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IPO Underpricing and Long-run Performance in Scandinavia: The Impact of governmental restrictions

A study of the effect of governmental restrictions during COVID-19 in the Scandinavian countries.

Master Thesis

BI Norwegian Business School

Master of Science in Finance

Jeppe Sigmond & Thomas Biermann

ABSTRACT

This thesis investigates IPOs issued between 2013 and 2022 in the Scandinavian countries. We analyze the impact of government restrictions during COVID-19 on underpricing and long-run performance. We found that restrictions had a significant effect on the underpricing of IPOs. The average underpricing was 10.07% higher in Scandinavia for IPOs issued during restrictions. Furthermore, we find that there was a significant positive difference in long-run performance of IPOs issued in Norway for 90 days compared to the periods with no restrictions.

This report has been written as part of our Master in Finance/Business.

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Table of content

1. Introduction

For the majority of people globally, the COVID-19 pandemic reshaped their social and economic realities. The global economy went into a crisis we haven't seen in a century according to The World Bank (2022). The crisis was met with an overall agreement of a decisive monetary policy response, which was set to lower the cost of human lives in the short run. The rise in public and private debt in the global economy also produced risks we hadn't seen before. WHO declared the COVID-19 outbreak a pandemic on March 11. 2020 (WHO, 2020). Both the economic and social costs of the COVID-19 pandemic were severe for the Norwegian, Danish, and Swedish governments. The countries adopted various strategies throughout this time. There was a general agreement on the need for monetary policy reaction, Norway and Denmark had similar restrictions in place at the time, but Sweden was more reluctant to implement the strictest ones.

Considerable research has been carried out on price developments after IPOs. However, to the best of our knowledge, there has not been any research into how the COVID-19 pandemics specific government lockdown measures have affected the underpricing and long-term price developments of IPOs in Scandinavia. Equity markets experienced increased volatility and uncertainty as a result of COVID-19 and governmental responses (Baig et al., 2021), which, according to Beatty & Ritter (1986), will lead to greater underpricing. Baig & Chen (2022) find that the average IPO experiences a greater degree of underpricing and uncertainty on the NYSE and NASDAQ, driven by governmental responses and an increase in IPOs in high-tech companies (Loughran & Ritter, 2004). Earlier research by Kuswanto (2021) on the Indonesian stock exchange argues that the underpricing during the pandemic was only statistically significant on the first trading day.

This thesis examines the underpricing and long-run price development of Scandinavian IPOs from January 1, 2013, to December 13, 2022. The primary goal of the thesis is to determine whether the governmental restrictions related to lockdowns of work, schools, public/social gatherings, and internal movement had

a significant effect on price development following the IPO, and if it can be anchored in known empirical evidence.

In our thesis, we will look at to what extent the restriction periods and the level of implemented restrictions affected the underpricing and long-run effects in the Scandinavian market. Consequently, the thesis research topic is:

How have government-imposed restrictions affected the IPO marked in Scandinavia?

We have developed 5 hypotheses in order to better answer our research question.

2. Theory and literature review

Numerous studies have been conducted on price development following an IPO. In this section of the thesis, we will examine relevant theories related to the research question, general literature on IPO underpricing, long-term price development, and the impact of COVID-19 and the governmental restrictions on the Scandinavian IPO market.

2.1 Public Offerings

The pros and cons of going public

There are several significant benefits for a company to go public, but there are also some potential drawbacks to consider.

The company can receive a considerable infusion of capital that can be used for new innovation, increased business growth, and debt repayment if it goes public. When a company goes public, its shares are traded on an exchange, increasing the company's liquidity for shareholders and potential investors.

Additionally, going public increases visibility, which can have both positive and negative effects. Public companies are frequently valued at a higher multiple than private companies, which can also contribute to the increase in the company's valuation.

On the other hand, a corporation must pay the costs associated with going public, such as legal and accountancy fees. Going public may also result in founders and administrators losing control, as a portion of it is transferred to external investors. Who frequently prioritize the short-run over the long-run (Roell, 1996).

The Players

There are three primary players in an initial public offering. In their own way, they play a significant impact the IPO process and underpricing.

The issuer

The company that makes the decision to go public is called the issuer. The issuer's objective is to raise as much capital as possible from the proceedings of the IPO. Setting the "correct" price can be challenging for the issuer, as there is a risk of “leaving money on the table”. Meaning that the offer price is set too low, and fails to exploit the full potential of the IPO (Thornton., et al, 2011). Therefore, there is a lengthy procedure in cooperation with the underwriter before the final price is determined. In order to be listed, the issuer must also comply with all applicable legal, regulatory, and exchange criteria. This includes any relevant information, including historical data and trustworthy financial statements.

Underwriter

During an IPO, the issuer usually has one or more underwriters. These are typically investment banks. Throughout the IPO process, the underwriter acts as a contact between the issuer and the investors and provides financial guidance. The underwriter agreement is the governing document for their relationship. The most common form of this contract is a firm commitment in which the underwriter agrees to assume the risk of purchasing all stock shares issued in an IPO and selling them to retail investors at the IPO price. Choosing the ideal underwriter is crucial for businesses because it can have a significant impact on the development of the share. According to research, the relative underperformance of IPO shares relative to the market over a three-year holding period is mitigated if the underwriter is viewed as prominent (Carter, H. Dark, and K. Singh, 2002).

Investor

A distinction can be made between Retail and Institutional investors. An institutional investor is an organization or company where there are employees who invest on behalf of clients, often other companies and organizations. These investors have financial weight and significant influence and are typically companies such as investment banks, pension funds, hedge funds, and private equity investors. They take up large parts of the market, on the New York Stock Exchange they take up about 80% of the volume (Forbes, 2022). Retail investors are individual nonprofessional investors with limited capital, and invest their own

capital and not as a service to others. Previous research shows that there is asymmetric information between institutional and retail investors, where institutional investors have more resources and better information regarding IPOs (Park et al., 2014).

2.2 Underpricing

According to Ljungqvist (2007), underpricing refers to the situation in which the price of the offer is lower than the first-day market price of the shares (*Initial return > 0*). Roger G. Ibbotson (1975) presents the first evidence for high first-day returns for IPOs in his essay titled "Hot issue" markets. This article states that new issue offerings tend to be susceptible to underpricing due to their favorable initial performance and aftermarket efficiency.

2.2.1 Explanations for Underpricing

Extensive research has resulted in the development of four primary explanations for why underpricing occurs. One of these is the information asymmetry explanation; in this case, the ex-ante uncertainty hypothesis asserts that every aspect of the IPO is influenced by future uncertainty (Kennedy et al, 2006). When there is greater uncertainty within a company, the IPO price will be underpriced more.

Asymmetric information

According to Ljungqvist (2007), asymmetric information refers to one of the parties having more accurate information than the others. These are the most well known theories for asymmetric information.

The winners curse

The most well-known model for asymmetric information is probably the winner's curse (Rock, 1986), which is an extension of Akerlof's (1970) lemon dilemma. The model makes the assumption that there are investors who are more knowledgeable about the true price of the offered share than the issuer, underwriter, and other investors. The winner's curse arises when informed

investors only bid on IPOs that are priced attractively, as opposed to uninformed investors who bid without consideration because they are unsure of whether the price is genuinely favorable. As a result, the shares given to the uninformed investors in the attractive offerings are diluted, and in the worst circumstances, all the shares in the unfavorable offerings are assigned to them. Rock (1986) further hypothesizes that the main market is dependent on ignorant investors since educated investors are unable to purchase all of the shares in the appealing offerings.

Furthermore, according to Rock (1986), it must be anticipated that all IPOs will be underpriced, allowing for at least a break-even point for uneducated investors. Due to the appealing offerings, this draws in uneducated investors who will nonetheless be diluted. He also raises the concern for new issuers to free-ride and slightly underprice their securities because the public will always think that there is a sufficient level of underpricing, which will allow them to raise more capital. On the other hand, because they rely on underwriters, Beatty and Ritter (1986) assert that investment banks are driven to make sure that new issues are underpriced in order to avoid losing the commission in the future.

Signaling Theory

The signal theory argues that not all parties have equal access to a company's financial information. A firm's financial health can be inferred from managerial decisions because managers have a superior understanding of the business.

Welch (1992) made the claim that strong early sales show that investors have received accurate information. In order to replicate their success, subsequent investors will attempt to do the same. However, if their efforts result in a weak initial sale, the effect will be the opposite. Accordingly, issuers can employ underpricing as a strategic choice for subsequent issuance (Welch, 1992). Thus, these businesses might employ underpricing as a strategy to demonstrate quality. Despite the fact that employing this strategy may be costly for the business, those who are of high caliber and have confidence that it will succeed will be able to make up for it through future offerings. Allen and Faulhaber (1989) assert that

underpricing is indicative of businesses with superior quality. This is because low-quality enterprises cannot afford to implement this strategy, and there is a greater likelihood that they will not recoup the cost of future offerings.

2.2.2 Behavioral Theories

According to behavioral theories, "irrational" investors drive up IPO share prices above their true worth, or the issuer has behavioral biases that prevent them from applying sufficient pressure on the underwriting banks to lower the underpricing (Ljungqvist, 2007).

Cascades

Informational cascades may arise when investors make judgments sequentially, meaning that they ignore their own information in favor of previous investors' bids (Welch, 1992). As was previously said, successful offerings are perceived by later investors as evidence that the earlier investors were given accurate information, and vice versa if the offering experiences disappointing first sales. This causes the demand to either gradually decline or suddenly rise (Ljungvist, 2007; Welch, 1989).

As a result of cascades, early investors gain more market power since they may "demand" a bigger discount for their investment in an IPO. This is one of the factors that cause these cascades which result in more underpricing (Ljungqvist, 2007). The underpricing of IPOs can therefore be significantly impacted by these cascades. Cascades can be avoided using book building since the signatory can preserve information on the evolution of the demand "in the book" and therefore decreasing the required underpricing. Because of this, there is less need for underpricing because the issuer now has the ability to raise the offer price in the event of demand (Ljungqvist, 2007).

Investor Sentiment

Due to their young age, inexperience, and reluctance to divulge information, IPO companies are more challenging to evaluate accurately (Ljungqvist, 2007). The first study on how an IPO business should respond to investor sentiment was published by Ljungqvist, Nanda, and Singh in 2004. They think that some sentiment investors have positive expectations for the IPO company's future prospects. Therefore, the aim of the IPO companies is to make the most of this investor attitude. The IPO business must be able to seize as much of the surplus of "the investor sentiment" as they can, before demand starts to decline in order to maximize the valuation over the share's actual value. The plan is then to hold back on issuing too many shares because doing so will decrease demand and drive down the price. This, according to Ljungvist (2007), is consistent with Ritter's (1991) conclusions that long-term IPO returns are negative.

2.3 Hot and cold issue markets

According to Ibottson and Jaffe (1975), there are cycles in the market where new issues experience periods of abnormally high returns (hot issue) and periods of abnormally low returns (cool issue). Ibbotson and Jaffe (1975) argue further that there is a degree of predictability in such hot issue markets. Investors can exploit these cycles to achieve a higher expected return, and new issuers can also take advantage of these periods with higher returns. Ritter (1984) notes that there is a substantial difference in returns between two 15-month periods.

The involvement of signatories in these cycles has also been the subject of study. Ritter and Welch (2002) demonstrate that an increase in the number of new issues leads to an increase in underpricing, as underwriters encourage companies to list on the stock exchange when the market is "hot" and discourage them when it is "cold". We expect to see the same result when analyzing the underpricing in Scandinavia later in the thesis.

2.4. Long-term performance of IPOs

Ritter (1991) concludes from a study on long-run performance in the period 1975-1984 with over 1,500 observations that new issues have a worse price development than comparable firms that are already listed over a three-year period. As a consequence, comparable businesses returned 61.86%, while fresh issues returned 34.47%. Furthermore, he believes that the phenomenon of underpricing appear to occur only in the short-run. Carter, Dark, and Singh (1998), Gompers and Learner (2003), and Levis (2011) have all conducted similar studies that have confirmed Ritter's (1991) original results that new issues underperform in the long run. When we examine our data, we expect to discover similar conclusions about underperformance in the long-run.

2.5 Impact of COVID-19

In this section of the thesis, we will look into how COVID-19 affected the different Scandinavian countries and the research regarding the impact on the IPO market.

2.5.1 Impact on IPO market activity

We will look at how the underpricing and long-term performance of IPOs in Scandinavia, as well as how their implemented restrictions influenced the results. Several studies have been carried out in other countries that examine the effect that COVID-19 has had on the IPO market.

During the three years (2020 to 2022), 97 firms were listed on the stock exchange in Norway, 199 in Sweden, and 35 in Denmark. If we look at the seven years prior to this, from 2013 to 2020, we can see that Norway had 68 entries, Sweden had 292, and Denmark had 28, which gives us a sample size of 719 overall. Ritter and Welch (2002) argue that a higher IPO activity results in an increase in underpricing. We will look into if this is the case in Scandinavia during this period.

	Norway	Sweden	Denmark	Sum
No Restrictions	68	208	25	301
Restrictions	97	292	29	418
% Change	42.65 %	40.38 %	16.00 %	38.87 %
All	165	500	54	719

Table 1: Number of IPOs during implemented governmental restrictions and before the restriction periods. % change is the increase in the number of IPOs during restrictions to the previous period

2.5.2 Impact on Underpricing and Long-run Performance

Research on COVID-19's effects on the American market reveals that the IPO market did remarkably well and that IPOs during the pandemic were more uncertain than IPOs before the pandemic (S. Baig & M. Chen, 2022). The article states that the IPOs in the high-tech and healthcare sectors are mostly to blame for the rise in uncertainty. Due to increased government interventions prior to the offering, they observe a stronger underpricing and greater volatility during the epidemic. They also draw the conclusion that the IPO market was negatively impacted by the pandemic.

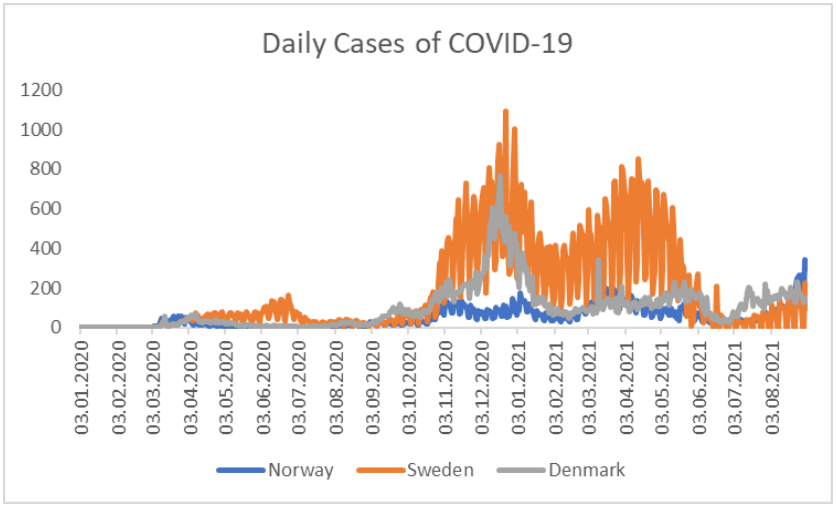
There is also research done by Mazumder and Saha (2021) which studies the fear of the COVID-19 pandemic and its effect on the IPOs during this period's initial return, where the fear variable is a weighted average COVID-19 cases and related deaths. This study suggests that the “underpricing of IPOs in the year 2020 is higher than the one in the last four decades” and that the fear of COVID-19 is negatively correlated with underpricing.

Randy Kuswanto (2021) researched the phenomenon of underpricing of IPO firms listed on the Indonesia Stock Exchange during the Covid-19 pandemic. When using a paired sample t-test, they find that the underpricing phenomenon occurred during the pandemic period, but was only statistically significant on the first trading day. The findings showed that the returns after the first trading day declined and were proven statistically insignificant.

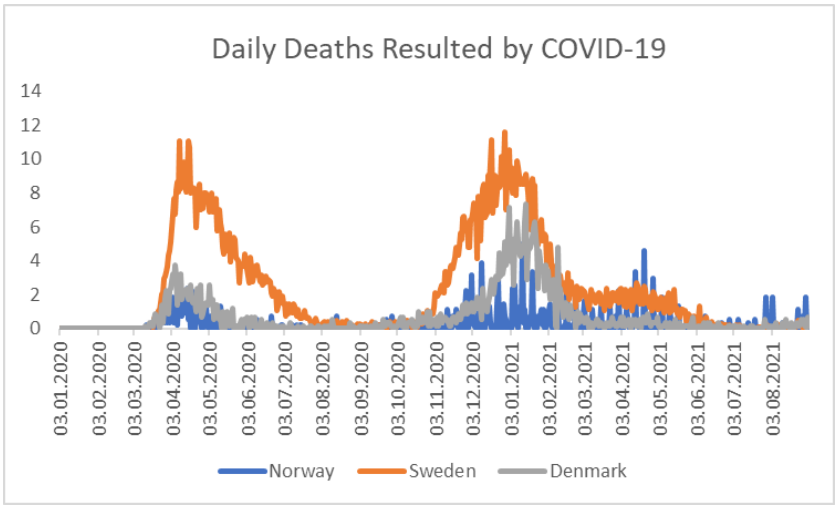
None of these articles looks at the Scandinavian IPO market. We will use these articles as a basis for our research for evaluating the significance of governmental restrictions on the IPO market in Scandinavia.

2.5.3 Public Health

According to Statista by 2023, the first coronavirus case was discovered in Norway on February 21 and six days later in Denmark, both less than a month after the first coronavirus case in Sweden was announced on January 31, 2020. The start of the restriction periods in the Scandinavian nations coincided with the introduction of the first restrictions in Denmark and Sweden on March 11, 2020, and Norway the day after(SSB). The social restrictions ended in Norway on January 31, 2022, January 11, 2022 in Demark and February 8, 2022 in Sweden (folkhalsomyndigheten.se). We want to look at how the population has been affected in terms of health during the period in the Scandinavian countries in order to understand the uncertainty created by the pandemic.



Graph 1: Daily cases of covid-19 from 03.01.2020 to 03.08.2021. Per million citizens, Norway, Sweden, and Denmark are represented.



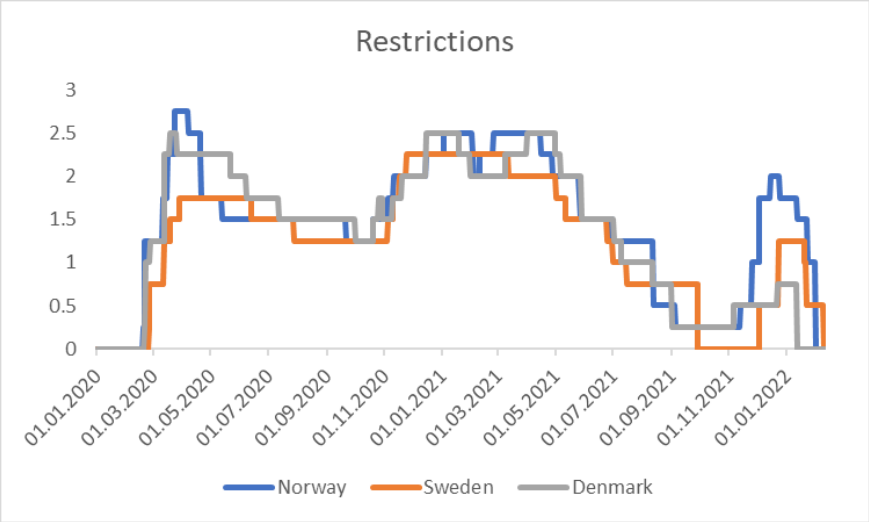
Graph 2: Daily covid-19 confirmed deaths from 03.01.2020 to 03.08.2021. Per million citizens, Norway, Sweden, and Denmark are represented.

The first 18 months of the epidemic are the main emphasis of these graphs, as this is the period where the Scandinavian nations had a significant spread in implemented restrictions. The population of Sweden has been the most severely affected, followed by Denmark, while Norway has been the least affected, as shown in the graphs. This is the outcome of the limitations that the authorities decided to impose. We need to look closer at restrictions in order to better understand how the Scandinavian nations have dealt with the spread of COVID-19.

2.5.4 Restrictions

We witness limitations in the form of policies that restrict people's ability to move around freely in their daily life. These are limitations pertaining to work, school, public/social gatherings, and internal movement. Throughout the pandemic, these areas have been subject to various levels of severity. We have decided to categorize the limits into three categories, ranging from 0 (no restrictions) to 3 (full restriction).

By the end of March 2020, Norway and Denmark had imposed more stringent restrictions. Sweden opted not to impose such limitations, instead advising extra caution while interacting with others in order to prevent the economy from being significantly impacted by the pandemic. As a result, Sweden distinguished itself in the development of cases from the rest of Europe and the other Scandinavian countries.



Graph 3: Restrictions represented from 0-3, where 3 equals total lockdown and 0 equals no restrictions. The index is a weighted average of restrictions the government implemented at work, schools, social/public gatherings, and internal movement each day from the first implemented restriction to the last.

	Norway	**Sweden**	**Denmark**
Work	1.016	0.634	1.053
School	0.868	0.682	1.078
Public/social gatherings	1.824	1.876	1.664
Internal Movement	0.390	0.304	0.073
Average	1.024	0.874	0.967

Table 2: Average restrictions divided into countries and restriction-groups from the entire COVID-19 period. 11, March 2020-8, February 2022.

The graph illustrates how nations responded to the corona pandemic in a variety of ways and to varying degrees of restrictions. We can see that the Norwegian government imposed the most restrictions on its citizens, while the Swedish government was the least restrictive. Sweden decided in the autumn of 2020 to impose restrictions that brought them closer to Norway and Denmark (Saunes et al., 2022) which we can see in the graph. From Table 1 we can also see that Sweden had the lowest average restrictions in all sectors. Later in this thesis, we will test whether these differences in restrictions have had a significant impact on the underpricing and long-term performance of the countries.

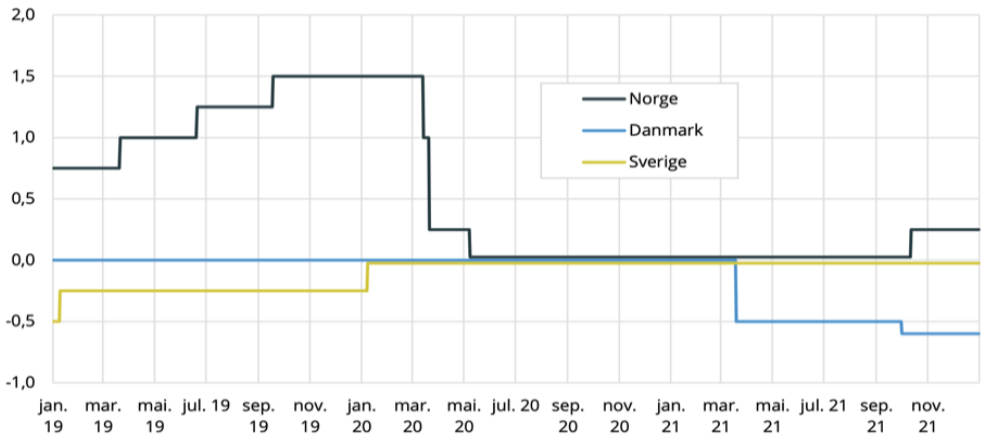
GOOGLE movements have monitored the increase in time spent at home during the COVID-19 period and monitored the movement of individuals throughout the pandemic. On average the Scandinavian population had a 4.77% increase in time

spent at home during COVID-19 with the highest increase within a two-week period as high as 16.11%. We wish to use the increase in time spent at home as a variable for fear in order to determine whether it has had a significant impact on underpricing.

2.5.5 Economic

A study on the state of the economies in the Scandinavian nations has been presented by SSB. Even though Norway and Denmark enacted stronger regulations than Sweden, the economic growth in all of the Scandinavian nations has been relatively similar. According to the predictions, the GDP of all three countries should have increased by between 4.2% - 5%. However, as a result of COVID-19, GDP decreased by about 4% to 5% in all countries as compared to the prior period. Services in the public and private sectors were the business sectors that had the biggest impact on the reduction in GDP, which resulted in declines of 2.3% in Denmark and 2.1% in Norway and Sweden (Blytt, Bougroug & Sletten, 2022).

Controlling demand, is a fiscal strategy aiming to maintain economic stability throughout the economic cycle. There are many ways to "push" the economy in this direction, including tax reductions, a rise in household benefits, and maintaining high levels of production in government operations even while tax rates decline (Blytt, Bougroug & Sletten, 2022). Denmark's currency is pegged to the Euro, while Norway and Sweden each have their own currencies that are not tied to any other currency. They try to stick to inflation targets in order to stabilize the value of their national currencies. As a result, various active monetary policy models were developed to try and address the economic challenges that Scandinavia faced. When the pandemic began, the policy rates in Sweden, Denmark, and Norway were 0% and 1.5 percent, respectively. The graph shows that whereas Sweden and Denmark were unable to do so because their policy rates were already at that level, the Norwegian government quickly decided to lower its policy rate to 0%. The goal of doing this is to incentivize economic growth.



Graph 4: Illustration of the interest rates in Norway, Sweden, and Denmark during the Covid period. Illustration made by SSB(2022).

Due to the redundancies that occurred during the epidemic, the private economy was impacted. Scandinavian nations quickly developed pay subsidies or layoff protection plans to help those who lost their jobs. In 2020, layoffs resulted in 477,000 unemployment benefits in Norway, 577,000 in Sweden, and 250,000 in Denmark (Blytt, Bougroug & Sletten, 2022). We will test whether the rise in unemployment has had a significant effect on underpricing, as we think higer unemployment will affect the underpricing negatively.

3. Hypothesis

On the basis of the earlier theoretical and empirical review in this thesis, we wish to investigate whether government-imposed restrictions on work, schools, public events/social gatherings, and internal movement have had a significant impact on the underpricing and long-run performance of IPOs in Scandinavia. The topic of underpricing and long-term performance has been the subject of extensive research in the past, but to our knowledge, there is still a lack of research on the impact of COVID-19 and the measures taken to prevent its spread and the effect it had on the IPO market in Scandinavia.

Baig & Chen (2022) and Mazumder & Saha (2021) demonstrate that COVID-19 and government policies have had a significant impact on underpricing in the US market. We anticipate comparable outcomes for our restriction variable in Scandinavia. Therefore, our initial hypothesis is

Hypothesis 1: *restrictions have had a significant effect on IPO underpricing in the Scandinavian countries*

Earlier in the thesis, we discussed how different nations chose varying degrees of restrictions during the COVID-19 period. Norway is the nation where the strictest restrictions were implemented, so we wish to determine whether Norway has been particularly affected by the pandemic restrictions. So, the following hypothesis is:

Hypothesis 2: *The restrictions had a significant impact on underpricing in Norway compared to Denmark and Sweden.*

Mazumder & Saha (2021) use the number of COVID-19 infection cases and deaths as a measure of fear. We intend to use the population's movements as a variable for fear. The duration of the restrictions in Scandinavia was just under three years, and it is conceivable that the impact cases and deaths on the population has diminished over time. Thus, we wish to assess the impact of the population's mobility on underpricing. We will use GOOGLE movements reports as a variable for fear, testing the if the decrease in the populations movements has a explanatory power on underpricing.

Hypothesis 3: *Stay-at-home had a significant impact on the underpricing*

In addition, we would like to investigate whether the government-imposed restrictions have affected IPOs beyond the first trading day. Ritter (1991) argues IPOs have a tendency to underperform in the long-run. Kuswanto (2021) confirms that during the pandemic there was still no significant underpricing bound the first trading date. However, we want to determine if there was a significant change in return between the periods preceding and following the restrictions. Ritter and Welch (2002) show that an increase in the number of new issues results in a rise in underpricing. During the years of Scandinavian restrictions, the number of IPOs increased significantly compared to the previous period. We would like to determine if the returns in the restriction periods are statistically different from the previous period. Consequently, our next hypothesis is:

Hypothesis 4: *Restrictions have had a significant impact on IPOs long-run performance in Scandinavia*

Further we would also like to examine whether country-specific restrictions have made a distinct impact on the long-run performance. Hence, our next hypothesis is:

Hypothesis 5: *The degree of restrictions during COVID-19 has had a distinct impact on long-run performance.*

Since there has been plenty of research suggesting that underpriced IPOs underperform in the long-run we want to test if this is true for the restriction period.

Hypothesis 6: *Underpriced IPOs underperform in the long-run during restrictions.*

4. Data

In this section of the thesis, we will go over the data we use to investigate the hypothesis and how we acquired and processed the data. It is important to gather accurate information from trustworthy sources for the thesis to have the highest level of credibility possible.

4.1 IPO data

Only IPOs issued between January 2013 and December 2022 will be evaluated for the purposes of this empirical analysis. We used this time span as this provides approximately an equal amount of observations during the restriction period and the comparison group. This was due to the substantial rise in IPO listings during the COVID-19 period. We are aware that an increased interest rate has the potential to trigger market instability and have a significant impact on IPOs (Ritter & Welch, 2002). As a result, we took an effort to select our time period such that there would be no substantial variations in interest rates between the various time periods. The interest rates haven't risen significantly since the financial crisis in 2008, so they vary between 0-1.5% over the years we're looking into.

The majority of the IPO data was obtained through Bloomberg Terminal, however, we rechecked the figures using Eikon Refinitiv to ensure they were valid. We have chosen and gathered data from several stock markets in various

countries, but due to time constraints, we have only done so from the biggest and most reputable stock exchanges in each country. We drew data from the Oslo stock exchange and Euronext Growth in Norway. In 2016 Euronext Growth was launched which was initially introduced as a stock exchange “light” which provides access to the capital market for small and medium-sized businesses that are not big enough or can't meet the standards set by the Oslo stock exchange (Abrahamsen & Sveen, 2022). The most significant stock exchange in Sweden, Stockholmsbörsen, also known as Nasdaq Stockholm. Like Oslo Børs, it is the most regulated stock exchange in Sweden and offers significant opportunities for Swedish investors to participate in the expansion and development of Swedish businesses (Nasdaq Inc). The Nordic Growth Market (NGM) is an alternative stock market that, like Euronext, has less stringent entry criteria. It is less regulated than the main stock exchanges in Norway and Sweden. In addition to the nation's primary stock exchanges, we use this exchange for Sweden and Denmark as well as the Nasdaq Copenhagen which is the main stock exchange in Denmark (Nasdaq Inc).

Furthermore, in order to accurately determine the volatility and intraday movement of the country's stock market, as well as the underpricing, we had to obtain extensive information about the individual countries' OMXCGI, OMEAX, and OMXSPI stock market indices. To guarantee that we received reliable figures, the data used to create the various indexes were verified using investing.com, Eikon Refinitiv, and yfinance. To measure the different buy and hold abnormal returns (BHAR), we had to gather the stock price for the 7-day, 1-month, 3-month, and 6-month periods. Since the tickers we were given from the Bloomberg terminal contained missing data, we had to check this against Eikon Refinitiv, and yfinance. We created a data scraping code in Python where we scraped yfinance for the missing data of this time span. There were approximately 100 of 719 values where we had to use yfinance to gather the missing data.

4.2 Restrictions Data

Finding reliable explanatory variables that measure restrictions and closures was necessary because the primary goal of this thesis is to examine the impact of restrictions and closures on underpricing. The Oxford COVID-19 Government Response Tracker, which maps the various countries' governments' usage of various pandemic-related measures, has been used to gather data on these variables. We have gathered information regarding limitations affecting the freedom to meet others from there. This is the amount to which regulations have been put on workplaces, schools, and Public/social gatherings. In order to gather missing data and verify the severity of restrictions, we additionally used oslo.kommune.no, helsenorge, folkhelsomyndigheten.se, and ssi.dk for Norway, Sweden; and Denmark respectively.

We have gathered monthly unemployment statistics from the websites SSB.no and fred.stlouisfed.org respectively. Finally, we wanted to determine if there were any other factors that could account for the population's freedom of mobility across the different nations, i.e., whether a change in the population's movement patterns could provide an explanation for underpricing. The population mobility in various places has been tracked by Google in an overview.

4.3 Data and variables

IPOs and their initial return are the subjects of our first informational gathering. The next step is to pinpoint the factors that influence IPO underpricing and ascertain if restriction periods in Norway, Denmark, and Sweden had an significant impact on IPO underpricing. Additionally, how the various degrees of restrictions affected the IPO underpricing.

We start by looking at previous research on the subject to find which variables might be suitable for the underpricing of IPOs.

4.3.1 Dependent Variable Underpricing

There are several different thoughts on when the market is efficient after going public, and the most common approach is McGuinness (1992), who contends that the stock is priced efficiently after the first day. Our dependent variable is underpricing which is found by calculating the initial return of each IPO. To try and shield the underpricing effect from market movements we subtract the daily movement in the all share index to the respective nations. Thus:

$$\frac{CP_t - CP_{t-1}}{CP_{t-1}} - \frac{Index_t - index_{t-1}}{index_{t-1}}$$

CP_t = *Closing price on the first day*

CP_{t-1}= *Opening price on the first day*

$Index_t$ = The closing index price from the respective country on the day of the IPO (OMXCGI, OMEAX, and OMXSPI)

$Index_{t-1}$ = The Opening index price from the respective country on the day of the IPO (OMXCGI, OMEAX, and OMXSPI)

4.3.2 Independent Variables

Age

During the COVID-19 period, we saw an increase in young firms going public. Using information from Ritter (1984) in order to accommodate for the information asymmetry of younger enterprises. We calculate the age as the IPO date subtracting the founding year. To avoid skewed data we took the Natural log of the firm age (LN AGE). According to previous studies, younger firms perform better than older firms, due to higher information asymmetry (Clark, 2008).

Formula lnAge:

ln(Founding year - IPO date)

Greenshoe dummy

We include a green shoe dummy 1 if there are green shoe options and zero otherwise. A greenshoe option is a privilege that allows the underwriter to sell more shares to investors than the issuer had originally intended (Paul, Cyril, 2021). The option often results in higher underpricing due to higher uncertainty before the IPO date.

Industry dummy

To categorize what industry the different companies going public belong to we use the industry classification benchmark (ICB). We include this as a dummy variable in our model, equal to 1 if the company operates in the tech industry and 0 otherwise. We saw that during the covid period, 23,7% of the IPOs were in the tech industry (Technology Hardware, Software, Technology Services, and Internet Media & Services) versus 19.9% in the period before COVID-19. There are several studies on underpricing in IPOs linked to the tech industry and how there is a positive relation between the two variables (Chi, & Padgett 2005). The tech industry appears to be underpriced more than the other sectors, due to uncertainty according to this article.

Market capitalization

Like in the firm age, market capitalization is necessary for tackling information asymmetry. This can be a forecast for uncertainty, which denotes a higher underpricing, as demonstrated by Beatty & Ritter (1986). In order to identify the variable, we calculate this by multiplying the number of outstanding shares by the offer price. We also naturally log this variable to avoid skewness and non-linear relationships in the variables.

Unemployment

In order to investigate if unemployment has any significant influence on the underpricing of IPOs, we looked at the percentage of people between the ages of 15 and 74 who were unemployed during the chosen time period.

Volume index

To see if the underpricing of IPOs on the first day was influenced by the market volume the previous month, we gathered the volume of the related OMXCGI, OMEAX, and OMXSPI indexes; as a result, we lagged the indexes by one month, because of slow impounding market effects.

Norway dummy

We also create an independent dummy variable for Norway to distinguish the Norwegian market from the rest of the Scandinavian. This dummy variable takes the value 1 if the IPO belongs to Norway which the dummy belongs to, and 0 otherwise. We do this to represent the variables of binary nature. Whether the IPOs are in Norway or not.

Volume

Because prior studies have shown that a higher trade volume is correlated with more investment and optimism, we have included the volume variable in our analysis. Then, in order to measure this, we estimated the volume of the IPO within the first 30 days following the trading date. The first MLR.1 assumption we must make while performing the regression is linearity, and we confirm linearity using the natural logarithm.

Restrictions

In order to determine whether there is a correlation between restrictions and underpricing of IPOs, we will evaluate this independent variable. The restrictions variable is essential to our thesis as it is the focus of our research. We have taken the levels of restriction regarding work, schools, public/social gatherings, and internal movements. We took the average score across these four restriction groups and divided them into four categories. Then we scaled them from 0 to 3 to have an equal measurement in all of the four categories. The first group is called no restriction, this is where we find the value 0 indicating that there was no restriction during the IPO period. For the second group, we set the low restriction period a value of 0.33. Then we have the middle restriction category which takes

the value of 0.66. Lastly, we set the value to 1 if there are full restrictions also called lockdown.

5. Methodology

We will discuss the approach taken to test our hypothesis in this section of the thesis, and the steps taken to ensure the validity of our data.

5.1 Regression model and potential violations

The OLS regression is considered the most efficient linear regression model. This model predicts the relationships between the dependent and independent variables. Gauss-Markov theorem states that under the assumptions that MLR.1-MLR.5 holds. The OLS estimators $(\hat{\beta})$ are the best linear unbiased estimation of the (β), BLUE for short. These are the assumptions that we need for $E\ [\widehat{\beta_J}] = \beta_j$ to hold.

5.1.1 Violations

We must confirm assumptions 1 through 5 in order to use an OLS regression to analyze the relationship between the dependent and independent variables (Wooldridge 2019).

Assumptions

1. **Linearity in parameters:** The model must be linear, which indicates that it has a linear relationship between the dependent and independent variables. To make sure of this we have taken the natural log of the independent variables *age*, *volume,* and *market capitalization*.

2. **Random sampling:** The second requirement is that all observations must be independent of one another. This means that information from one observation cannot be used to provide information about another. We must have a random sample of n observations $\{(x_{i1}, x_{i2}, \ldots, x_{ik}\ , y_i)\colon i\ = 1,2, \ldots, n\}$

3. **No perfect multicollinearity:** This means that the independent variables cannot be a perfect linear function of the other explanatory independent variables.

4. **Zero conditional mean:** Normal distribution in the error term. This means that there should be a normal distribution in the error term around zero, hence $E(u|x_1, x_2, \ldots, x_k) = 0$.

5. **Homoskedasticity:** There must be homoscedasticity, which means that the data must have a consistent spread. The error term u_i must have the same variance given any value of the explanatory variables. Hence $Var(u_i|x_1, \ldots, x_k) = \sigma^2$
We check that all the Gauss-Markov assumptions hold, which indicates (BLUE) for information uncertainty (Jeffrey M. Wooldridge). See the appendix for the controlling of assumptions.

5.2 Underpricing

We will first go through the methodology we use to analyze the impact of governmental restrictions on underpricing.

5.2.1 Multiple Regressions Models

Multiple regression analysis is a great way to measure relationships between variables. In this subchapter of the thesis, we will go through the OLS models we use for testing hypotheses. We will run the regression three times for testing hypotheses 1, 2, and 3.

We run the first model with underpricing as the dependent variable. We provide the regression to test our hypothesis that restrictions had an effect on the underpricing of IPOs in the Scandinavian market:

Model (1):

$$UP = \alpha_0 + \beta_1\, restriciton\ variable_i + \beta_2 Greenshoe_i + \beta_3 lnAge_i + \beta_4 marketcap_i + \beta_5 industy\ dummy_i + \beta_6 Lagged\ volum\ index_i + \beta_7 Unemployment\ lagged + \beta_8\, lnVolume_i + u_i$$

(equation 1)

To test our second hypothesis, we run a regression where we add Norway as a dummy variable, to see whether there was more or less underpricing in Norway under the constraints given by the government. We are aware that Sweden was the

least restrictive, followed by Denmark and Norway, which had the toughest restrictions.

Regression for underpricing in Norway:

Model (2)

$$UP_{Nor} = \alpha_0 + \beta_1 Norway\ dummy + \beta_2\ restriciton\ variable_i + \beta_3 Greenshoe_i + \beta_4 lnAge_i + \beta_5 marketcap_i + \beta_6 industy\ dummy_i + \beta_7 Lagged\ volum\ index_i + \beta_8 Unemployment\ lagged + \beta_9\ lnVolume_i + u_i$$

(equation 2)

To test if there is any significant iteration effect between the Norway dummy and restriction variable, we run the third regression as this measure the X1*X2, where X1 represents restriction and X2 represents Norway.

Model (3)

$$UP_{Nor} = \alpha_0 + \beta_1 Norway\ dummy + \beta_2\ restriciton\ variable_i + \beta_3 * (X1 * X2) + \beta_4 Greenshoe_i + \beta_5 lnAge_i + \beta_6 marketcap_i + \beta_7 industy\ dummy_i + \beta_8 Lagged\ volum\ index_i + \beta_9 Unemployment\ lagged + \beta_{10}\ lnVolume_i + u_i$$

(equation 3)

Slow impounding information(3-day)

We will rerun the same regression against a new dependent variable, the underpricing at day three (IR3), to see whether we can detect any gradual impounding of information into stock prices. This is to determine whether the slow impounding of information has an impact on the Scandinavian market (*Equation 4-6)*. (See appendix)

5.3 Long-run performance

Earlier in the thesis we discussed previous research on the long-run performance of IPOs, where Ritter (1991) argued that IPOs underperform in the long-run compared to already listed comparable stocks. The most common methods for analyzing the long-run performance of new issues are CAR (Cumulative Abnormal Returns) and BHAR (Buy-and-Hold Abnormal Returns) (Barber and Lyon, 1997; Fama, 1998). There has been some criticism towards the CAR model

by Barber and Lyon that the method ignores the compounding effect and therefore we have chosen to use the BHAR model for our analysis.
The BHAR formula for calculating the buy-and-hold abnormal returns is as follows:

$$BHAR_i = \frac{1}{n}\sum_{t=1}^{n}[(\prod_{T=1}^{T}(1 + r_{i,t})) - (\prod_{T=1}^{T}(1 + r_{b,t}))]$$

(equation 7)

Since the timespan since the governmental restrictions where implemented are relatively short, we have chosen to use BHAR to analyze the IPO performance for 7, 30, 90 and 180 days when measuring long-run performance.

Two-sided t-test

To investigate if there is any significant difference between the IPOs issued during restrictions and not, we perform a two-sided t-test. When determining whether there is a significant difference between the means of two groups. The goal of this test is to determine whether the difference between the means of the two groups' restrictions and the comparison group is greater than you would anticipate occurring by chance.
The two-sided t-test is given by:

$$t = \frac{\underline{\underline{x_1}} - \underline{x_1}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

(equation 8)

General data and descriptive statistics

No Restriction							
Independent variables	**Mean**	**Median**	**Min**	**Max**	**Std.dev**	**Skewness**	**Kurtosis**
Green shoe dummy	0.2805	0.0000	0.0000	1.0000	0.4497	0.9774	-1.0446
LN Age	2.4163	2.3979	0.0000	5.2095	1.0336	0.0726	0.5580
LN Market cap	5.6337	5.6052	0.0000	11.9672	2.1557	-0.4217	0.7148
Industry dummy	0.2046	0.2046	0.0000	1.0000	0.4039	1.4645	0.1449
LAGGED VOLUME INDEX	0.0391	0.0253	-0.5138	1.2696	0.2098	1.4568	5.9067
Unemployment Lagged	6.7069	7.0000	3.1000	8.9000	1.3571	-1.0596	0.4275
Ln Volume	14.1015	14.4695	0.0000	19.2624	2.9324	-2.9827	12.2022
Observations	301	301	301	301	301	301	301

Table 3: Raw data of general statistics No restrictions

Restriction							
Independent variables	**Mean**	**Median**	**Min**	**Max**	**Std.dev**	**Skewness**	**Kurtosis**
New restriction variable	0.6680	0.6600	0.3300	1.0000	0.2192	0.0220	-0.6559
Green shoe dummy	0.2739	0.0000	0.0000	1.0000	0.4469	1.0139	-0.9720
LN Age	2.2828	2.3026	0.0000	5.0106	1.0406	-0.1129	-0.0268
LN Market cap	6.2418	6.4806	0.0000	11.5458	1.9932	-0.6445	1.1786
Industry dummy	0.2130	0.0000	0.0000	1.0000	0.4104	1.4016	-0.0354
LAGGED VOLUME INDEX	0.0073	-0.0744	-0.9979	1.3155	0.3465	1.7123	4.6763
Unemployment Lagged	7.3896	8.5000	3.2000	9.5000	1.9426	-0.4626	-1.5393
Ln Volume	14.7595	14.8651	0.0000	20.8407	2.2791	-3.4779	21.0237
Observations	418	418	418	418	418	418	418

Table 4: Raw data of general statistics Restrictions

Here, we compare the raw data from restricted and unrestricted IPOs.

As we can see, the average is greater with restrictions than without. Furthermore, we observe age, unemployment, and volume, all have a higher skewness. We see an increase in unemployment, which makes sense, considering that people were made terminated during the restriction period. The volume index is lower in the second than in the first, which should indicate that there was less activity in the market during the restrictions. We can also see a higher MarketCap this will indicate higher uncertainty in the restriction period which may indicate that the underpricing will be higher (Beatty & Ritter, 1986).

6. Results and Analysis

6.1 First day Underpricing

In the first part of this chapter we will go through the results of the underpricing.

Multiple underpricing regression:

In this section, we will run and go through the results from the OLS regressions, and the long-run results from the buy and hold strategy. We will run the regression with underpricing as the dependent variable three times with regard to the linear regressions we outlined in equations (1-3).

After this, we run the linear regression in (4-6) to check if the information is slowly impounding in the Scandinavian market. Then we will run a regression for each of the restrictions that violated the freedom of movement. *(see Appendix for equations and resgressions)*

Variable	(1)	(2)	(3)
Constant	-0.2121 (0.137)	-0.0184 (0.155)	-0.0178 (0.156)
Restriction	0.1007** (0.044)	0.1571*** (0.056)	0.1703** (0.072)
GreenShoe	0.0522** (0.024)	0.0577** (0.024)	0.0572** (0.024)
lnAge	-0.0120 (0.012)	-0.0135 (0.012)	-0.0138 (0.012)
lnMarketCap	-0.0092 (0.006)	-0.0069 (0.006)	-0.0068 ((0.006)
Industry	0.0009 (0.031)	-0.0068 (0.03)	-0.0068 (0.030)
Lagged Volume	0.0477 (0.074)	0.0449 (0.073)	0.0387 (0.073)
Lagged Unemployment	-0.0086 (0.008)	-0.0392** (0.016)	-0.0394** (0.017)
lnVolume	0.0270*** (0.008)	0.0288*** (0.008)	0.0297*** (0.008)
Norway dummy		-0.0515** (0.065)	-0.1386** (0.06)
X1*X2			-0.0415 (0.085)
Observations	719	719	719
R2	0.034	0.045	0.045
Adjusted R2	0.023	0.033	0.032
F-stat	5.232	4.837	4.358

Table 5: Impact of restrictions on underpricing of IPOs. This table represents the equations 1 - 3. The table represents the coefficients and the standard error (in parenthesis). The regression is with whites' robust

*standard errors and the dependent variable is underpricing. Some of the independent variables are naturally logged to avoid skewed data. Different significant levels: *p < 0.1; **p < 0.05; ***p < 0.01*

Restrictions effect on underpricing

To answer our hypothesis of whether the restrictions affected underpricing in Scandinavia we look at the first regression in Table 5. We observe a negative constant of -0.2121, given that when all other independent variables are held at constant there is less underpricing for IPOs. We find that the restriction variable is statistically significant at 5%. This supports our first hypothesis that underpricing is affected by governmental restrictions. We find that this variable has a positive coefficient, which means that a unit increase in restrictions causes the underpricing to increase by 0.1007, meaning that on average the IPOs in Scandinavia during restrictions received 10.07% more underpricing. lnVolume and Greenshoe are also statistically significant and have a positive coefficient. This result suggests that these independent variables also lead to more underpricing, which is in line with previous research (Paul, Cyril, 2021). lnAge, lnMarketCap, and Unemployment are negatively correlated, but not statistically significant.

In the second regression (2) we added the Norway dummy variable, to observe if restrictions in Noway had a distinct impact on underpricing. There is significant evidence at a 5% level to ascertain that underpricing in Norway is lower than in the reference group (Sweden, Denmark). In the Norwegian market, underpricing of IPOs is 5.15% less compared to the rest of Scandinavia, if all other variables are held constant. Even if there is underperformance in Norway during our time period, the data is evidence of an increase in the restriction variable compared to the first regression (1). This could mean that the Norwegian market's special characteristics or regulations are picked up by the variable Norway and it affects Norwegian investors and their behavior. This increase provides evidence that the independent variable Norway proves the significance of the variable restrictions. This could assist us in determining whether restrictions have an effect on underpricing, particularly in Norway. As we can see, adding the Norway variable increases the significance of the restricted variable to now be statistically

significant at a 1% level, supporting our second hypothesis. This could also indicate an interaction effect between the variable Norway and the restrictions as we can also notice a positive change in the dependent variable, suggesting that restrictions could have affected the underpricing of IPOs more in Norway than in the reference group. Further, our regression suggests that unemployment is significant and leads to less underpricing by -0.0392, which is in line with what we thought.

The third regression (3) in the table checks for an interaction effect between the two variables Norway and restriction (X1*X2). An interaction effect between the two independent variables doesn't appear to be significant. This is proof that the two variables affect underpricing in a unique and separate way.

The R-squared for the models from regression one to three is respectively 0.35, 0.45, and 0.45. This is considered a low R-squared as this measures the fit of a model. There can be several explanations for this, there can be important variables that affect the underpricing of IPOs that we haven't taken into consideration. The underpricing of IPOs might also be fairly unpredictable. The F-statistic for all the models is above 4, this result indicates that the overall model is significant.

Our goal for this test is to determine what impact the financial repercussions and restrictions related to Covid-19 had on the pricing of the IPO market. Since restrictions may have an impact on investors' willingness to take risks and the demand for shares in such a volatile market. The data indicates that investors during restrictions were willing to pay more on the IPO trading date during restrictions. Numerous factors could be at play here, but one of the most probable ones is that market volatility increased, leading to investors demanding a larger rate of return. This is taking place in a situation where people are almost obliged to save because of the restrictions.

3-day

To determine market efficiency, we run the regressions (4-6). As can be seen in table 9 we find no significant evidence that disproves the market efficiency theory. (See appendix for results)

Time-Spent-home

Since there was an increase in the time spent at home during the pandemic we are going to take a look at this specific "movement" regulation and see how this affected the underpricing and if in Norway where there was the least movement outside of the home had anny different effects than in the other Scandinavian countries.

Variable	(1)	(2)
Constant	-0.2333*	-0.0602
	(0.135)	(0.152)
Time spent home	0.0080	0.0130**
	(0.005)	(0.006)
GreenShoe	0.0474*	0.0504**
	(0.024)	(0.024)
lnAge	-0.0133	-0.0148
	(0.012)	(0.012)
lnMarketCap	-0.0077	-0.0052
	(0.007)	(0.006)
Industry	-0.00031	-0.0028
	(0.031)	(0.031)
Lagged Volume	0.0254	0.0157
	(0.072)	(0.072)
Lagged Unemployment	-0.0091	-0.0358**
	(0.008)	(0.017)
lnVolume	0.0281***	0.0300***
	(0.008)	(0.008)
Norway dummy		-0.1284**
		(0.065)
Observations	719	719
R2	0.030	0.037
Adjusted R2	0.019	0.025
F-stat	4.566	4.195

*Table 6: This table shows the impact of Time spent at home as a new independent variable on the dependent variable underpricing. The other independent variables are the same as in table. The Time spent at home variable is a variable measured by how much time the population spent at home in percentage. Different significant levels: *p < 0.1; **p < 0.05; ***p < 0.01*

If we compare the two regressions, we can see that time spent at home is not a significant variable prior to the introduction of the Norway dummy, however, it increases and becomes significant after the introduction of the Norway dummy. This suggests that even while it is a small effect it does affect underpricing in Norway, time spent at home has a significant impact fulfilling hypothesis 3. Given that this independent variable is not significant in the first regression model, we lack evidence to claim that this is true for all of Scandinavia.

6.2 Buy and hold abnormal returns (BHAR)

To measure the long-run performance of IPOs, we run the buy-and-hold abnormal returns (BHAR) for four periods of time. (BHAR) for four periods of time.

All Values

	Restrictions				**No Restrictions**			
	Norway	**Sweden**	**Denmark**	**Scandinavia**	**Norway**	**Sweden**	**Denmark**	**Scandinavia**
7 Days	0.44 %	1.20 %	4.49 %	1.35 %	0.86 %	2.74 %	-0.28 %	2.39 %
1 Month	-0.16 %	0.52 %	-5.67 %	-0.54 %	-3.35 %	7.80 %	-10.54 %	5.23 %
3 Month	20.34 %**	7.57 %	12.56 %	12.94 %**	4.32 %	9.23 %	-5.13 %	7.85 %
6 Month	9.84 %	0.01 %**	-24.08 %**	0.51 %**	8.52 %	8.43 %	-3.96 %	8.01 %

Table 7: BHAR calculations for each country All values.

The results suggest that the price development in the period with restrictions against the one without differs. If we review the Scandinavian market as a whole, we see that the IPOs during the time of no restrictions outperformed the ones with restrictions. We concluded earlier that the restrictions had a positive effect on underpricing, this seems to not have the same effect in the long term as they are statistically significant but negative, which indicates that the restrictions do have a distinct negative impact on long-run performance. If we look at the country-specific results this applies for both Norway and Sweden even after 7 days. After 1 month this is still true for Sweden, but Norwegian and Danish IPOs issued during restrictions outperformed the ones with no restrictions, even though they are lower than on the first day. We can say the same for the third month, in this timespan the price for Norway and Denmark becomes positive compared to the first day for the IPOs issued during restrictions, and all countries have a positive

average return since the IPO date. We find significant proof on a 5% level that there is an abnormal return for IPOs issued under restrictions in Norway for 3-months. Only in Norway, over a period of six months, do companies with restrictions during their stock exchange listings do better than those without, but it is not significant. We do find that both Sweden and Denmark are statistically significant at a 5% level after 6 months. This is in line with earlier research that underpriced IPOs underperform in the long-run.

In other words, our findings indicate that IPOs during restrictions in the long-term in Norway performance over 6 months on average gave a return of 9.83%. The benchmark index OSEAX for 6 months for the same stocks was at 0.09166 (9.166%). Findings suggest that it outperforms the OSEAX index in a 6 month period. It is critical to determine whether the limits have impacted the past evidence that suggests that IPO underpricing affects long-term success. We felt it would be interesting to investigate whether there is a substantial difference between the return on IPO bonds issued with restrictions and those issued without restrictions over the long term. We come to the conclusion that some of the periods differ significantly, and we will investigate this further.

Underpriced vs. Not

Since restricted IPOs in Norway outperformed unrestricted IPOs and beat the OSEAX benchmark we are going to check if the theory that IPOs that are underpriced, underperform in the long run. We are now interested in determining whether or not this is because the companies are underpriced. Then, we evaluate the restricted stock market listings of the companies to see if the underpriced companies beat the non-underpriced ones.

IPOs in Norway during restrictions

	Underpriced	Not underpriced
7 Days	3.61 %	-3.90 %
1 Month	-3.96 %	5.05 %
3 Month	7.66 %	37.70 %
6 Month	0.75 %	22.27 %

Table 8: Buy and hold IPOs in Norway during restrictions, measuring underpriced vs not underpriced in percentage.

We see from Table (8) that after 7 days the IPOs issued during restrictions, who were underpriced on the first day, clearly underperformed in relation to the companies that were not underpriced. Which is in line with earlier theories on the subject Ritter (1991).

Underpricing Restriction vs. No Restriction

Although we discovered that the underpriced companies listed under restrictions, were outperformed by the companies without underpricing. We would like to examine more closely whether the underpriced companies in Scandinavia issued during restrictions, actually outperform the underpriced companies listed under no restrictions.

IPOs with underpricing

	Restrictions				No Restrictions			
	Norway	**Sweden**	**Denmark**	**Scandinavia**	**Norway**	**Sweden**	**Denmark**	**Scandinavia**
7 Days	3.61 %	2.78 %	8.60 %	3.84 %	3.09 %	7.33 %	0.56 %	6.36 %
1 Month	-3.96 %	1.44 %	-0.61 %	-0.69 %	-3.93 %	1.44 %	-11.84 %	5.48 %
3 Month	7.66 %	10.35 %	30.53 %	12.10 %	-1.93 %	12.07 %	0.93 %	9.38 %
6 Month	0.75 %	-3.36 %	-22.60 %	-4.64 %	-8.28 %	-9.91 %	5.04 %	-4.64 %

Table 9: Measuring the long-term effects of IPOs in percentage, the table represent all IPOs where there was underpricing, Restriction vs, No restriction.

For Scandinavia, there were no differences in the IPOs issued during restriction versus no restrictions for the long-term period of 6 months. Sweden and Norway did a little bit better, with Norway being the only nation to have a positive return after six months. In Denmark, restricted IPOs performed worse than unrestricted IPOs during that time. We arrive at the conclusion that there was no meaningful

evidence of this after getting into further depth regarding whether the underpricing in Scandinavia nation by the country had any substantial change compared to if the IPO was issued under restrictions. This might be proof that IPOs have little impact on their long-term performance. Another reason could be that our sample size or time frame is insufficient.

7. Conclusions

In this master's thesis, we looked at how the COVID-19 pandemic restrictions affected the underpricing of IPOs in the Scandinavian market. We've examined Scandinavia as a whole and went into detail about how Norway performed in comparison to Denmark and Sweden. We have examined the long-run return and the underpricing in different periods where IPOs were conducted with or without restrictions. We did this because we wanted to see what impact restrictions on the IPO market had on the economy in the long and short run. Additionally, there was an interest in determining whether there was anything that may suggest that restricted IPOs would perform better than unrestricted IPOs that were similarly underpriced.

When analyzing our dataset containing 719 IPOs from the three countries in Scandinavia, we have found that there is a significant difference between IPOs that were issued under restrictions versus those that were not. We found that restrictions had a significant effect on the underpricing of IPOs, and the underpricing was on average 10.07% higher in Scandinavia for IPOs issued under restrictions. We also found that Norwegian IPOs tend to have less underpricing compared to the other Scandinavian countries. Despite this, during the restrictions Norwegian IPOs on average were higher than in the other countries with a 15,71% higher underpricing in the restriction period. We concluded that this was not due to any interaction effect, which indicates that the influence of the two variables is unique.

Furthermore, we looked at how restrictions affected the long-term effect of underpriced IPOs. Previous research has shown that these IPOs tend to

underperform, we find that there is a significant difference in the long-term group of IPOs that were issued under restrictions. It also turns out that in Norway, IPOs that were issued during restrictions outperform the OSEAX index. We then look at only the underpriced IPOs to see if these were the ones that accounted for these effects. It turned out that these were outperformed by the IPOs that were not underpriced, we also found that there was no significant difference between the IPOs that contained underpricing under restrictions and those that did not. Thus, we have discovered data that suggests constraints had an immediate impact on underpricing, and in the long-run.

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Appendix A

Equations:

$$UP3 = \alpha_0 + \beta_1\, restriciton\ variable_i + \beta_2 Greenshoe_i + \beta_3 lnAge_i + \beta_4 marketcap_i + \beta_5 industy\ dummy_i + \beta_6 Lagged\ volum\ index_i + \beta_7 Unemployment\ lagged + \beta_8\, lnVolume_i + u_i$$

(equation 4)

$$UP3_{Nor} = \alpha_0 + \beta_1 Norway\ dummy + \beta_2\, restriciton\ variable_i + \beta_3 Greenshoe_i + \beta_4 lnAge_i + \beta_5 marketcap_i + \beta_6 industy\ dummy_i + \beta_7 Lagged\ volum\ index_i + \beta_8 Unemployment\ lagged + \beta_9\, lnVolume_i + u_i$$

(equation 5)

$$UP3_{Nor} = \alpha_0 + \beta_1 Norway\ dummy + \beta_2\, restriciton\ variable_i + \beta_3 * (X1 * X2) + \beta_4 Greenshoe_i + \beta_5 lnAge_i + \beta_6 marketcap_i + \beta_7 industy\ dummy_i + \beta_8 Lagged\ volum\ index_i + \beta_9 Unemployment\ lagged + \beta_{10}\, lnVolume_i + u_i$$

(equation 6)

Tables:

Variable	(1)	(2)	(3)
Constant	-0.0815	-0.0500	-0.0501
	(0.086)	(0.092)	(0.092)
Restriction	0.0043	0.0135	0.0120
	(0.020)	(0.026)	(0.033)
GreenShoe	-0.0076	-0.0067	-0.0066
	(0.013)	(0.013)	(0.013)
lnAge	-0.0071	-0.0074	-0.0073
	(0.007)	(0.007)	(0.007)
lnMarketCap	0.0009	0.0013	0.0012
	(0.003)	(0.003)	(0.003)
Industry	0.0039	0.0027	0.0027

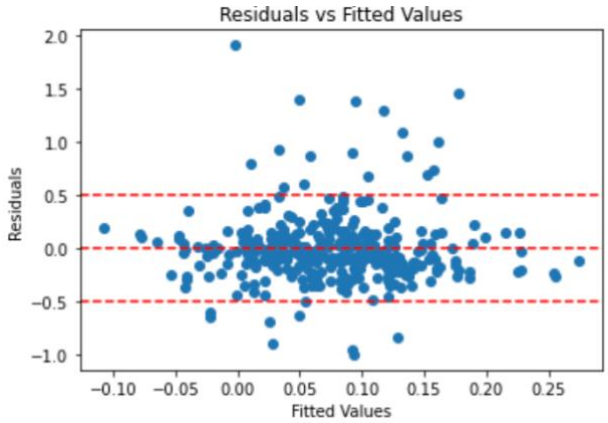
	(0.017)	(0.017)	(0.017)
Lagged Volume	0.0863*	0.0858*	0.08625*
	(0.045	(0.046)	(0.045)
Lagged Unemployment	-0.0066	-0.0115	-0.0115
	(0.005)	(0.008)	(0.008)
lnVolume	0.0096*	0.0099*	0.0099*
	(0.006)	-0.006	-0.006
Norway dummy		-0.0246	-0.0260
		(0.092)	(0.033)
X1*X2			0.0045
			(0.038)
Observations	719	719	719
R2	0.019	0.020	0.020
Adjusted R2	0.008	0.007	0.006
F-stat	1.150	1.078	0.9796

*Table 10: This table shows the impact of restrictions on underpricing of IPOs on day 3. This table represent equation 4-6. The table represent coefficients and standard error (in parenthesis). The dependent variable here is the return from day 1 to minus return day 3. Different significant levels: *p < 0.1; **p < 0.05; ***p < 0.01*

		Norge	Sverige	Danmark	Scandinavia
7 Days	T-statistic	-0.1478	-0.6592	0.6400	-0.5411
	P-value	0.8826	0.5100	0.5249	0.5885
1 Month	T-statistic	0.7588	-0.9713	0.6420	-0.5894
	P-value	0.5557	0.3318	0.5237	0.5557
3 Month	T-statistic	0.4490	-1.1689	0.9635	2.5000
	P-value	0.0356	0.2430	0.3397	0.0126
6 Month	T-statistic	0.0895	0.2430	0.3397	-2.4386
	P-value	0.9287	0.0236	0.0256	0.0149

Table 11: T-test of the different BHAR results in long-term performance.

Plot:

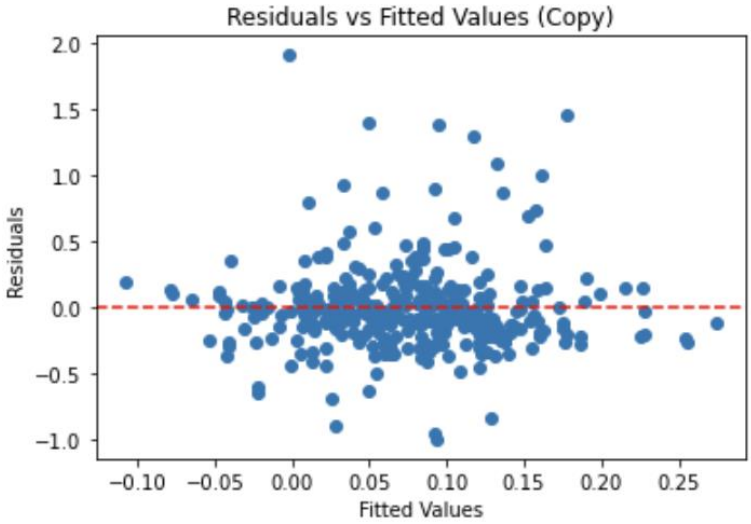


Plot 1: Residuals vs Fitted values plot with a horizontal band

Appendix B

Assumptions Results

1. **Linearity in parameters:** Testing for linearity with residual vs fitted. When making a residual plot, we should see an equal spread of the residuals along a horizontal line. If we look at the plot (plot 1), we can confirm that there indeed is linearity in the parameters. This is a so-called well-behaved residual vs fits plot, which will be explained in MLR.4.



Plot 2: Residuals vs Fitted values plot to check for linearity in our independent variables.

2. **Random sampling:** To ensure random sampling in our data, we are using the Durbin-Watson test. This is a test where we derive the sum of the difference

square and divide it by the sum of the squared error. The mathematical model used in this study is to determine if there is any autocorrelation in the residuals. it can be expressed as follows:

$$DW = \frac{\Sigma_{t=2}^{T}(\hat{e}_t - \hat{e}_{t-1})^2}{\Sigma_{t=1}^{T}(\hat{e}_t)^2}$$

ê is the regression residual for period t, the difference between the actual value and predicted value $(y_i - \hat{y}_i)$.

If we take a look at durbin watson statistics calculation (Table 11), we see that we have a value of approximately 1.952. The acceptable range for a successful test is between 1,5 -2,5. A value close to 2 such as we have is an indication that there is no first-order autocorrelation in our samples.

Statistics	**Value**
Durbin-Watson-statistics	1.952970857626232

Table 12: This table represents the value for the Durbin-Watson-statistics.

3. **No perfect multicollinearity:** To see if there is any multicollinearity between our independent variables we create a correlation matrix with the independent variables. When we look at the correlation matrix (Table 3) we need to see if there is any medium to high positive or negative correlations and test them.

	Restrictions	lnVolume	Greenshoe	lnAge	lnMarketCap	Lagged Unemployment	Industry	Lagged Volume
Restrictions	1							
lnVolume	0,12761216	1						
Greenshoe	-0,021235751	0,192320379	1					
lnAge	-0,084786078	0,046336098	0,321843062	1				
lnMarketCap	0,128933594	0,231450586	0,467853385	0,330440953	1			
Lagged Unemployment	0,084904749	0,035711751	0,005138542	-0,011863119	-0,164600236	1		
Industry	0,038268825	-0,058668016	-0,010830517	0,007502904	-0,043516345	-0,034733748	1	
Lagged Volume	-0,034773686	-0,05538538	-0,005947056	0,030933079	-0,055252708	0,046900324	0,048265085	1

Table 13: Correlation Matrix for all the independent variables.

With a correlation of 0.467, which is considered to be moderately positive, Greenshoe dummy, and LN market Cap have the strongest tendency to rise together. Additionally, we see a modestly significant association between lnAge

and the Greenshoe of 0.32. These variables are within the threshold of maybe having collinearity. We use a test called the Variance Inflation Factor (VIF) to ensure that these are independent of one another. We compare the three variables to one another as follows (Wooldridge, 2019):
CALCULATION OF VIF:

A.
Green shoe dummy ~ LN age + LN Market cap
B.
LN Market cap ~ LN age + Green shoe dummy
C.
LN Age ~ LN Market cap + Green shoe dummy

Dependent variable	lnAge	Greenshoe	lnMarketCap
R-squared	0.145	0.25	0.255

Table 14: Table showing the R-squared regression results for the independent variables, Age, Greenshoe, and MarketCap.

The VIF test, which is provided by:
VIF = $\frac{1}{(1-R^2)}$

We insert the R-squared found in Table 4, and get the results:
A = 1,066666667 B = 1,0695473 C = 1,021476544
Calculation 1: VIF

4. **Zero conditional mean:** We assume normal distribution in the error term which should be around zero. As mentioned in the first assumption the residuals vs fitted plot (Plot 1), is an example of a well-behaved residual plot, this means that we can use this plot to determine if there is Zero conditional mean. We take the same plot and look for a “horizontal band” around 0 (Plot 2). As you can see, we can assume that the error term's variance is constant.

5. **Homoskedasticity:** To test if there is a similar or equal variance in the groups being compared in our dataset, we run the Breusch-Pagan test (Wooldridge, 2019). The null hypothesis is that the variation of the error term is equal, resulting in homoskedasticity. If the p-value is statistically significant at a 5% level we reject the null hypothesis and have evidence for heteroskedasticity.
There are three steps to perform this test, the first one is to obtain the $\hat{u}^{2,}$for all the residuals, and then run the regression:

$$\hat{u}^2 = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + \ldots + \delta_k x_k + u_i$$

After this, we keep the $R^2_{\hat{u}}2$, and either use the Lagrange Multiplier (LM) or F-statistic and compute the p-value. We then compute the F-statistics for the joint significance for $x_1, \ldots, x_k$. The formula given is:

$$F = \frac{R^2_{\hat{u}}2/k}{(1 - R^2_{\hat{u}}2)/(n - k - 1)}$$

k = the number of regressors in the equation above, $R^2_{\hat{u}}2$ is a term used to distinguish from R-squared from the original regression. It represents the R-squared in the regression for the residuals above. n stands for the total number of observations, *and k indicates the number of variables.*

When we perform a Breusch-Pagan test, the long-range multiplier statistic comes out to be 31.285, and the p-value is 0.039971. We can observe in Table 12 that there is also an f-value of 4.043157 and an f p-value of 0.039326. The p-value is statistically significant at a 5% level, and we must therefore further investigate how we can handle the heteroskedasticity.

	Lagrange multiplier statistic	p-value	f-value
Breusch-Pagan test	16.172881	0.039971	2.042242
f p-value			0.039326

Table 15: Breusch-Pagan test, table show the test results.

In light of the result from the Breusch-Pagan test, we perform heteroscedasticity-robust standard errors, also known as White's standard errors (White 1980). For the OLS estimator to be BLUE it is assumed that the error term has constant variance, also known as homoscedasticity, it is crucial for the OLS regression that all the error terms are at equal values. We use the so-called HC3 version of heteroscedastic robust standard errors because it is more robust than the prior version and is better for relatively small and limited datasets as we have.

To test for heteroscedasticity, we subsequently use White's test (Wooldridge, 2019) for heteroscedasticity which is based on an estimation of the estimated error term:$\hat{u}^2 = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + \ldots + \delta_9 x_9 + \delta_{10} x_1^2 + \delta_{11} x_2^2 + \ldots + \delta_{18} x_9^2 + \delta_{19} x_1 x_2 +$

$$\delta_{20} x_1 x_3 + \ldots + \delta_{27} x_8 x_9 + u_i$$

	Test Statistic	p-value
White's test	55.71503946071805	0.07636660281485189

Tabel 16: Shows the test results for Whites test.

After we run the test with the new estimated error term, our p-vale is no longer significant and we accept the null hypothesis of homoskedasticity.

Extreme Outliers

When doing an OLS regression, outliers must also be considered because they can lead to inaccurate assumptions about the shape of the connection with the variables. As a result, we have decided to handle outliers in the underpricing day 1 and lnVolume variables as follows: We began by determining which points in the data set were outliers by calculating and examining the Z-score of each observation. Outliers were found as values larger than 3 and -3. Then we had to see if these were true values or if there was something else going on; for most values above this Z-score, there was an error in the observation, so we decided to look into it further from other reliable sources such as Eikon, Yahoo Finance and Investor.com. We chose mean imputation (MI) when we discovered outliers that were real but skewed our findings. This is easily accomplished by simply

substituting the mean of this variable for the outlier that confuses our analysis (Jamshidian & Mata, 2007).