Common shares outstanding;
- End of year closing price per share;
- Net income;
- Depreciation;
- Amortisation;
- Gains on Sales of property;
- Funds from Operations;

Table B, Data mutations

Var. Name	#Obs. Removed	Errors removed	Maximum	Minimum
Abnormal return	9	0	184,35%	-436,72%
Beta	13	12	23,52	-
Deal attitude	5	5	-	-
M/B ratio	321	313	839,00	-301,89
Market Cap.	13	0	1.532.123.109	-4.392,21
Cash	0	0	-	-
LnCash	2726	2726	-	-
D/E ratio	42	20	912,00	-756,12
Free Cash	0	0	-	-
Tobin's Q	50	0	382,74	0,00
Free Cash Flow	7	0	0,00	-64,97

Explanation:
A total of four observations have been removed with huge negative abnormal returns ranging between -436,72% and -84,38%. The next most negative return is -53,62% and many abnormal returns follow closely after this. Coincidentally, also four hugely positive abnormal return observations have been removed. These observations ranged from +134,81% to 184,35%. The next most positive abnormal return is 78,32% with many more positive returns following closely to that observation. For the Beta, only 1 observation is removed as this observation has a Beta of 23,52 while the next highest beta is 12,78 with more Betas near to that value.
The Deal Attitude variables has been lowered with 5 values as the errors have been removed.
For the M/B ratio a total of two very low negative numbers have been removed while also removing two very high positive numbers. Also here coincidently two negative and two positive observations.
The variable Cash is in line with what may be expected (no outliers) and remains untouched. For LnCash, however, a total of 104 observations are removed since these have a Cash value of 0. This gives and error while calculating the natural logarithm as the natural logarithm is only defined for $x > 0$.
Free Cash remains untouched as no outliers are present here.
For the other models the data mutations are displayed in bullet format to increase the readability. The following data mutations have been executed:

UK OLS regression

- Abnormal return, 1 negative outlier removed
- Beta, 11 errors removed
- M/B ratio, 1 negative outlier removed, 1 positive outlier removed and 312 errors removed
    - This variable uses 3 different variables for calculation as this explains the large amount of errors removed
- LnCash removed 2 errors where Cash was equal to 0, and this causes errors when calculating the natural logarithm
- Free Cash remains untouched

US Probit model

- LnCash, 12 outliers & 2400 observations of Ln errors (Cash = 0) removed
- Debt/Equity ratio, removed 18 outliers both positive and negative and 9 errors
- Market Cap: removed 13 outliers
- M/B ratio 5 negative & 2 positive outliers removed
- Tobin's Q 12 positive outliers removed, since this variable is only positive
- Free Cash Flow removed 5 negative outliers

UK Probit model

- Ln Cash, removed no outliers but removed 220 errors
- D/E ratio, removed 4 negative outliers and 11 errors
- Deal Attitude remains untouched
- M/B ratio, removed 1 negative outlier and 3 positive outliers
- Tobin's Q, removed 19 negative outliers and 19 positive outliers

- Free Cash Flow, removed 1 positive outlier and 1 negative outlier

Table C, Multivariate OLS regression

Linear regression

Number of obs	= 7,606
F(3, 7602)	= 26.21
Prob > F	= 0.0000
R-squared	= 0.0100
Root MSE	= .05989

Abnormalre~n	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
MarketCap	1.66e-08	1.23e-08	1.35	0.176	-7.46e-09	4.07e-08
LnCash	-.0027076	.0003632	-7.45	0.000	-.0034195	-.0019956
Freecash	.0188704	.0054539	3.46	0.001	.0081792	.0295617
_cons	.0256291	.0018426	13.91	0.000	.0220171	.0292411

Table D, Probit regression

Probit regression — Number of obs = 42,419
LR chi2(8) = 750.32
Prob > chi2 = 0.0000
Log likelihood = -18816.123 — Pseudo R2 = 0.0195

RepurchaseYN	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
UK	-.4841847	.0806767	-6.00	0.000	-.6423082	-.3260612
Attitude	1.32265	.5982224	2.21	0.027	.1501559	2.495145
MBratio	.0012291	.0005657	2.17	0.030	.0001203	.0023379
MarketCap	1.58e-07	8.72e-08	1.81	0.070	-1.27e-08	3.29e-07
LnCash	.079615	.0035276	22.57	0.000	.0727011	.0865289
DEratio	-.0031025	.0010241	-3.03	0.002	-.0051097	-.0010953
TobinsQ	-.0118707	.0044189	-2.69	0.007	-.0205315	-.0032099
Freecashflow	.3991602	.0494329	8.07	0.000	.3022736	.4960469
_cons	-1.305429	.017455	-74.79	0.000	-1.33964	-1.271218

Table E, Correct classification

Probit model for RepurchaseYN

Classified	True D	True ~D	Total
+	3	8	11
-	7116	35292	42408
Total	7119	35300	42419

Classified + if predicted Pr(D) >= .5
True D defined as RepurchaseYN != 0

Sensitivity	Pr(+| D)	0.04%
Specificity	Pr(-|~D)	99.98%
Positive predictive value	Pr(D| +)	27.27%
Negative predictive value	Pr(~D| -)	83.22%
False + rate for true ~D	Pr(+|~D)	0.02%
False - rate for true D	Pr(-| D)	99.96%
False + rate for classified +	Pr(~D| +)	72.73%
False - rate for classified -	Pr(D| -)	16.78%
Correctly classified		83.21%

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