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Turbulent Waters: How Share Repurchases Influence Market Liquidity

A Quantitative Study on The Stockholm Stock Exchange

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Abstract

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Keywords: Repurchases, Relative Spread, Depth, Information Asymmetry, The Competing Market-Maker Theory

Purpose: To investigate how share repurchases in Sweden during Covid-19 impacted stock liquidity.

Methodology:
Initially, a pooled OLS economic approach is used on panel data. After receiving empirical evidence in order to determine the most effective model, fixed effects were chosen. Separate regressions are being executed for both dependent variables, relative spread and depth, where repurchases in the form of a dummy serve as the main independent variable. Multivariate regression analyses are then conducted using the fixed effect model and are used in order to examine the hypotheses. To further examine hypotheses 2 and 3, interactive variables are introduced.

Theoretical Perspectives:
The study analyzes the results through the lens of previously known theories with respect to prior research conducted on stock market liquidity, where information asymmetry theory and the competing market-maker theory are central.

Empirical Foundation:
After collecting market data, taken at 30-minute intervals, the initial sample consists of 464,490 observations. This is later converted to daily data, leading to a final sample of 28,097 daily observations between March 2020 and December 2021. Of these 28,097 daily observations, 2,346 of the days consist of repurchases.

Conclusions:
Share repurchases are found to increase both the relative spread as well as the depth during the days of repurchases. After controlling for the size of the companies, the results suggest that larger companies experience larger increases in both the relative spread and depth. No significant relationship is found when examining the impact of the size of the repurchase and stock liquidity. The results partly align with the hypothesis drawn from the theoretical perspectives mentioned above.

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TABLE OF CONTENTS

1. Introduction

This chapter provides the background of this paper, beginning with a discussion of the problematization and deficits in previous research. Moreover, it outlines the purpose and research questions being investigated. Furthermore, the main findings of the research area and our contributions to the topic is discussed. Lastly, the outline is presented.

1.1 Background

In today's landscape of financial markets, concerns surrounding liquidity have become increasingly prevalent among investors and policymakers (Weir, 2021; IMF, 2015). For markets to operate effectively, there must be a certainty of liquidity so that investors are able to buy and sell assets without affecting the market price (Amihud & Mendelson, 1986). An illiquid market comes with a variety of problems, some of which include, increased volatility in prices, higher transaction costs, increased risk of a financial crisis, lower bond prices, and the fact that capital raising becomes more expensive (Douglas, 2015). However, recent events, especially the Covid-19 outbreak, have highlighted the vulnerability of financial markets, raising concerns about market liquidity in times of market distress. In March 2020, fund managers faced withdrawals from customers all over the world, creating enormous selling pressure of shares and bonds in the absence of any buyers. This ultimately led to collapsing share and bond prices, drying up the liquidity in the financial markets (Tooze, 2020).

The Covid-19 pandemic highlighted weaknesses in the financial markets, as liquidity dried up and volatility increased. Enow (2023) tried to gain a deeper understanding of how liquidity in various markets was affected during times of market distress. The results presented strong signs of market illiquidity during both the 2007-2008 financial crisis and the Covid-19 pandemic. In 2007-2008, although most markets saw a decline in liquidity, there were still a few markets that were able to maintain sufficient liquidity during the crisis like the DAX and Nikkei-225. In both crises, investors and policymakers faced the harsh reality of illiquidity, which not only worsened the market volatility but also made it more difficult for investors to exit their positions without impacting the fair market price. The implications of historical crises like the 2007-2008 crisis have been studied and known for years, yet the magnitude of the Covid-19 pandemic highlighted and underpinned the importance of maintaining solid liquid markets to protect investor confidence and enhance market stability on another level. Moreover, during

times of market turmoil, companies often reassess their corporate pay-out policies by reducing cash dividends and share repurchases to adjust for changing market conditions (Ali, 2022).

Corporate pay-out policies are one of the most researched areas within finance, with cash dividends being the dominant form of pay-out method historically. In 1980, more than 75% of the companies listed on the S&P 500 used cash dividends to distribute excess cash flow to their shareholders, while only 30% of the companies conducted share repurchases. There has, however, been a structural change over the last few decades, and in 1997, share repurchases surpassed cash dividends and became the dominant pay-out form for companies traded on the S&P 500 (Luk & Zeng, 2020). The shift in corporate payout policy has led to an increasing interest in share repurchases from researchers, and the phenomenon has been well-researched in many different contexts.

In light of this, share repurchases are widely used as a motive to increase and provide support for the company's own stock in terms of liquidity and is often one of the benefits considered by management when deciding on a repurchase program (Grullon & Ikenberry, 2000). In the context of share repurchases, one well-researched area is share repurchases' effect on firm value, where many previous studies have found a positive relationship between share repurchases and firm value (Vermaelen, 1981; Andriosopoulos & Lasfer, 2015). Similarly to share repurchases, improved liquidity has also been found to generate a higher firm value. According to De Cesari, Espenlaub, and Khurshed (2011), improving liquidity benefits both investors and companies in a variety of ways. The authors concluded that improved liquidity yields a lower cost of equity, ultimately leading to a higher firm value.

Other than liquidity improvements and a lower cost of equity, there are various motives why companies choose to conduct share buybacks (Grullon & Ikenberry, 2000; Farrugia, Graham, & Yawson, 2011). Corporate executives might utilize share repurchase programs as a signaling tool for strong cash flows and undervaluation of their stock. Additional motives include reducing the total number of shares outstanding, leading to an increase in earnings per share, a financial ratio many investors put a lot of emphasis on. Overall, companies that have decided to buy back shares have seen abnormal returns of around 2–12% historically (Pettit, 2001), but not all buyback programs are successful. Fingerprint Cards is one case where management repurchased shares at an all-time high and instead destroyed 800 million SEK in shareholder value. Although many factors played a role in Fingerprint Cards downfall, an unsuccessful

share repurchase program contributed to the rapid decline in its market capitalization in the coming years (Mothander, 2017).

Previous research on market liquidity during times of market turmoil concludes that most markets experience illiquidity during times of market distress (Enow, 2023; Rösch & Kaserer, 2014). However, during the Covid-19 pandemic, all financial markets experienced significant illiquidity (Enow, 2023; Gofran, Gregoriou & Haar., 2022). Following the meltdown in all financial markets during Covid-19, research on liquidity during periods of market distress has become increasingly important. Moving forward, scholars are calling for research to better understand how liquidity shortages during times of market distress affect the equity markets and how liquidity can be improved during these times (Enow, 2023; Gofran et al., 2022).

1.2 Problematization

Market liquidity is perceived as the cornerstone of an efficient market. The absence of market liquidity would inhibit traders from executing trades which would cause price distortions that fail to accurately reflect all available information, leading to increased transaction costs (Amihud & Mendelson, 1986; Fama & French, 1993). The relationship between share repurchases and stock market liquidity has been widely studied throughout the past decades. This area is, however, marked by conflicting results, indicating that share repurchases can have both positive and negative effects on stock liquidity. On one hand, Hillert, Maug & Obernberger (2016) analyzed 50,204 repurchase months between 2004-2010, arguing that share repurchases have a positive effect on stock liquidity while simultaneously reducing price volatility. The authors explain that the positive relationship likely is due to firms engaged in share repurchases being patient traders and having low demand for immediacy. They also found that stock liquidity in times of crises increases when firms serve as buyers when the sell pressure is heightened, ultimately reducing the volatility. Similarly, De Cesari et al. (2011) investigated whether companies that traded their own stock could improve their liquidity. By analyzing data obtained from annual reports, covering 386 Italian companies, the authors were able to draw the conclusion that share repurchases improved liquidity. When firms engage in buy-backs, they find that the difference between sell and buy prices narrows, thus reducing the spread. Moreover, Eberhart & Siddique (2004) studied 7,079 share buyback announcements on the US market between 1981 and 1995. The authors found a positive relationship between share buyback announcements and stock liquidity, explaining the relationship with the liquidity hypothesis, where trading with a company's own shares does not change the intrinsic value of

the company but instead lower the transaction costs. The positive results are consistent with previous studies (Barclay & Smith, 1988; Franz, Rao & Tripathy, 1995). On the other hand, Brockman & Chung (2001) analyzed intraday data from Hong Kong and found evidence that share repurchases widen the gap between the bid-ask spread, meaning they have a negative impact on stock liquidity. Consistently, Ginglinger & Hamon (2007) analyzed monthly data from 352 French firms and found a negative relationship between share repurchases and stock liquidity as well.

A potential factor contributing to the conflicting results could be the differences in disclosure requirements and regulatory environments between different countries. The majority of previous research has used data before the Market Abuse Directive (MAD) was introduced. MAD was set in motion in the European Union in 2003, before being revised in 2014 and renamed to the Market Abuse Regulation (MAR). The objective of MAR is to enhance financial transparency and prevent market abuse such as insider trading and market manipulation. Transparency is deemed a prerequisite to prevent market abuse, and companies are therefore, according to Regulation No. 296/2014 of the MAR, obligated to disclose adequate information about the buy-back program. Moreover, according to Swedish regulation, two-thirds of the shareholders present at the general meeting must vote in favor of a proposed buy-back program in order for it to come into force (Bolagsverket, 2022). Firms in Sweden are also required to disclose information about the share repurchases no later than 3 days after the trade has occurred (Finansinspektionen, 2023). The US is, however, less regulated regarding disclosure of adequate information concerning repurchasing activities. Until 2003, companies traded in the US had no obligation to disclose their share repurchases, while after 2003 this shifted, and US companies were now obligated to disclose buy-backs from the previous quarter in their quarterly reports (Ginglinger & Hamon, 2007). Contrary to Sweden, the board of directors in the US can also approve buy-back programs without the approval of shareholders.

In Hong Kong, any shares repurchased on a specific day must be reported to the SEHK by 9:30 a.m. the following business day (Brockman & Chung, 2001), while French firms are obligated to disclose the number of shares repurchased the previous month to the public (Ginglinger & Hamon, 2007). Most previous research on the US market (Barclay & Smith, 1988; Franz et al., 1995; Eberhart & Siddique, 2004; Cook, Krigman & Leach, 2004) was done before the new law came into force in the US in 2003. Ginglinger & Hamon (2007) stated that the absence of comparable disclosure requirements in the US makes it impossible to directly compare their

research with studies conducted on the US market. The authors also state that there may be other factors influencing the contradictory results, such as differences in how the market operates between countries. Additionally, Cook et al. (2004) argue that the divergence in findings between their results and those of Brockman & Chung (2001) is most likely attributable to differences in disclosure requirements.

Other reasons for the conflicting results could potentially be explained by disparities in data availability and time periods. Firstly, Ginglinger & Hamon (2007) and Brockman & Chung (2001) have examined the relationship between share repurchases and stock liquidity by using intraday data. Ginglinger & Hamon (2007) argue that previous studies (De Cesari et al., 2011; Cook et al., 2004; Hillert et al., 2016) have relied on monthly data, which is to be considered as imprecise data. Ginglinger & Hamon (2007) conclude that this makes it impossible to compare previous studies using monthly data with studies using intraday data. Moreover, Hillert et al. (2016) acknowledge in their study that their limited access to intraday data makes it hard to analyze the impact of share repurchases precisely. Market conditions are another important factor that has been overlooked in previous research. Enow (2023) shows that market distress has a negative impact on market liquidity in general, with the Covid-19 crisis experiencing the most notable liquidity shortage. Previous research has used various time periods and ignored fluctuating market conditions, which makes the data more vulnerable to being affected by exogenous market factors.

To overcome the limitations of previous research, this study focuses on the Swedish market. Firstly, the Swedish market overcomes the problem with data availability by offering highly detailed and comprehensive intraday data, retrieved at 30-minute intervals. Secondly, the Swedish market overcomes the problem of the absence of disclosure requirements by being highly regulated and transparent. Thirdly, no previous studies have factored in market conditions when examining the relationship between share repurchases and stock liquidity. Given the major effects Covid-19 had on market liquidity, the highly precise data on the Swedish market creates a unique opportunity to precisely analyze the impact of share repurchases on stock liquidity during Covid-19, serving as a proxy for times of market distress. Analyzing the relationship between share repurchases and stock liquidity during times of market distress creates a broader and deeper understanding of share repurchases' effect on stock liquidity, contributing to what is already known.

1.3 Purpose and research questions

The purpose of this study is to investigate whether share repurchases have any impact on stock liquidity during periods of market distress. Furthermore, this study aims to investigate if the size of the repurchase and the size of the repurchasing company has any moderating effects on the relationship between share repurchase and stock liquidity.

Q1: How do share repurchases impact stock liquidity during periods of market distress?

Q2: What is the influence of repurchase size on stock liquidity during periods of market distress?

Q3: How does the impact of share repurchases on stock liquidity differ between larger and smaller firms during periods of market distress?

1.4 Findings

This paper uses a sample of 28,097 daily observations of market data between March 1, 2020, and December 31, 2021, with 2,346 repurchasing days. The results in this study support the statement that share repurchases have an impact on stock liquidity. Firms experience increased *Depth* and a widening of the *Relative Spread* on the day of repurchase. After introducing the interaction term *Repurchase x Size*, the relationship between *Repurchase* and the liquidity measures remained significant, the interaction term however showcased no significant results. Moreover, after replacing *Repurchase* with the interaction variable *Repurchase x Market Capitalization*, the study found a significant increase in *Depth*. However, a significant increase in *Relative Spread* is also found, thus decreasing the liquidity. Finally, the results regarding the variable *Depth* remain robust after the robustness check, while the variable *Relative Spread* lost its significance.

1.5 Contribution

Although various previous studies have investigated the relationship between share repurchases and stock liquidity with conflicting results, no other studies have investigated the relationship during times of market distress. Moreover, as per our understanding, no previous studies have utilized interaction terms to further study the potential moderating effects of the

size of the repurchase and the size of the repurchasing firms. This study could therefore be of interest to investors, management, and academia seeking to gain a deeper understanding when it comes to liquidity, corporate pay-out policies, and risk management.

1.6 Outline

This paper is structured as follows: Section 2 provides the empirical literature, the theoretical framework, and the hypothesis development. Section 3 outlines the data and descriptive statistics, while section 4 specifies the empirical methodology. Section 5 entails the findings of this study, the findings are further analyzed and discussed in section 6. Lastly, section 7 concludes this study.

2. Literature review and hypothesis development

This chapter aims to explain the regulatory landscape regarding share repurchases in Sweden, followed by the previously conducted studies and the theoretical basis for this study. Next, it explains the information asymmetry theory and the competing market-maker theory to support the analysis. Lastly, the hypothesis development is presented.

2.1 The regulatory landscape in Sweden regarding share repurchases

The regulation of share repurchases varies among different countries, with variability in the treatment of the repurchased shares. There are two major treatments for the repurchased shares, they are either canceled or held as treasury shares, meaning that outstanding shares have been repurchased by the company to be re-offered to the public at a later date. In Italy, companies are provided the option to choose between the two aforementioned options, while in the US and Spain, repurchased shares are retained and held as treasury shares on the balance sheet. In contrast, in countries such as Canada, France, and the UK, regulations force the cancellation of repurchased shares (Saxena and Sahoo, 2022; De Cesari et al., 2011).

Since 1895, under Swedish law, Swedish companies have been prohibited from repurchasing their own shares, but this changed in 2000. In proposition 1999/2000:34, put forth by Lena Hjelm-Wallén on November 25, 1999, Lena proposed that publicly traded companies in Sweden should be permitted to repurchase their own shares. The purpose of this new legislation was to offer a new alternative for overcapitalized companies to distribute excess cash flow. This would enable companies to transfer capital to their investors without reducing their shareholders' equity capital through cash dividends. Moreover, the governments believed that this legislation would enhance flexibility and competitiveness since the financial market has undergone internationalization for many years. Companies have been allowed to repurchase their shares in many other countries, such as the US, Denmark, and Finland. The lack of competitiveness and efficient capital allocation for Swedish-listed companies made the Swedish government afraid that investors would allocate their money toward investments in other countries. The law came into force on March 10, 2000, when Sweden entered the realm of share repurchases, allowing Swedish-listed companies to repurchase up to 10% of their total outstanding shares (Sveriges Riksdag, 1999).

Share repurchases in Sweden are mainly regulated by the Swedish Company Act (ABL), the Financial Instruments Trading Act (LHF), and the Annual Accounts Act (ÅRL). Multiple criteria must be met for companies to engage in share buybacks. Usually, the board of directors first prepares a proposal regarding the share repurchase that the shareholders need to consider at the general meeting. The proposal must contain information and details such as the total repurchase amount, the timeframe for the repurchase, and a specific price range for the repurchase. The shareholders must, according to ARL, receive the proposal a minimum of two weeks before the general meeting. For the proposal to come into force, two-thirds of the shareholders present at the general meeting need to vote in favor of the proposal (Bolagsverket, 2022).

In contrast to Swedish law, post a share repurchase, the company is obligated to report all transactions regarding their shares repurchase no later than seven trading days after the trade took place to Nasdaq (Nasdaq, 2024). The report to Nasdaq must contain information such as;

1. The number of shares traded
2. Price paid
3. Date(s) of the transaction
4. The company's current holding of its shares
5. Total outstanding shares in the company
6. Brooker(s) buying the shares on the behalf of the company

2.2 Liquidity

Market efficiency is defined as the ability to incorporate all publicly accessible information into asset pricing and refers to how fast and effectively a share can be bought or sold on the market at a fair value. A market with a high level of liquidity has numerous buyers and sellers, making it easier to trade shares without impacting their prices or incurring transaction costs. Market liquidity is one of the most important elements for the market to be efficient and is often associated with market depth. The lack of market liquidity could result in market inefficiency because investors are unable to execute trades, leading to prices not reflecting all available information and higher transaction costs (Amihud & Mendelson, 1986; Fama & French, 1993). Furthermore, Mselmi, Hamza, Lahiani & Shahbaz (2019) argue that liquidity is an important element that also influences systematic risk. According to Enow (2023), the stock market tends to experience liquidity shortages during times of market distress. Liquidity is

therefore an important element for investors during these periods, since they cannot diversify away from systematic risk (Mselmi et al., 2019).

2.3 Empirical literature

Earlier research investigating the relationship between open market share repurchases and stock liquidity has shown various outcomes. Barclay & Smith (1988) conducted the first study in the area, examining the relationship between share repurchases and stock liquidity for firms traded on the New York Stock Exchange. The authors formulated two nonmutally hypotheses about the impact of open market share repurchases on bid-ask spreads. The first hypothesis is called the competing market-maker hypothesis, which predicts that the bid-ask spread will narrow since firms that decide to buy-back shares ultimately serve as market makers, thereby increasing competitive behavior. Conversely, the second hypothesis, the information asymmetry hypothesis, states that if managers have inside information and are willing to trade on that information, the bid-ask spread will increase. The authors were able to demonstrate that when managers traded on inside information, an increase in the bid-ask spread was observed. This was analyzed empirically by investigating the bid-ask spreads pre and post share buyback announcements.

A few years after Barclay and Smith's (1988) study, Franz et al. (1995) conducted a similar study on the US market and hypothesized that the bid-ask spread should decrease following an open market share repurchase announcement. They argue that this is in line with the signaling theory, as managers convey positive private information about the company's future. By analyzing open share repurchases on Nasdaq, the authors were able to show that the bid-ask spreads tend to decrease following share repurchase announcements. Similarly, Eberhart & Siddique (2004) also examined the relationship between share buyback announcements and stock liquidity on the US market. The authors analyzed a sample of 7,079 buyback announcements on the US market between 1981 and 1995. The authors introduced the concept of market depth, which refers to a security's liquidity based on the quantity of buys (bids) and sells (offers) at various price bounds. Consistently with previous research (Franz et al., 1995), Eberhart & Siddique (2004) found that buyback announcements have a positive impact on market liquidity, showcasing that share buybacks enhance market depth.

Furthermore, De Cesari et al. (2011) examined the relationship between open market share repurchases and bid-ask spreads, but expanded the study by including volatility as an additional measure. The authors analyzed companies listed on the Italian Stock Exchange between 1997 and 2004. By this time, companies in Italy were only obligated to report any share repurchases and the sale of previously repurchased shares, in their annual reports. This meant that investors were unaware of when companies repurchased their shares, forcing the authors to rely on yearly averages of data to assess the impact on liquidity. They used the bid-ask spread as a liquidity ratio and concluded that the spread decreased post share repurchases. The authors also found that the effect was most prominent for companies with low liquidity prior to the announcement, but also that the volatility in the stock decreased prior to the share repurchase.

In accordance with De Cesari et al. (2011), Cook et al. (2004) conducted a study on 64 companies listed on the NYSE between 1993 and 1994. The authors used voluntarily disclosed share repurchases by firms and found a positive relationship between share repurchases and liquidity on the days of repurchase due to a decrease in the bid-ask spreads. Moreover, Hillert et al. (2016) extended the focus on the US market further. By collecting data from quarterly and annual reports, they analyzed 50,204 repurchase months during the period between 2004 and 2010 and investigated the impact of share repurchases on stock liquidity. According to the authors, this study is more comprehensive than previous studies examining the US market due to a new obligation, which mandates US companies to disclose monthly share repurchases in their quarterly and annual reports. The authors however acknowledge that the monthly frequency data could be impacted by noisy events and exogenous factors, potentially skewing the entire monthly data. Consistent with the previous research (Barclay & Smith, 1988; Franz el al., 1995; De Cesari et al., 2011; Eberhart & Siddique, 2004), the authors concluded that share repurchases have a positive impact on stock liquidity. The authors argue that their findings are in line with the competing market-maker theory (Barclay & Smith, 1988), where companies submit buy limit orders to create a lower bid price quote.

In contrast to the literature claiming that there is a positive relationship between share repurchases and stock liquidity, apart from Barclay & Smith (1988). Other authors have used intraday data and found evidence that share repurchases have a negative impact on stock liquidity. Ginglinger and Hamon (2007) studied the relationship between share repurchases and stock liquidity in the French market. The authors analyzed 36,848 share repurchases executed by 352 French firms between the years 2000 and 2002. From 2000 to 2002, French firms were

only obligated to disclose their share repurchases to the market the following month. The disclosure included information about the number of shares the company had bought back in the prior month, without mentioning the exact dates. Although the firms were not required to disclose their repurchases to the public, they were required to submit comprehensive information to the Autorité des Marchés Financiers (AMF), which operates similarly to the Securities and Exchange Commission (SEC) in the US. The authors, however, received detailed intraday data from AMF in order to conduct their study, which partly mitigates noisy events. The results from the study showcased that market liquidity tended to decline following a share repurchase. Ginglinger and Hamon (2007) argue that this is mainly due to management being better informed about when to conduct share repurchases. Managements are therefore able to buy-back shares at a cheaper price than outside investors, in line with the information asymmetry theory.

Likewise, Brockman and Chung (2001) studied the relative spread and market depth on repurchase days for 190 repurchasing firms on the Stock Exchange of Hong Kong between 1991 and 1999. Contrary to other countries, any shares repurchased on a specific day in Hong Kong must be reported to the SEHK by 9:30 a.m. on the following business day. The authors conclude that the relative spread increased while the market depth deteriorated on repurchasing days. The authors argue that this is in line with the information asymmetry theory, where managers have more private inside information and are willing to trade on that information. Moreover, by using intraday data, the authors were able to mitigate the problem of noisy events, as earlier mentioned as a problem by Hillert et al (2016). The authors also highlight that the absence of disclosure rules and inadequate data used in previous studies on the US market (De Cesari et al., 2011; Hillert et al., 2016) makes it difficult to precisely measure the impact of share buybacks on liquidity, thus the use of intraday data in their study is more precise and reliable. Moreover, the authors conclude that the absence of comparable disclosure requirements in the US and Hong Kong makes it impossible to directly compare their research with studies conducted on the US market.

The majority of previous studies, as mentioned above, consists of studies conducted during normal market conditions. Gofran et al. (2022) instead examined the impact of Covid-19's effect on market liquidity by conducting an event study, limiting the time frame to a single event. The authors were able to conclude that there was a short-term liquidity impairment looking at the bid-ask spread during the pandemic across all examined markets. Looking closer

at the reasons, they saw that across all markets except in China, the adverse selection problem was an important factor causing the bid-ask spread to widen. Moreover, Gofran et al. (2022) were able to highlight the effect market distress can reveal itself in terms of market liquidity.

2.5 Theoretical background

2.5.1 Information asymmetry

Information asymmetry can best be described as a phenomenon where one party has more valuable information regarding a good or service that they are able to use in order to exploit their counterpart, putting them in a disadvantageous position. The counterpart may not have access to the information, or it might be too costly to acquire the information, which forces them to rely on the information presented by the more informed party, in essence taking a risk (Balakrishnan & Hoza, 1993). This can create exploitative behavior but also cause market inefficiencies. The theory steams from Akerlof (1970), who simplifies information asymmetry by using an example of buying a car. Imagine a dealer shop where the majority of cars sold are considered good cars, although most of them are good, a few bad cars are being sold as well, known as "lemons". The buyer is not able to distinguish between the good cars and the "lemons" but knows that the odds are in his favor of buying a good car. After buying a car and using it for some time, the buyer will most likely be able to tell if he bought a good car or a "lemon". This puts the buyer in a situation where he now has more information regarding the specific car than a potential buyer would if he were to sell it. Since the next buyer will not be able to tell if it is a good car or a "lemon" he will not be willing to pay the fair market value of a good car. The risk of buying a "lemon" creates a market inefficiency in the form that all the cars, both the good ones and "lemons" will be sold at the same price but below the fair market value for a good car. The example applies directly to stock market liquidity situations as well, where management has superior knowledge over investors in terms of company performance. Due to the information disparity between the parties, the adverse selection cost will be reflected in an increase in the transaction cost according to the theory (Brockman & Chung 2001). In order to diminish the effect of information asymmetry and, in essence, decrease market inefficiency, the information gap between the buyer and seller must be mitigated.

2.5.2 Competing market-maker theory

Barclay & Smith's (1988) competing market-maker theory suggests that when firms choose to repurchase shares in the open market, the firm will increase the market-maker competition,

thus lowering the bid-ask spread. Market makers' purpose is to provide liquidity in a specific stock so that investors can buy and sell the stock without incurring too hefty transaction costs and causing large price movements. Market makers enhances market depth by quoting both offer and purchase prices in the stock, thus also lowering the bid-ask spread and, in essence, the transaction cost. Market makers earn their profit from the bid-ask spread by capturing the trading volume in the stock. Since the company in a share repurchase essentially serves as a market maker as well, it increases the competitive behavior, forcing other market-makers and investors to offer more competitive prices in order to capture more of the trading volume. Grossman and Miller (1988) also argue, in accordance with Barclay & Smith's (1988) that an increase in market makers will lower the spread, but with the argument that more market makers will increase risk sharing of the assets' fundamental risk between more parties.

2.6 Hypothesis development

Companies that engage in share repurchases are expected to increase their stock market liquidity (Barclay & Smith, 1988; Franz el al., 1995; De Cesari et al., 2011; Eberhart & Siddique, 2004; Cook et al., 2004). Barclay & Smith (1988) argue, in line with the competing market-maker theory, that stock liquidity will increase from share repurchases since firms act as market makers. By introducing increased competitive behavior among already existing market makers, it forces existing market makers to offer more competitive price bounds to be able to compete for the trading volume. Contradictory, stock liquidity, measured as the relative spread, widens when management is willing to trade on private information, further increasing the information gap between well-informed and uninformed traders (Franz et al., 1995; Barclay & Smith, 1988). However, Franz et al. (1995) argue that greater disclosure of private information reduces the information asymmetry, hence also reducing the proportion of well-informed and uninformed traders. Given the high level of transparency and disclosure of information in the Swedish market (Råsbrant & De Ridder, 2013), Sweden is believed to exhibit a lower level of information asymmetry, overall leading to higher liquidity.

Moreover, Gofran et al. (2022) found that the Covid-19 pandemic had a major negative impact on the liquidity across global markets, with increased bid-ask spreads and diminished market depth. Despite the trend of liquidity drying up during market distress, studies by Cook et al. (2004) and De Cesari et al. (2011) have found that companies engaging in share buybacks after declines in their share prices often were able to stabilize the share price, meaning that

repurchasing firms were able trade against the negative trend to support their stock price. To summarize, previous empirical research indicates that liquidity tends to dry up in times of market distress (Rösch & Kaserer, 2014; Enow, 2023), therefore the positive effect of share repurchases is proposed to be even more pronounced during times of market distress. Given the widespread negative effects of Covid-19, coupled with high uncertainty, especially with low liquidity, this clearly highlights the positive effects of share repurchases. The repurchases would provide liquidity by boosting depth and signaling value in terms of stability during times of heightened uncertainty and market distress, thus, the following hypothesis is formulated:

H1: *Share repurchases increase stock liquidity on repurchasing days compared to non-repurchasing days during Covid-19*

During periods of market distress, characterized by poor market liquidity (Gofran et al., 2022), companies seek to increase their earnings per share through share repurchases in order to gain further interest from investors. Given that EPS is an important metric for investors, larger share repurchases increase the EPS to a greater extent, attracting even more investors (Pettit, 2001). Studies have also shown that the size of share repurchases is positively correlated with abnormal returns (Fruin & Ma, 2014). Since abnormal returns increase awareness of the company and the number of shareholders, as shown by Amihud, Mendelson & Uno (1999), liquidity should increase in companies growing their shareholder base. This is further supported by Amihud et al. (1999), who concluded that there is a positive relationship between an increase in the number of shareholders and stock liquidity. This is in line with the competing market-maker theory, as the inflow of new investors, combined with the company acting as a market maker, creates a broader order book, resulting in increased stock liquidity (Barclay & Smith, 1988).

During Covid-19, stock liquidity was one of the major implications for the global equity markets, fueled by the absence of investors on the buy-side (Gofran et al., 2022). Eberhart & Siddique (2004) and Franz et al. (1995), argue that more intense trading activity from companies increases the market depth, thus the stock liquidity. Given the liquidity collapse in the global equity markets attributed to Covid-19, larger share repurchases should undoubtedly be positively correlated with improved stock liquidity during periods of market distress, thus, the following hypothesis is formulated:

H2**:** *During Covid-19, firms conducting larger share repurchases exhibited increased stock liquidity on repurchasing days compared to non-repurchasing days*

Finally, periods of market distress are characterized by high uncertainty and volatility where investors, both institutional and retail, tend to pay closer attention and resort to larger established firms, in hopes of mitigating their exposure to firm-specific risk (Biermann, 2023). In general, due to worsening market conditions in times of market distress, sell pressure increases, and more investors want to exit their positions. As research has shown, increased uncertainty leads to increased information asymmetry (Akerlof, 1970). In times of normal market conditions, the dispersion between large and small firms regarding information asymmetry is already substantial (Chae, 2005). Larger companies benefit from media attention, global presence, and more analyst coverage, contributing to the narrowing of the information gap between informed and uninformed traders. In times of market distress like Covid-19, uncertainty is heightened, creating an increase in the magnitude of differences regarding information asymmetry between larger and smaller firms. Due to changing attitudes towards risk, the largest sell pressure will arise in the smallest firms, creating an excess supply of sell-side depth which will ultimately result in a widening of the bid-ask spread. According to the competing market-maker theory, a firm that chooses to conduct share repurchase would be able to establish a competitive trading market, in essence increasing the liquidity (Barclay & Smith, 1988). Since larger firms already attract large portions of investors due to risk-shifting in times of market distress (Chen, 2020), it is anticipated that the introduction of a buyer into the market of smaller firms would yield a greater positive effect. The following hypothesis is therefore formulated:

H3**:** *During Covid-19, smaller companies experienced greater stock liquidity from share repurchases than larger companies*

3. Data and descriptive statistics

The data and descriptive statistics provide details about the sample selection and description of the variables used in this study.

3.1 Sample selection

71 Swedish companies conducted share repurchases between 2020.03.01 - 2021.12.31. January and February have been excluded with the reason that Covid-19 pandemic hit Sweden in late February and early March. Excluding these months raises the likelihood that the market had entered a stage of market distress. The following data regarding size, price, and date of the repurchases are retrieved from NASDAQ OMX Nordic's website, yielding an initial sample of 2,588 repurchasing days (Nasdaq, 2024). Intraday market data, stamped 30 minutes apart, for the repurchasing companies is collected from the Swedish House of Finance's database (Nasdaq HFT, 2024). The Stockholm Stock Exchange is open between 09:00-17:30, equaling 18 observations per company and day. However, due to a lack of data availability from 17:00-17:30 in the Swedish House of Finance's database, 17 observations per day and company are retrieved using reconstruction of the orderbook. One company is excluded from the sample due to missing data from the Swedish House of Finance, resulting in 70 companies. Similarly, there are missing data in the Swedish House of Finance's database regarding certain trading dates where repurchases have occurred; these particular days have therefore been excluded as well, leaving the sample with 2,346 repurchasing days. For the 70 companies, a total of 466,786 observations are collected, but after manual exclusion of observations impacted by unusual trading conditions such as halted trading, the total number of observations is left at 464,490. The 30-minute intervals market data is then later used to calculate daily averages for the liquidity and control variables, yielding a total of 28,097 daily observations. Moreover, market capitalization is retrieved on a daily basis from Capital IQ's database (S&P Capital IQ, 2024) due to the lack of daily data on this variable in the Swedish House of Finance's database.

3.2 Liquidity measures

Previous literature and research have used a broad range of measures as proxies for market liquidity, indicating that there is an absence of agreement on the most suitable measure of liquidity (Atiken & Comerton-Ford, 2003). The authors define liquidity as the ability to quickly convert a security into cash and then reconvert into a security again at no cost. Moreover, the various liquidity measures can be categorized as either trade-based or order-based. Trade-based

measures are often characterized as being simple to calculate and include variables such as value, volume, frequency, and turnover ratio. Trade-based measures have, however, been criticized as well due to being retrospective rather than ex ante, with a strong focus on the past. Order-based measures instead focus on order-book liquidity measures, specifically the bid-ask spread. The spread between the ask price and bid price is the transaction cost, which is the cost investors must pay to be able to execute the transaction immediately. By calculating the transaction cost as a percentage of the share price, also known as the relative spread, liquidity can be compared between different securities (Atiken & Comerton-Ford, 2003).

3.2.1 Choice of liquidity measures

Lee, Mucklow & Ready (1993) conclude that previous research within the area of liquidity, mainly focused on the size of bid-ask spreads. Through the lens of information asymmetry, the proportion of informed and uninformed traders is the driver of wider spreads. The authors, however, argue that the bid-ask spread is only one dimension of liquidity, more specifically the price dimension. According to Lee et al. (1993) it is essential to take the quantity dimension into account in order to fully understand the concept of market liquidity. This dimension is frequently overlooked in prior research, despite its significance in grasping the complete concept of market liquidity. For instance, if a specialist perceives an increased likelihood of certain traders possessing inside information, the specialist could quote fewer shares, in essence depth to protect itself. In conclusion, there is no optimal choice of measure, it rather depends on data availability and the purpose of the research (Goyenko, Holden & Trzcinka, 2009). In this paper, in accordance with previous research on liquidity (Barclay & Smith, 1988; Brockman and Chung 2001; Ginglinger & Hamon, 2007; Hillert et al., 2016), the following order-based measures are used:

3.3 Relative Spread

Relative Spread, also known as the Percentage Quoted spread, has been used rigorously in previous scientific literature when measuring liquidity (De Cesari et al., 2011; Hillert et al., 2016; Ginglinger & Hamon, 2007). *Relative Spread* is an ex-ante measure where a higher value indicates greater illiquidity in the stock and the measure is, in essence, a relative measure of the bid-ask spread. To calculate the *Relative Spread,* Equation (1) is used, where *Ask* stands for the lowest price the first seller quote is willing to accept for stock *i* at time *t*, while *Bid*

represents the highest price the buyers in the first quote are willing to pay for stock *i* at time *t*. The *Midpoint* is calculated in accordance with Equation (2).

Equation 1

$$Relative\ Spread_{i,t} = \frac{Ask_{i,t} - Bid_{i,t}}{Midpoint_{i,t}}$$

Equation 2

$$Midpoint_{i,t} = \frac{Ask_{i,t} + Bid_{i,t}}{2}$$

3.4 Depth

Depth is a measure of the market's ability to process large transactions without affecting the price of the stock. The measure reflects the volume of orders and is a measure of market thickness rather than transaction cost. Similarly to Brockman & Chung (2001) and Cobandag Guloglu & Ekinci (2021), *Depth* is defined as the value of all outstanding shares at the highest price bound for the *Bid* in stock *i* at time *t* and all outstanding shares at the lowest price bounds for the *Ask* in stock *i* at time *t* (Equation 3).

Equation 3

$$Depth_{i,t} = Total\ number\ of\ shares\ outstanding\ at\ highest\ bid_{i,t} + Total\ number\ of\ shares\ outstanding\ at\ lowest\ ask_{i,t}$$

3.5 Independent variable

Since this study is examining the effect share repurchases have on stock liquidity, share repurchases will serve as the main explanatory variable in the study in accordance with previous research (Brockman & Chung, 2001; De Cesari et al., 2011). Share repurchase is expressed as a dummy variable, where if the company has bought back shares at time *t,* it takes on a value of 1 and 0 if otherwise. The dummy variable will be included in the regression in hopes of establishing a positive relationship between share repurchases and increased stock liquidity while still considering the potential effects of the included control variables.

3.6 Control variables

Acknowledging previous research (Hillert et al., 2016; Brockman & Chung, 2001; Ginglinger & Hamon, 2007; De Cesari et al., 2011; Råsbrant & De Ridder, 2013), the following control

variables are included in this paper: *Book to Market, Market Capitalization, SEK Volume Traded, Average Daily Price and Volatility.*

Book to Market is defined as the book value of equity divided by the market value of equity. Firms with lower book to market multiples attract institutional investors to a greater extent, which ultimately may impact the bid-ask spread and market *Depth*, thereby affecting liquidity (Fang, Noe & Tice (2009). *Market Capitalization* is an additional control variable included and is defined as the market value of equity. Following Hillert et al. (2016), natural logarithmic scaling of *Market Capitalization* is used. According to Galvani and Ackman (2021), firms with higher market capitalization tend to have higher market liquidity compared to firms with smaller market capitalizations. This is partly because there is more interest and trading activity for stocks with higher market capitalization (Hillert et al., 2016; Brockman & Chung, 2001). Moving on, *SEK Volume Traded* represents the daily transactions value in SEK, which also is naturally logarithmically scaled (Hillert et al., 2016). According to Ginglinger & Hamon (2007) the bid-ask spread consists of three cost elements, inventory-holding cost, order and processing cost, and adverse selection cost. The authors suggest that since order and processing costs are mainly fixed, the overall cost should decrease with higher volume. Higher volume will directly impact the overall cost because, since order and purchasing costs are fixed, increased volume allows the cost to be distributed on more trades, thereby lowering the overall cost of the transaction, in essence narrowing the bid-ask spread. Therefore, the *SEK Volume Traded* is included as a control variable. *Average Daily Price* represents the average daily trading price and is naturally logarithmically scaled in accordance with Hillert et al. (2016). According to Brockman & Chung (2001), higher trading prices are correlated with improved liquidity. Lastly, following previous studies (Hillert et al., 2016; Brockman & Chung, 2001), *Volatility* is included as a control variable. Ginglinger & Hamon (2007) argue that bid-ask spreads should widen during times of increased volatility. Grossman & Miller's (1988) way of measuring volatility using the natural logarithm of the intraday highest price divided by the intraday lowest price is the measure used in this study.

3.7 Summary statistics

Table 1 shows summary statistics for all the variables used in this paper, excluding the interactive terms. All liquidity measures and control variables are winsorized to adjust for outliers and misleading observations in order to increase the accuracy of the regressions. The

Relative Spread, expressed as a percentage, is scaled up by a factor of 1,000. Moreover, due to multiple negative book values for one of the firms in the sample, while *Depth* experiences hefty variations, *Depth* and *Book to Market* have been winsorized at the 5th and 95th percentiles, respectively. The natural logarithm of *Market Capitalization, SEK Volume Traded* and *Volatility* is used in order to account for the skewness of the residuals, increasing their normality. The sample consists of 28,097 daily observations over the period 2020.03.01 - 2021.12.31. The variable *Repurchase* represents the dummy variable for repurchasing firms, where the variable takes on a value of 1 if the firm conducted a share repurchase during that day and 0 if otherwise. As shown, *Repurchase* has a mean value of 0.083, meaning that a share repurchase occurred on 8.3% of the 28,097 daily observations. The *Relative Spread* is on average (median) 2.4% (1.7%) with a standard deviation of 2.3%, hinting that there are large variations between the firms. The average *Depth* amounts to 229.677 kSEK with a maximum value of 897.859 kSEK, indicating that there are firms that experience substantially better market *Depth* than the average firm during certain periods. Moreover, *Book to Market* yields an average (median) of 0.529 (0.349), which indicates certain differences in the market's valuation of the companies since the standard deviation also yields a value of 0.568. The large discrepancy in the market's valuation is mainly attributable to real estate companies and financial institutions, which generally have *Book to Market* values much higher than firms operating outside these sectors. The variable *Market Capitalization* yields a mean (median) of 54,846 (15,400), judging by the standard deviation, min, and max, the companies tend to experience large variations in terms of size. Similar to *Market Capitalization,* large differences are observed for the variable *SEK Volume Traded* with a mean value of 73,565 which is more than three times the median value of 22,297. The differences in *SEK Volume Traded* is mainly attributable to the size of the companies, where larger companies generally experience larger trading volumes than smaller companies. Lastly, *Volatility* yields a mean (median) value of 1.022 (1.018), whilst the *Daily Average Price* yields a mean (median) value of 176.921 (131.024).

Table 1: Summary Statistics

Variable	N	Mean	Median	SD	Min	Max
Relative Spread (%)[1,4]	28,097	2.440	1.732	2.302	0.245	13.658
Depth (kSEK)[2]	28,097	223.451	174.338	142.582	66.547	597.860
Repurchase[3]	28,097	0.083	0.000	.277	0.000	1.000
Book to Market[2]	28,097	0.529	0.349	0.568	.018	2.39
Market Capitalization (bSEK)[1]	28,097	54.846	15.400	106.319	930.102	596.632
SEK Volume Traded (mSEK)[1]	28,097	73.565	22.297	124.804	0.273	702.066
Volatility[1]	28,097	1.022	1.018	0.015	1.004	1.088
Average Daily Price[1]	28,097	176.921	131.024	167.018	2.767	932.629

Note: The following variables are included in the table: **Relative Spread:** The stock's ask price minus the bid price, divided by the midpoint. **Depth:** The value of all shares available for trading at the highest and lowest price bounds on the bid and ask sides. **Repurchase:** A dummy variable equal to 1 if a share repurchase has occurred, and 0 otherwise. **Book to Market:** The book value of equity divided by the market value of equity **Market Capitalization:** The market value of equity. **SEK Volume Traded:** The daily transaction value in SEK. **Volatility:** The intraday highest price divided by the intraday lowest price. **Average Daily Price:** The average daily trading price in SEK.

[1] Winsorized at the 1st and 99th percentile

[2] Winsorized at the 5th and 95th percentile

[3] Dummy variable

[4] Multiplied by 1,000

3.8 Pearson's correlation matrix

All variables used in this paper are included in a Pearson's correlation matrix. As seen in Table 2, all variables used in this study are significantly correlated with the independent variable *Repurchase.* Both the *Relative Spread* and *Depth* are significant, with the explanatory variable *Repurchase* at the 1% significance level, indicating that repurchases have a positive impact on liquidity. The results indicate that spreads tend to diminish once a share repurchase is conducted, while *Depth* increases. Moreover, *Relative Spread* is negatively correlated with the variables *Market Capitalization* and *SEK Trading Volume* at the 1% level, indicating that companies with higher *Market Capitalization* and *SEK Trading Volume*, experience narrower *Relative Spread* than smaller companies. This makes economic sense since larger companies often attract more investors, thus increasing the volume traded, reducing the gap between bid and ask prices. The same argument can be said for *Depth,* where the results shows positive coefficients regarding *Market Capitalization* and *SEK Trading Volume.* The highest correlation of 0.988 is observed between *Repurchase* and *Market x Capitalization*, indicating that multicollinearity exists. To further examine the correlation between two variables, Wooldridge (2016) argues that a VIF-test can be conducted. The VIF-test (Appendix 1), shows a VIF-value

of 47.44 for *Repurchase* and 47.04 for *Repurchase x Market Capitalization,* further supporting the presence of multicollinearity. To account for this, *Repurchase* will be dropped as the main independent variable when testing hypothesis 3. After dropping *Repurchase*, the new VIF-value for *Repurchase x Market Capitalization* amounts to 1.10 instead. This will be further discussed in section 6.3. Furthermore, in Pearson's correlation matrix, a correlation of 0.752 is noticed between *Market Capitalization* and *Trading Volume,* which is slightly above the cutoff point of 0.7, where multicollinearity starts to become problematic. The relationship between these variables was however anticipated, since larger firms tend to have higher trading volume due to inflows from mutual funds, pension funds, and institutional investors. Since both variables are considered important to understand the dependent variable, the argument is made to still include the variables. However, the correlation of -0.742 between *SEK Volume Traded* and *Relative Spread*, is not considered problematic since it concerns one of the dependent variables and one control variable. After analyzing the correlation between all variables provided in the table, no variables appear to be problematic, hence no adjustments are made.

Table 2: Pearson's Correlation Matrix

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
(1) Repurchase	1.000										
(2) Relative Spread	-0.067***	1.000									
(3) Depth	0.115***	-0.435***	1.000								
(4) Quantity	0.253***	0.003	0.030***	1.000							
(5) Repurchase x Size	0.423***	0.008	0.046***	0.619***	1.000						
(6) Repurchase x Market Capitalization	0.988***	-0.097***	0.151***	0.248***	0.416***	1.000					
(7) Book to Market	-0.058***	0.114***	-0.085***	-0.014**	-0.026***	-0.068***	1.000				
(8) Market Capitalization	0.111***	-0.630***	0.653***	0.024***	0.043***	0.154***	-0.113***	1.000			
(9) SEK Volume Traded	0.133***	-0.742***	0.556***	0.025***	0.027***	0.164***	-0.083***	0.756***	1.000		
(10) Volatility	-0.014**	0.348***	-0.261***	0.006	0.005	-0.034***	0.025***	-0.275***	-0.011*	1.000	
(11) Average Daily Price	0.062***	-0.292***	0.314***	-0.015***	0.059***	0.076***	-0.133***	0.465***	0.372***	-0.080***	1.000

Note: The following variables are included in the table: **Relative Spread:** The stock's ask price minus the bid price, divided by the midpoint. **Depth:** The value of all shares available for trading at the highest and lowest price bounds on the bid and ask sides. **Repurchase:** A dummy variable equal to 1 if a share repurchase has occurred, and 0 otherwise. **Quantity:** No. of shares repurchased. **Repurchase x Size:** Repurchase times quantity times average daily price. **Repurchase x Market Capitalization:** Repurchase times market capitalization. **Book to Market:** The book value of equity divided by the market value of equity **Market Capitalization:** The market value of equity. **SEK Volume Traded:** The daily transaction value in SEK. **Volatility:** The intraday highest price divided by the intraday lowest price. **Average Daily Price:** The average daily trading price in SEK.

***, **, and * deonte signifiance at 10%, 5% and 1% levels.

4. Methodology

The methodology chapter outlines the econometric methodology used in this study, followed by a description of the robustness check.

4.1 Model description and approach

This paper seeks to examine the relationship between share repurchases and stock liquidity, where the dependent variables consist of *Relative Spread* and *Depth* as the two liquidity measures. *Repurchase* serves as the independent variable in the form of a dummy variable, where it yields a value of 1 on the days the company has bought back shares and 0 if not. Relevant control variables included to test all the hypotheses are *Book to Market, Market Capitalization, SEK Volume Traded, Volatility* and *Average Daily Price.* Furthermore, to test hypotheses 2 and 3, two additional interaction terms are included. Moreover, since panel data is used in this study, hence Pooled Ordinary Least Square is the first step in the multivariate analysis. Going forward, to address omitted variable bias and the issue of heterogeneity, the fixed effects model is employed to assess the consistency of the results. Lastly, as a robustness check, the same models are used on a new dataset to check if the results are robust.

4.2 Univariate test

Similar to Brockman & Chung (2001), a univariate test is conducted to compare the means between observations of two groups, based on whether a share repurchase has been conducted (Table 3). This study will utilize a univariate test in order to determine if there is a significant difference in the chosen variables between repurchasing days and non-repurchasing days. A null hypothesis is formulated and rejected if a significant relationship is found. Like almost all statistical tests, the univariate test comes with a few assumptions, the sample is assumed to be normally distributed and that there is homogeneity of variances across the sample. Moreover, the test shows significant results at the 1% level for the dependent variables *Relative Spread* and *Depth* which are consistent with previous research (Råsbrant & De Ridder, 2013; Hillert et al., 2016; Cook el al., 2004), showing that companies exhibit narrower relative spread and increased depth on repurchasing days compared to non-repurchasing days. On repurchasing days, firms exhibit higher *SEK Volume Traded,* while *Market Capitalization* and *Volatility* is higher on non-repurchasing days. The findings of firms on repurchasing days on average having increased *Depth* and narrowed *Relative Spread* are consistent with the competing

market-maker theory and previous research, showing that share repurchases improves liquidity during times of financial distress.

Table 3: Univariate test

	Non-repurchase day	Repurchase day	Difference	T-statistics (P-value)
Variables	**Mean**	**Mean**	**Mean**	
Relative Spread[1]	2.487	1.927	0.560***	11.299
				.000
Depth (kSEK)	218.517	277.606	-59.089***	-19.344
				.000
Book to Market	.539	.420	.119***	9.746
				.000
Market Capitalization	9.676	10.278	-.602***	-18.701
				.000
SEK Volume Trade	10.750	9.916	-.833***	-22.555
				.000
Volatility	.022	.021	.001**	2.273
				.023
Average Daily Price	173.797	211.211	-37.413***	-10.407
				.000

Note: The following table compares the means of firm characteristics between non-repurchase days and repurchase days. The following variables are included in the table: **Relative Spread:** The stock's ask price minus the bid price, divided by the midpoint. **Depth:** The value of all shares available for trading at the highest and lowest price bounds on the bid and ask sides. **Repurchase:** A dummy variable equal to 1 if a share repurchase has occurred, and 0 otherwise. **Book to Market:** The book value of equity divided by the market value of equity **Market Capitalization (log):** The market value of equity. **SEK Volume Traded (log):** The daily transaction value in SEK. **Volatility (log):** The intraday highest price divided by the intraday lowest price. **Average Daily Price:** The average daily trading price in SEK.

[1] Multiplied by 1000
***, **, and * deonte signifiance at 10%, 5% and 1% levels.

4.3 Pooled OLS

Pooled OLS is a panel data estimation method that pools the data together, ultimately estimating a single OLS regression while ignoring the panel structure of the data, time or individual specific effects. Additionally, POLS assume that individual effects are uncorrelated with the explanatory variables, which is a prerequisite for an efficient and unbiased model. To control for industry effects and monthly effects, dummy variables for each industry and month are created, allowing the intercept to differ across time and industries. Despite controlling for this, the presence of unobserved heterogeneity could lead to inefficient and biased results (Wooldridge, 2016). Moreover, to test for heteroskedasticity in the POLS regression, a White's

test is employed to determine whether the variability of the errors in the POLS regression is constant or not. The White's test yields a p-value of 0.000, indicating the presence of heteroskedasticity in the data (Appendix 2). To deal with the presence of heteroskedasticity, clustered robust standard errors will be used. The POLS equations used to test the hypotheses using the aforementioned control variables and interaction terms are presented in Appendix 3. Moreover, please see section 3 for definitions and motivations of the variables used in the regressions.

4.4 Endogeneity

Various sources might contribute to the problem with endogeneity in the model, including omitted variables and time-invariant unobserved heterogeneity (Wooldridge, 2016). Trying to account for the problem with omitted variables considers carefully choosing control variables in hopes of including as many factors as possible that might have an impact on the dependent variables, in this case *Relative Spread* and *Depth.* This while simultaneously trying to control for variables that might correlate with other independent variables. Control variables are therefore chosen in accordance with previous research (Hillert et al., 2016; Brockman & Chung, 2001; Ginglinger & Hamon, 2007; De Cesari et al., 2011; Råsbrant & De Ridder, 2013) following an extensive review of existing literature, despite this, omitted variables cannot be ruled out. Time-invariant unobserved heterogeneity can lead to inefficient estimates of coefficients and misspecification of the model, ultimately yielding unreliable and biased results. In order to address the problem, the authors chose to employ the fixed effects model thereby reducing the influence of unobserved variables that are static over time and allow the model to include firm-specific effects that potentially capture unobserved heterogeneity.

4.5 Fixed effect

According to Wooldridge (2016), when employing a POLS regression, unobserved heterogeneity could impact the dependent variable, skewing the results and produce biased estimations. To address this problem, it is necessary to estimate the models using fixed effects (FE) or random effects (RE). To decide whether to employ FE or RE, a commonly used method is the Hausman test (Wooldridge, 2016). The Hausman test is conducted for both the dependent variables, yielding significant results at the 1% level, indicating no systematic difference in the coefficients (Appendix 4). If the yielded p-value is lower than the significance level of 0.05,

the fixed effects model is the preferred one. Therefore, the null hypothesis is rejected, and FE is employed. The models specified below are used.

FE Model 1 - Hypothesis 1

$$LIQ_{i,t} = \alpha + \beta_1 REP_{i,t} + \beta_2 BTM_{i,t} + \beta_3 MCAP_{i,t} + \beta_4 VOLUME_{i,t} + \beta_5 VOLATILITY_{i,t} + \beta_6 PRICE_{i,t} + \beta_7 MONTH_t + \beta_8 INDUSTRY_{i,t} + \varepsilon_{i,t}$$

FE Model 2 - Hypothesis 2

$$LIQ_{i,t} = \alpha + \beta_1 REP_{i,t} + \beta_2 QUANTITY_{i,t} + \beta_3 BTM_{i,t} + \beta_4 MCAP_{i,t} + \beta_5 VOLUME_{i,t} + \beta_6 VOLATILITY_{i,t} + \beta_7 PRICE_{i,t} + \beta_8 MONTH_t + \beta_9 INDUSTRY_{i,t} + \varepsilon_{i,t}$$

FE Model 3 - Hypothesis 2

$$LIQ_{i,t} = \alpha + \beta_1 REP_{i,t} + \beta_2 QUANTITY_{i,t} + \beta_3 REPxSIZE_{i,t} + \beta_4 BTM_{i,t} + \beta_5 MCAP_{i,t} + \beta_6 VOLUME_{i,t} + \beta_7 VOLATILITY_{i,t} + \beta_8 PRICE_{i,t} + \beta_9 MONTH_t + \beta_{10} INDUSTRY_{i,t} + \varepsilon_{i,t}$$

FE Model 4 - Hypothesis 3

$$LIQ_{i,t} = \alpha + \beta_1 REPxMCAP_{i,t} + \beta_2 BTM_{i,t} + \beta_3 MCAP_{i,t} + \beta_4 VOLUME_{i,t} + \beta_5 VOLATILITY_{i,t} + \beta_6 PRICE_{i,t} + \beta_7 MONTH_t + \beta_8 INDUSTRY_{i,t} + \varepsilon_{i,t}$$

4.6 Robustness test

To test the robustness of the results, the used models has been employed on a new dataset for a different time period (Catherine, Ebrahimian, Sraer & Thesmar, 2022). This to use the same model on a new population and re-estimate the FE regressions to see if the results remain significant. The last market distress event before Covid-19 was the financial crisis of 2008-2009. Unable to gather data from the financial crisis due to lack of data availability in the Swedish House of Finance's database, data from a four-month period between May 1, 2011, and September 1, 2011, is collected (Nasdaq HFT, 2024). The time period is chosen since the Stockholm Stock Exchange experienced a drop of around 23% which makes this period considered as financially turbulent. The data management and selection process follow the same path as described in section 3.1 This new dataset amounts to 1,881 days in total, with share repurchase conducted on 380 of those.

5. Results

This chapter aims to present the regression results for hypotheses 1,2 and 3 as well as the results from the robustness check.

5.1 Hypothesis testing: Hypothesis 1

With the limitation of the POLS model in mind, which fails to account for heterogeneity, the results produced using this model cannot be seen as reliable. Arguments in favor of using the FE model are convincing and showcased by the tests in Appendix 4. As determined by the arguments, the FE model is the appropriate model to use in order to account for unobserved heterogeneity and individual firm-specific effects. As a result of this, FE Model 1 is chosen as the best suited model for examining hypothesis *H1*. Separate regressions have been executed in order to examine the relationship for each of the dependent variables, *Relative Spread* and *Depth.* In respect to the control variables, *SEK Volume Traded* and *Volatility* remain significant at the 1% level throughout all the regressions while *Average Daily Price* shows no significance. *SEK Volume Traded* indicates a negative relationship with *Relative Spread* as the dependent variable and a positive relationship with *Depth* as the dependent one, significant at the 1% level. The results suggest that higher traded volume leads to a decrease in the *Relative Spread* and an increase in market *Depth* which makes economic sense, since higher trading volume often indicates more awareness and interest in the stock. *Book to Market* and *Market Capitalization* show statistical significance in the regressions with *Relative Spread* as the dependent variable where the direction of the coefficient is negative, indicating that larger companies and lower valued companies experience a lower *Relative Spread*. *Book to Market* exhibits significance at the 5% level, while *Market Capitalization* exhibits significance at the 1% level. As seen from the regressions results (Table 4), where *Depth* is the dependent variable, *Book to Market* and *Market Capitalization* showcases no statistical significance.

H1*: Share repurchases increase stock liquidity on repurchasing days compared to non-repurchasing days during Covid-19*

Looking at the results, in FE regression 1 (Table 4), *Relative Spread* yields a positive coefficient of 0.274 significant at the 1% level. This implies an increase of 0.000274 percentage points in *Relative Spread* following a share repurchase, since it is multiplied by 1,000, leading

to rejection of hypothesis *H1*: "*Share repurchases increase stock liquidity on repurchasing days compared to non-repurchasing days during Covid-19*".

In respect to *Depth*, the positive coefficient of 16.751, significant at the 5% level in FE regression 2 (Table 4), indicates that there is an increase in market *Depth* of 16,751 SEK each day there is a repurchase since *Depth* is expressed in thousands. In contrast to the increase in *Relative Spread* in regression 1 (Table 4), the increase in *Depth* following a repurchase indicates an improvement in liquidity, thus supporting hypothesis *H1*: "*Share repurchases increase stock liquidity on repurchasing days compared to non-repurchasing days during Covid-19*". Overall, since both dependent variables showcase different effects on liquidity, the results only partly support hypothesis *H1*.

5.2 Hypothesis testing: Hypothesis 2

In order to examine hypothesis *H2*, an interactive variable has been added, *Repurchase x Size.* Prior to integrating the interactive variable, *Quantity* has been added as an additional control variable and regressed against both the dependent variables in separate regressions. The *Quantity* is the number of shares repurchased, when the dummy variable, *Repurchase,* yields a value of 1, scaled by divided by 1 million. *Quantity* has been added with the purpose of serving as one of the inputs in the interactive variable. *Repurchases x Size* consists of the *Quantity* times *Average Daily Price* times *Repurchase,* which is the total SEK amount of the repurchase that day. The control variables exhibit the same significance levels and directions of the coefficients as seen in FE regressions 1 and 2.

H2: *During Covid-19, firms conducting larger share repurchases exhibited increased stock liquidity on repurchasing days compared to non-repurchasing days*

FE regression 5 (Table 4) yields a positive coefficient for the interactive variable *Repurchase x Size*, although no significance is recorded. Interpreting the results, larger repurchases do not appear to have a significant impact on liquidity compared to smaller repurchases in the aspect of decreasing the *Relative Spread*. In respect to hypothesis *H2*: the results yield a different effect than anticipated. Although, with the moderating effect of the interactive variable, *Repurchase* in regards to *Relative Spread* still yields a significant relationship, although now significant at the 5% level, hinting that there is a moderating effect of repurchasing size on the relationship between *Repurchase* and *Relative Spread*. Interpreted from the results, Hypothesis

H2: "*During Covid-19, firms conducting larger share repurchases exhibited increased stock liquidity on repurchasing days compared to non-repurchasing days*" is therefore not found to be in support.

The results for *Depth* as the dependent variable are shown by FE regression 6 in Table 4, the interactive variable yields a positive coefficient, however no significance is determined. Interpreting from the result, the relationship between an increase in *Depth* as a mean of larger repurchases cannot therefore be determined. *Repurchase* is still significant although at the 10% level, hinting of a moderating effect of *Repurchase x Size.* With insignificant results for the interactive variable regarding both the dependent variables, *Relative Spread* and *Depth*, the hypothesis "*During Covid-19, firms conducting larger share repurchases exhibited increased stock liquidity on repurchasing days compared to non-repurchasing days*" is therefore rejected.

5.3 Hypothesis testing: Hypothesis 3

To test hypothesis *H3*, the interaction variable *Repurchase x Market Capitalization* is added to regression 7 and 8. As previously mentioned in section 3.8, the variable *Repurchase x Market Capitalization* is highly correlated with the variable *Repurchase*, creating problems with multicollinearity. To address this, *Repurchase* is dropped when testing hypothesis *H3*. Thus, *Repurchase x Market Capitalization* serves as the independent variable in FE regression 7 and 8 (Table 4). Looking at the control variables, the same significance levels and directions of the coefficients are observed as for the previous hypothesis tests.

H3: *During Covid-19, smaller companies experienced greater stock liquidity from share repurchases than larger companies*

In FE regression 7 with *Relative Spread* as the dependent variable, *Repurchase x Market Capitalization* yields a positive coefficient of 0.027, significant at the 1% level. Since *Relative Spread* is scaled up by a factor of 1,000, for every 10% increase in *Repurchase x Market Capitalization, Relative Spread* is expected to increase by 0.00027 percentage points. This implies that larger firms on average exhibit a larger increase in the *Relative Spread* in comparison to smaller companies following a share repurchase. Since the increase in *Relative Spread* is less pronounced in smaller companies, the result is in support of Hypothesis *H3*:

"*During Covid-19, smaller companies experienced greater stock liquidity from share repurchases than larger companies*"

The results in FE regression 8 also present a positive coefficient of 1.956 for the interaction term *Repurchase x Market Capitalization*, significant at the 5% level. Since *Depth,* the dependent variable, is expressed in kSEK, this suggests that larger firms expect a 19,560 SEK increase in *Depth* when *Repurchase x Market Capitalization* increases by 10%. Judging from the coefficient of market *Depth*, Hypothesis *H3* is thereby successfully rejected. As the study's initial expectation was that smaller companies experience greater liquidity following a share repurchase, the results overall somewhat align with the initial expectation, and therefore partially support Hypothesis *H3*.

Table 4: FE Regressions

Regression	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Model	**FE**	**FE**	**FE**	**FE**	**FE**	**FE**	**FE**	**FE**
Dependent Variable	**Relative Spread**	**Depth**	**Relative Spread**	**Depth**	**Relative Spread**	**Depth**	**Relative Spread**	**Depth**
Repurchase	0.274***	16.751**	0.266***	16.570**	0.254**	13.982*		
	(0.092)	(8.093)	(0.096)	(7.872)	(0.105)	(8.210)		
Quantity			0.055	1.363	0.012	-7.649		
			(0.059)	(8.588)	(0.057)	(4.677)		
Repurchase x Size					0.001	0.205		
					(0.001)	(0.131)		
Repurchase x Market Capitalization							0.027***	1.956**
							(0.008)	(0.855)
Book to Market	-0.824**	-13.539	-0.823**	-13.519	-0.825**	-13.859	-0.829**	-13.832
	(0.394)	(19.743)	(0.393)	(19.765)	(0.393)	(19.673)	(0.393)	(19.598)
Market Capitalization	-1.072***	23.148	-1.072***	23.142	-1.072***	23.309	-1.077***	22.726
	(0.355)	(19.535)	(0.355)	(19.554)	(0.356)	(19.571)	(0.355)	(19.469)
SEK Volume Traded	-0.762***	40.708***	-0.762***	40.704***	-0.762***	40.723***	-0.761***	40.737***
	(0.070)	(6.136)	(0.070)	(6.146)	(0.070)	(6.134)	(0.070)	(6.131)
Volatility	28.324***	-1,136.979***	28.329***	-1,136.858***	28.312***	-1,140.427***	28.322***	-1,137.590***
	(2.820)	(164.848)	(2.822)	(164.967)	(2.823)	(165.526)	(2.820)	(164.897)
Daily Average Price	0.001	-0.087	0.001	-0.087	0.001	-0.088	0.001	-0.086
	(0.001)	(0.055)	(0.001)	(0.055)	(0.001)	(0.055)	(0.001)	(0.054)
Constant	19.947***	-374.239*	19.949***	-374.187*	19.942***	-375.807*	19.984***	-371.385*
	(3.733)	(214.884)	(3.735)	(215.101)	(3.737)	(215.090)	(3.736)	(214.907)
Monthly effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	No	No	No	No	No	No	No	No
Firm fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28,097	28,097	28,097	28,097	28,097	28,097	28,097	28,097
Number of firms	70	70	70	70	70	70	70	70
F-statistic	23.52	10.98	22.86	12.14	21.56	12.34	23.66	11.88
Adjusted R-squared	0.400	0.164	0.400	0.164	0.400	0.164	0.400	0.165

Note: This regression table outputs the regression results based on the fixed effect model. The independent variable is **Repurchase** in regression 1-6. In regression 7-8, the interaction term **Repurchase x Market Capitalization** serve as the independent variable. In regression 1 and 2, **Repurchase** is regressed against the dependent variables. In regression 3 and 4, **Quantity** is added as an additional control variable. Regression 5 and 6 output the results after the interaction term **Repurchase x Size** is introduced. Lastly, regression 7 and 8 output the results with the interaction term **Repurchase x Market Capitalization** as the independent variable. The following variables are included in the table: **Relative Spread:** The stock's ask price minus the bid price, divided by the midpoint. **Depth:** The value of all shares available for trading at the highest and lowest price bounds on the bid and ask sides. **Repurchase:** A dummy variable equal to 1 if a share repurchase has occurred, and 0 otherwise. **Quantity:** No. of shares repurchased. **Repurchase x Size:** Repurchase times quantity times average daily price. **Repurchase x Market Capitalization:** Repurchase times market capitalization. **Book to Market:** The book value of equity divided by the market value of equity **Market Capitalization (log):** The market value of equity. **SEK Volume Traded (log):** The daily transaction value in SEK. **Volatility (log):** The intraday highest price divided by the intraday lowest price. **Average Daily Price:** The average daily trading price in SEK.

Clustered robust standard errors in parentheses
***, **, and * deonte signifiance at 10%, 5% and 1% levels.

5.4 Robustness results

As shown by Table 5, as a robustness check, the same model has been applied to a different data set and time period to examine the robustness of the results. For the variable *Repurchase* in respect to the dependent variable *Relative Spread,* the direction of the coefficients are altered in some of the regressions. Since the results regarding *Relative Spread* are partly showing opposite effects on liquidity but without any significance, the results regarding *Relative Spread* need to be handled with care and cannot be considered robust. Why the differences regarding the variable *Relative Spread* can only be speculated upon. Omitted variables in the different data sets or changes in investor behavior, are potential reasons. With increased information availability and the ease of transacting in the marketplace without brokers, investor attention, awareness and perceptions might have changed as the financial industry and market have developed further. Also, since more trades today are executed by computers and AI today, it is reasonable to assume that the rational investor is not the same today as it once was. The output in Table 5 showcases that the relationship between *Repurchase* and *Depth* still holds across all the robustness regressions with *Depth* as the dependent variable, although the coefficients are slightly higher. Since the results portray the same relationship between the different time periods, it adds to the robustness of the relationship that share repurchase increases liquidity in terms of market *Depth*. The results regarding *Depth* are therefore considered to be more reliable and robust.

Table 5: Robustness Regressions

Regression Model	**1 Fixed Effect**	**2 Fixed Effect**	**3 Fixed Effect**	**4 Fixed Effect**	**5 Fixed Effect**	**6 Fixed Effect**	**7 Fixed Effect**	**8 Fixed Effect**
Dependent Variable	**Relative Spread**	**Depth**	**Relative Spread**	**Depth**	**Relative Spread**	**Depth**	**Relative Spread**	**Depth**
Repurchase	-0.548	36.131***	0.842	37.041**	0.423	36.640**		
	(3.085)	(11.803)	(3.611)	(14.192)	(3.526)	(14.365)		
Quantity			-13.232*	-8.668	-33.094***	-27.709		
			(7.712)	(40.558)	(6.706)	(26.366)		
Repurchase x Size					0.197***	0.190		
					(0.056)	(0.281)		
Repurchase x Market Capitalization							-0.042	4.165***
							(0.315)	(1.298)
Book to Market	-6.730	68.160	-5.349	69.065	-3.514	70.824	-6.641	64.769
	(22.522)	(58.800)	(22.478)	(60.091)	(21.924)	(58.996)	(22.399)	(59.016)
Market Capitalization	-60.159**	516.747*	-59.069**	517.462*	-60.035**	516.535*	-59.972**	509.760*
	(22.975)	(275.757)	(22.469)	(276.504)	(22.505)	(277.014)	(22.854)	(278.231)
SEK Volume Traded	4.297***	6.223	4.253***	6.195	4.198***	6.142	4.286***	6.547
	(1.354)	(7.183)	(1.359)	(7.196)	(1.341)	(7.214)	(1.343)	(7.142)
Volatility	-19.979	-119.923	-17.398	-118.232	-18.695	-119.475	-19.842	-125.152
	(35.635)	(116.888)	(36.023)	(119.425)	(36.005)	(119.989)	(35.464)	(117.630)
Daily Average Price	-0.027	-0.012	-0.030	-0.013	-0.035	-0.019	-0.028	-0.023
	(0.143)	(1.036)	(0.139)	(1.038)	(0.140)	(1.034)	(0.142)	(1.052)
Monthly effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	No	No	No	No	No	No	No	No
Firm fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	529.706**	-4,505.962*	519.586**	-4,512.592*	527.221**	-4,505.273*	528.148**	-4,445.551*
	(203.240)	(2,362.116)	(198.766)	(2,369.103)	(198.350)	(2,373.005)	(202.035)	(2,383.504)
Observations	1,881	1,881	1,881	1,881	1,881	1,881	1,881	1,881
Number of firms	24	24	24	24	24	24	24	24
F-statistic	9.36	8.59	9.26	7.66	17.55	9.33	9.37	9.45
Adjusted R-squared	0.197	0.063	0.198	0.062	0.199	0.062	0.197	0.063

Note: This regression table outputs the regression results based on the fixed effect model on a new dataset. The independent variable is **Repurchase** in regression 1-6. In regression 7-8, the interaction term **Repurchase x Market Capitalization** serve as the independent variable. In regression 1 and 2, **Repurchase** is regressed against the dependent variables. In regression 3 and 4, **Quantity** is added as an additional control variable. Regression 5 and 6 output the results after the interaction term **Repurchase x Size** is introduced. Lastly, regression 7 and 8 output the results with the interaction term **Repurchase x Market Capitalization** as the independent variable. The following variables are included in the table: **Relative Spread:** The stock's ask price minus the bid price, divided by the midpoint. **Depth:** The value of all shares available for trading at the highest and lowest price bounds on the bid and ask sides. **Repurchase:** A dummy variable equal to 1 if a share repurchase has occurred, and 0 otherwise. **Quantity:** No. of shares repurchased. **Repurchase x Size:** Repurchase times quantity times average daily price. **Repurchase x Market Capitalization:** Repurchase times market capitalization. **Book to Market:** The book value of equity divided by the market value of equity **Market Capitalization (log):** The market value of equity. **SEK Volume Traded (log):** The daily transaction value in SEK. **Volatility (log):** The intraday highest price divided by the intraday lowest price. **Average Daily Price:** The average daily trading price in SEK.

Clustered robust standard errors in parentheses
***, **, and * deonte signifiance at 10%, 5% and 1% levels.

6. Analysis

This section aims to analyze the findings in the light of previously presented theories and empirical literature.

6.1 The impact of share repurchases on stock liquidity

The main purpose of this paper is to examine whether companies can increase their liquidity through share repurchases during times of market distress. Both the POLS and FE regression models yielded significant results, indicating a relationship between share repurchases and liquidity. The results from POLS regressions 1 and 2 (Appendix 5) examining hypothesis 1 reveal contradictory directions of the coefficients, indicating that repurchasing companies enjoy both an increase in *Relative Spread* and an increase in *Depth* on the day of repurchase. When taking unobserved heterogeneity into account, as suggested by the Hausman test (Appendix 3), our findings remain significant using the FE models.

The positive coefficient for *Repurchase* in relation to *Relative Spread* is significant at the 1% level, leading to the rejection of hypothesis *H1*, as we can statistically show that on the day of repurchase, *Relative Spread* tends to increase. These results are contradictory to our initial expectation as presented by Hypothesis *H1*, which proposes that the *Relative Spread* should decrease following a share repurchases. These results instead align with earlier research, which found a positive relationship between *Relative Spread* and *Repurchase* leading to worsening market liquidity (Barclay & Smith, 1988; Brockman & Chung, 2001; Ginglinger & Hamon, 2007), which is supported by the information asymmetry theory. As discussed by Brockman & Chung (2001) this positive relationship can potentially be explained by adverse selection, where the company is viewed as the better-informed part, leading to investors becoming more hesitant to trade the stock because management is better informed regarding the company's internal health and future projects, leading to a wider *Relative Spread*. Additionally, the increase in *Relative Spread* shown by FE regression 1 counters the findings from De Cesari et al. (2011) and Hillert et al. (2016), who stated that share repurchases diminish the relative spread, which is in line with our expectations but contrary to our findings. One major distinction between this paper and previous studies by De Cesari et al. (2011) and Hillert et al. (2016) is the preciseness of the data used. In accordance with Brockman & Chung (2001) and Ginglinger & Hamon (2007), this paper has used intraday data, whereas De Cesari et al. (2011) and Hillert et al. (2016) have used either monthly or yearly data, potentially skewing the results.

Using more precise data, such as intraday data in this paper, we observe a negative relationship between share repurchases and *Relative Spread*.

However, contrary to the results regarding *Relative Spread* and in line with previous research (Eberhart & Siddique, 2004; Franz et al., 1995; Råsbrant & De Ridder, 2013), FE regression 2 yields a positive coefficient for *Repurchase*, indicating that repurchases have a positive impact on liquidity in terms of *Depth,* consistent with our expectations. This can be due to various reasons. Franz et al. (1995) suggested that more intense trading activities from companies increase the number of active investors, thus increasing the liquidity of the stock. This argument aligns with the competing market-maker theory, meaning that share repurchases at a fixed price increase the competitiveness of the market, leading to increased liquidity. Moreover, the financial market suffered from high uncertainty during the Covid-19 crisis, with low market depth and high volatility (Enow, 2023). Thus, introducing a market maker during times of high uncertainty should increase the *Depth*. This makes economic sense because, when introducing a market maker during times of high volatility, it increases competition on the bid side, thereby enhancing overall market depth. In accordance with Franz et al. (1995), the result can be interpreted as companies conducting share repurchases are able to convey certain stability to investors in terms of the company's future performance, thereby stabilizing price action and trading activity. This makes economic sense since uncertainty is heightened during market distress, information regarding management's limited need for cash retention could potentially provide the investor with certain confidence that the company is counting on being able to withstand the market turmoil.

6.2 Size of Share Repurchases and Stock Liquidity during Covid-19

Using the interactive variable *Repurchase x Size* to examine hypothesis 2, the relationship between the size of the repurchase and its effect on liquidity yields contradictory results compared to what was initially anticipated. Judging from the results in FE regression 5 (Table 4), there seems to be no link between the sheer size of the repurchase and *Relative Spread*. However, when examining the variable *Repurchase*, it seems like repurchase has a negative effect on *Relative Spread* (FE regression 5), but a positive effect on *Depth* (FE regression 6), even when considering the moderating effect of repurchase size. Since the *Relative Spread* and *Depth* measure different aspects of liquidity, the results make economic sense. According to Fruin & Ma (2014), larger share repurchases are found to generate higher abnormal returns,

which increases interest and awareness in the stock, ultimately increasing the number of shareholders. The increased shareholder base is expected to improve liquidity, as proposed by Amihud et al. (1999). However, since the coefficient for *Repurchase x Size* shows no significance for either *Relative Spread* or *Depth,* the findings do not support the link as proposed by Amihud et al. (1999). The results are contradictory to our initial expectations, leading to the rejection of Hypothesis *H2*. Various reasons might affect the relationship, but part of the differences could potentially be explained by the differences in the study's settings. Investor behavior might have changed as a byproduct of another macroenvironment than usual, where cohorts of people behave differently than expected. The effect might be different when stocks surge upwards compared to when they decline, aligning with the observation that the interest for the stock market tends to decline with a negative market sentiment (Enow, 2023).

Further analysis of the results interpreted through the lens of competing market-maker theory, larger repurchase size should potentially have introduced a stronger and more competitive market-maker into the market, thus increasing the competition. The heightened competition, as hypothesized, should have further lowered the transaction cost. Although Brockman and Chung (2001) found that the relative spread increased following a repurchase, they also observed a deterioration in market depth during repurchase days, something this study did not find. The difference in the results might depend on the moderating effect the interactive variable *Repurchase x Size* has on the relationship between repurchases and liquidity, although this seems unlikely, since *Depth* still had a positive coefficient in the regressions that were significant without the interactive variable. Despite the lack of significance for the interactive variable, *Depth* still increased following a repurchase, even when considering the moderating effect of the repurchase size. The absence of significance for the interactive variable could potentially have to do with reverse causality. Companies with already high liquidity might be more inclined to pursue larger share repurchases, giving the impression that the repurchase itself is what is driving the increase in liquidity.

One potential explanation for the non-significant relationship between *Repurchase x Size* and the dependent variables could also be due to a nonlinear relationship between the two variables. It is possible that companies might have to conduct share repurchases above certain thresholds in order for it to have a significant impact on market liquidity. Since many skeptics advocated for a cancellation of dividends and share repurchases during Covid-19, it is possible that companies still engaging in sizable share repurchases did so to a lesser extent compared to

during normal market conditions, thereby the effect is less prominent. Although Fruin & Ma (2014) was able to find increases in abnormal returns following larger share repurchases, and Amihud et al. (1999) that abnormal returns increased the interest and awareness for the stock, the results reveal a different story as mentioned above. It is possible that instead of conveying strong performance, investors can be skeptical when companies conduct larger share repurchases, thinking the company has reached a mature state with little to no profitable investment opportunities going forward. Meaning that investors are afraid of companies prioritizing short-term earnings over long-term growth, leading to investors seeking sustainable growth elsewhere. Moreover, it is also worth highlighting the impact of market distress. The rapid decline in the stock market during Covid-19 (Enow, 2023; Gofran et al., 2022), potentially led investors to perceive large share repurchases as a misuse of financial resources which instead should have been conserved to navigate the uncertain financial landscape, resulting in investors rather investing their money elsewhere. Although these potential explanations shed light on the non-significance of the interaction variable, *Depth* still increased following a share repurchase, even when considering the moderating effect of repurchase size.

6.3 Share Repurchase Impact on Stock Liquidity by Company Size during Covid-19

Looking at the significant results from FE regressions 7 and 8, it is shown that firm size has an impact on both liquidity measures in relation to repurchases. In respect to hypothesis 3, *Relative Spread* increases more for larger companies, thus indicating that smaller firms are less impacted by a share repurchase in terms of increasing the *Relative Spread*. Although the negative effect is of less magnitude for smaller firms, repurchases have an overall negative impact on *Relative Spread.* Since smaller companies are less impacted, this goes in line with our initial expectation. As proposed by the results, one can argue that it is easier for large firms to trade on private information compared to smaller firms due to the many shares and high volume traded, making it harder for regulatory bodies to identify insider trading. This is supported by the information asymmetry theory, which states that the presence of better-informed traders increases the adverse selection (Ginglinger & Hamon, 2007), making investors prone to include an adverse selection cost into the relative spread in order to cover their expected loss to the better-informed part.

Contrary to our expectations, *Depth* increases more for larger companies, as interpreted from the interactive variable *Repurchase x Size's* positive coefficient. As interpreted from the results, even if the sell pressure is generally higher for smaller companies in times of market distress (Biermann, 2023), repurchases in smaller companies are not able to convey stability and confidence to a greater magnitude than in larger companies as anticipated. Instead, the heightened uncertainty seems to be the aspect that drives investors to shift their risk, where share repurchases in smaller companies are unable to calm investor concerns. When uncertainty is heightened, it is reasonable to assume that larger companies gain more interest from investors due to their financial stability and attractiveness as a less risky investment. Furthermore, it is rational to assume that larger firms have a larger cash pile compared to smaller ones, making it easier and more efficient for larger firms to conduct share repurchases during times of market distress. The results align with the competing market-maker theory: when managers thereby submit limit buy orders during periods of market distress, market depth tends to increase (Barclay & Smith, 1988). Although, the effect was anticipated to be greater in smaller companies, the results still align with the theory. Moreover, within the framework of the information asymmetry theory, it is also rational to assume that larger companies benefit from broader coverage from the media and analysts, thus mitigating the information disparity (Franz el al., 1995). Brockman & Chung (2001) use firm size as a proxy for how good companies disclose information, meaning that larger firm size often equals greater disclosure. During times of heightened uncertainty, communication between companies and investors are essential for companies to retain trust from investors. It is rational to assume that larger companies have access to a broader range of information channels to uphold investor confidence and thereby achieve greater market depth from share repurchases than smaller companies.

7. Conclusion

Prior research in this area has yielded conflicting results. The highly precise data available for the Swedish market creates a unique opportunity to precisely analyze the impact of share repurchases on stock liquidity during periods of market distress. To address the problem of unobserved heterogeneity and endogeneity, clustered, robust fixed effect models have been employed. We find that, on average, share repurchases during Covid-19 increased the market depth, as well as the relative spread. When controlling for the size of the repurchase, we find no evidence that the size of the share repurchase has any significant impact on liquidity. Lastly, our study suggests that, on average, larger companies experience greater market depth following a share repurchase compared to smaller companies. In contrast, larger companies also enjoy a wider relative spread compared to smaller companies. Our findings regarding depth remain intact after test for robustness, adding further strength to the results, while the results for relative spread lost some of their significance.

Various parties may benefit and make use of the findings in this study, including, managements, investors, and researchers. Since we are able to conclude that market depth increases following share repurchases, the findings support share repurchases as a way for management to uphold quote sizes in times of market distress, thereby providing liquidity to the stock. Although repurchases provide liquidity support, this action comes at a small cost in terms of increasing the stock's relative spread. Management will ultimately face a tradeoff in deciding what to prioritize. Since we are able to show that market depth increases as well as the relative spread following a share repurchase, investors would make use of this study in the sense that it provides them with a clearer picture of how to view share repurchases in times of market distress. This will allow investors to make more rational decisions and give insights on how trading conditions might be impacted following a repurchase. This study contributes to the scientific community by examining the phenomenon of share repurchases in respect to liquidity during abnormal market conditions. As of our knowledge, this area has not been researched previously, and therefore opens up the possibility of not just expanding the theoretical framework, but also the practical implications in the context of academia.

For future research, it would be of interest to extend the time period to capture different types of market conditions and examine how liquidity differs between them and potentially examining the similarities and differences of liquidity during different market conditions.

Additionally, further research could also investigate entire share buyback periods rather than solely focusing on the days when buybacks occurred. By doing so, it would be possible to analyze liquidity before, during, and after buybacks, thereby facilitating a clearer assessment of whether the competing market-maker theory and information asymmetry theory holds. In addition to this, the design of the interaction term *Repurchase x Size* can be further developed. This study has expressed the variable in absolute terms and not in relation to the total amount traded during the same day. Expanding the research further, an alternative would be to include both absolute and relative terms to better capture the overall picture of repurchase size effect on liquidity. Furthermore, the choices of liquidity measures open up the possibility for examining other measures and further develop the interactive variables.

With the exclusion of various liquidity measures, there is a risk that there are better suited measures for the dataset in order to capture the effect that share repurchases have on liquidity. Although the chosen liquidity measures have been chosen carefully and with the purpose of capturing various aspects of liquidity, they may not be the best suited ones. Further, due to the design of the study and use of intraday data, metrics and measures reported quarterly limit the inclusion of accounting variables, ultimately increasing the risk of omitted variables affecting the results. Although steps were taken with respect to endogeneity issues such as carefully choosing control variables and the implementation of the fixed effect model, the concern still persists. It is acknowledged with humility that the chosen approaches might have had limited effect on addressing endogeneity. Also, with the potential risk of reverse causality or simultaneity there might have been further steps that could have been taken in order to further control for the potential problems.

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Appendices

Appendix 1 – VIF Test

Variables	VIF	1/VIF
Repurchase	47.44	0.021077
Repurchase x Market Capitalization	47.04	0.021260
Market Capitalization	3.30	0.302661
SEK Volume Traded	2.63	0.379955
Average Daily Price	1.33	0.749349
Volatility	1.21	0.827620
Book to Market	1.08	0.922924
Quantity	1.07	0.934445

Variables	VIF	1/VIF
Market Capitalization	3.21	0.311179
SEK Volume Traded	2.63	0.379970
Average Daily Price	1.33	0.750541
Volatility	1.20	0.830042
Repurchase x Market Capitalization	1.10	0.911392
Book to Market	1.08	0.922977
Quantity	1.07	0.937148

Appendix 2 - White test

White test	H0	P-value	Decision
Relative Spread	Homoskedasticity	0,000	Reject
Depth	Homoskedasticity	0,000	Reject

Appendix 3 – POLS Models

Equation 1

$$LIQ_{i,t} = \beta_0 + \beta_1 REP_{i,t} + \beta_2 BTM_{i,t} + \beta_3 MCAP_{i,t} + \beta_4 VOLUME_{i,t} + \beta_5 VOLATILITY_{i,t} + \beta_6 PRICE_{i,t} + \beta_7 MONTH_t + \beta_8 INDUSTRY_{i,t} + \mu_{i,t}$$

Equation 2

$$LIQ_{i,t} = \beta_0 + \beta_1 REP_{i,t} + \beta_2 QUANTITY_{i,t} + \beta_3 BTM_{i,t} + \beta_4 MCAP_{i,t} + \beta_5 VOLUME_{i,t} + \beta_6 VOLATILITY_{i,t} + \beta_7 PRICE_{i,t} + \beta_8 MONTH_t + \beta_9 INDUSTRY_{i,t} + \mu_{i,t}$$

Equation 3

$$LIQ_{i,t} = \beta_0 + \beta_1 REP_{i,t} + \beta_2 QUANTITY_{i,t} + \beta_3 REPxSIZE_{i,t} + \beta_4 BTM_{i,t} + \beta_5 MCAP_{i,t} + \beta_6 VOLUME_{i,t} + \beta_7 VOLATILITY_{i,t} + \beta_8 PRICE_{i,t} + \beta_9 MONTH_t + \beta_{10} INDUSTRY_{i,t} + \mu_{i,t}$$

Equation 4

$$LIQ_{i,t} = \beta_0 + \beta_1 REPxMCAP_{i,t} + \beta_2 BTM_{i,t} + \beta_3 MCAP_{i,t} + \beta_4 VOLUME_{i,t} + \beta_5 VOLATILITY_{i,t} + \beta_6 PRICE_{i,t} + \beta_7 MONTH_t + \beta_8 INDUSTRY_{i,t} + \mu_{i,t}$$

Appendix 4 – Hausmann Test

Hausman Test	H0	P-value
Relative Spread	Difference in coefficients not systematic	0,000
Depth	Difference in coefficients not systematic	0,006

Appendix 5 – POLS Regressions

Regression Model Dependent Variable	1 POLS Relative Spread	2 POLS Depth	3 POLS Relative Spread	4 POLS Depth	5 POLS Relative Spread	6 POLS Depth	7 POLS Relative Spread	8 POLS Depth
Repurchase	0.423***	24.983*	0.406***	24.395*	0.394**	24.823		
	(0.145)	(13.560)	(0.153)	(14.003)	(0.177)	(15.127)		
Quantity			0.131	4.617	0.082	6.238		
			(0.121)	(9.648)	(0.094)	(9.084)		
Repurchase x Size					0.001	-0.035		
					(0.003)	(0.233)		
Repurchase x Market Capitalization							0.040***	2.815**
							(0.013)	(1.365)
Book to Market	0.197	15.798	0.198	15.822	0.197	15.831	0.198	15.930
	(0.145)	(11.714)	(0.145)	(11.708)	(0.145)	(11.728)	(0.146)	(11.722)
Market Capitalization	-0.072	47.221***	-0.072	47.228***	-0.072	47.223***	-0.076	47.005***
	(0.137)	(13.109)	(0.137)	(13.108)	(0.137)	(13.097)	(0.137)	(13.121)
SEK Volume Traded	-1.010***	15.788	-1.010***	15.786	-1.009***	15.777	-1.010***	15.658
	(0.123)	(10.066)	(0.123)	(10.067)	(0.123)	(10.084)	(0.123)	(10.060)
Volatility	42.334***	-899.508***	42.333***	-899.544***	42.318***	-899.043***	42.369***	-896.010***
	(4.353)	(209.866)	(4.362)	(209.927)	(4.389)	(209.987)	(4.358)	(209.214)
Daily Average Price	0.001**	0.002	0.001**	0.002	0.001**	0.003	0.001**	0.003
	(0.000)	(0.045)	(0.000)	(0.045)	(0.000)	(0.045)	(0.000)	(0.045)
Monthly effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effect	No	No	No	No	No	No	No	No
Constant	12.147***	-298.607***	12.145***	-298.665***	12.142***	-298.562***	12.176***	-295.088***
	(0.862)	(61.122)	(0.862)	(61.121)	(0.863)	(61.075)	(0.868)	(61.119)
Observations	28,097	28,097	28,097	28,097	28,097	28,097	28,097	28,097
Adjusted R-squared	0.715	0.488	0.715	0.488	0.715	0.488	0.715	0.489

Note: This regression table reports the POLS results. The independent variable is **Repurchase** in regression 1-6. In regression 7-8, the interaction term **Repurchase x Market Capitalization** serve as the independent variable. In regression 1 and 2, **Repurchase** is regressed against the dependent variables. In regression 3 and 4, **Quantity** is added as an additional control variable. Regression 5 and 6 output the results after the interaction term **Repurchase x Size** is introduced. Lastly, regression 7 and 8 output the results with the interaction term **Repurchase x Market Capitalization** as the independent variable. The following variables are included in the table: **Relative Spread:** The stock's ask price minus the bid price, divided by the midpoint. **Depth:** The value of all shares available for trading at the highest and lowest price bounds on the bid and ask sides. **Repurchase:** A dummy variable equal to 1 if a share repurchase has occurred, and 0 otherwise. **Quantity:** No. of shares repurchased. **Repurchase x Size:** Repurchase times quantity times average daily price. **Repurchase x Market Capitalization:** Repurchase times market capitalization. **Book to Market:** The book value of equity divided by the market value of equity **Market Capitalization:** The market value of equity. **SEK Volume Traded:** The daily transaction value in SEK. **Volatility:** The intraday highest price divided by the intraday lowest price. **Average Daily Price:** The average daily trading price in SEK.

Clustered robust standard errors in parentheses
***, **, and * deonte signifiance at 10%, 5% and 1% levels.