A New Era of the Swedish IPO Market?

A Study of the Impact of Firm Age on Underpricing and Long-Run Post-IPO Performance in the Swedish Financial Markets

HENRIK FORSS

TED WAHLSTRÖM

Bachelor Thesis

Stockholm School of Economics

2022

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Abstract:

Through a quantitative study, we set out to further the understanding of the Swedish IPO landscape, aiming to contribute to the partly fragmented literature on the topic. By running a multiple ordinary least squares regression and a Mann-Whitney U-test on 260 Swedish IPOs listed between 2014 and 2021, we analyse the effects on underpricing and post-IPO long-run performance stemming from disparate firm ages. While not statistically significant, a pattern of higher first-day returns among young firms can still be observed. Our two event variables, i.e., the control variables "Hot market" and "Coronavirus", are shown to significantly impact the level of underpricing prevalent in the Swedish financial markets, with the "Hot market" being the most important explanatory factor. In line with previous literature, we document that, in general, younger firms tend to exhibit a lower post-IPO performance.

Keywords:

IPO, Underpricing, Long-run performance, Firm age, Hot market.

Authors:

Henrik Forss (24638)

Ted Wahlström (24867)

Tutor:

Ye Zhang, Assistant Professor in Finance, Swedish House of Finance

Examiner:

Adrien d'Avernas, Assistant Professor, Department of Finance, Stockholm School of Economics

Bachelor thesis
Bachelor Program in Business and Economics
Stockholm School of Economics

1. Introduction

1.1 Background and Research Question

The climate for initial public offerings, especially in Sweden, has been on a tear in recent years. A large number of newly founded companies have chosen an initial public offering as a strategic choice of equity funding. This study aims to increase the understanding of how firm age affects the level of underpricing in an initial public offering and the long-term post-IPO performance.

The market for IPOs in Sweden has experienced substantial growth in recent years, with innumerable and prominent offerings in 2021 in particular, where companies such as Volvo Cars, Hemnet, Synsam, and Truecaller have decided to go public. Due to recent years' development, the incentive to understand the underpricing phenomenon has undeniably increased. In order to fully understand the significance of the level of underpricing that takes place in the Swedish financial markets of today, the result must be compared to times of less activity in the markets. To capture the entire spectrum of the consequences of underpricing, a long-term perspective that sheds light on the financial post-IPO performance in regard to the overall market performance should most definitely be included in the analysis.

Many newly started companies, not seldom within the tech sector, have decided to go public during the last couple of years. Fast-growing companies, driven by new technology and distribution systems together with easy access to capital, have revolutionised the Swedish service sector and, followingly, the Swedish financial markets (EY, 2021). Today, the number of what can be characterised as young firms (see definition below) outweighs the number of old firms which decide to go public. This distribution was not observable a few years ago, and hence, the interest to dig into this emerging trend and examine if the underlying dynamics of the financial market have been affected in any way has heightened.

The Coronavirus hit the global stock market with full power, leading to a significant decline across the entire financial system. However, even though the virus still affects millions of people's lives at the time of conducting this study, the stock markets worldwide, especially in Europe and the United States, recovered sharply during the second half of 2020 and continued in the same direction during 2021. The strong market performance and ebullient market sentiment pushed recent years' increased number of transactional services to a historical peak in 2021, with over 100 registered IPOs (excluding direct listings and spin-offs) directed to the public in Sweden alone (Affärsvärlden, 2021). This study will contribute to understanding how the Coronavirus and the historical peak in activity have affected the decision to go public in recent years.

Underpricing, defined as the increase between the initial offering price and the stock's first-day closing price, is non-existent in an efficient market. However, it is most definitely a recurring reality in the real world. The issue is partly stemming from the winner's curse problem evident in the market for initial public offerings, in which there are two types of investors, namely sophisticated (informed) and uninformed buyers. As the less informed buyers are worried they

might overpay in the transaction, companies might find it increasingly challenging to attract investors willing to offer a high price, which can incentivise firms to jettison NPV positive projects (Rock, 1986). These dynamics constitute the foundation of underpricing and are the points of departure for this study.

The purpose of this thesis is thus to examine if, and if so, to what extent, the firm age has an impact on the level of underpricing. Furthermore, we aim to combine and extend current studies on the topic by focusing on potential discrepancies stemming from a hot- and cold IPO environment, respectively. The study will be conducted on the Swedish IPO market between 2014 and 2021. To answer this, the following research questions will be addressed:

1) *To what extent does firm age affect the level of underpricing?*
2) *Can we observe any meaningful differences in a hot compared to a cold IPO environment?*

Moreover, we aim to delve deeper into the long-run performance of IPOs, which have historically been shown to display abnormal returns over time (Ritter, 1991). Studying the long-run returns of IPOs enables us to understand how fluctuations in the financial markets influence a firm's decision to go public. Given the large variations in IPO volume, companies are likely trying to take advantage of changes in investor optimism as well as overall market sentiment, something Ritter calls "windows of opportunity", which might subsequently affect the long-run performance of the stock. This has profound repercussions for investors and the capital market and has been a recurring theme, especially in Sweden during our studied time frame. In addition, the IPO market has been diagnosed with the "hot-issue market phenomenon", where different market climates affect financial prices, ultimately putting the efficiency of the IPO market in question (Shiller, 1990). Finally, previous empirical evidence indicates a relationship between firm age and market enthusiasm, as long-run underperformance has been particularly prevalent in younger firms, at least in the US (Ritter, 1991). Thus, in order to study the potential effects stemming from these anomalies, our third and final research question is:

3) *Does firm age affect the long-run post-IPO performance?*

1.2 Methodology Introduction

The methodology of the data analysis of this study takes its point of departure from two different perspectives, specifically a short- and long-term perspective, which together provide insights into companies' market value of equity developments after an initial public offering. To begin with, a least ordinary squares regression analysis, including key variables such as firm age, market climate, the Coronavirus, the choice of exchange, and the firm size (measured through market capitalisation), will determine whether underpricing differs between young and old firms and if any long term financial performance differences can be observed. In this study, the applied definition of underpricing is the difference between the offer and the first-day closing prices. Then, to determine the long-run financial performance of the IPOs, the so-called Buy-and-Hold Abnormal Returns (BHAR) methodology is applied. This methodology builds on the concept of buying a stock at the IPO and holding on to it for a specific time period, which in this study is

one, two, and three years. The performance is then compared to a benchmark, which in this study is set to be the OMXSPI index, a market value-weighted index targeting all of the listed stocks in the Swedish stock market. Finally, the least-square regression analysis will be complemented by the Mann-Whitney U-test, a nonparametric test that does not require the sample groups to be normally distributed, to see if a mean value difference in underpricing and long-run financial performance can be observed between young and old firms. The methodology is presented in greater detail in Section 4.

1.3 Brief Results

1.3.1 Underpricing

The regression analysis of this study points to a modest difference that is not statistically significant in the level of underpricing between young and old firms. However, the market climate for IPOs has been shown to significantly affect the level of underpricing. The difference in underpricing is, on average, 23.7 % between firms that went public during a hot- respectively cold IPO climate. This difference is statistically significant at a 1 % level in our test. According to our Mann-Whitney U-test, a significant difference between underpricing and firm age does not seem to exist.

1.3.1 Long-Run Performance

The findings from the regression analysis indicate a recurring pattern, as young firms tend to exhibit a relatively lower BHAR than old companies. However, this result is not statistically significant, and the overall model exhibits a relatively low R-squared value for all different time periods. When comparing the difference between young and old firms in terms of the long-run performance through the nonparametric Mann-Whitney U-test, we can observe a lower mean rank for young firms in all different time series, with the result being significant at the 5 % level for the three-year period.

The structure of the remainder of this paper is as follows. Section 2 describes previous studies on underpricing and long-run performance, emphasising our contribution to the existing literature. Section 3 describes the sample and data collected for our study. Section 4 outlines the applied methodology, including both the regression analysis and Mann-Whitney U-test. In Section 5, the results from our statistical analysis are presented. Section 6 subsequently contains the discussion regarding our main empirical findings, along with limitations and further research. Finally, our main conclusions are outlined in Section 7.

2. Literature Overview

Among the closest papers that we have identified for our research is the seminal study conducted by Ritter (1991), which subsequently is asserted to be of most relevance for our study and the development of our research questions, in which he examines the level of underpricing for firms

going public on the US stock market, as well as the long-run performance of these companies. Ritter finds evidence for the previously documented "hot-issue market phenomenon" and discovers a significant pattern between young growth companies, hot markets, and underpricing. Since Ritter published this study in the Journal of Finance in 1991, both the stock markets and the economy have radically transformed, not least in the western hemisphere, thus making a renewal of his work highly essential. This is not least evident in the fact that most firms characterised as young in Ritter's study were oil and gas companies.

Helwege and Liang (2004) is another closely related paper. The authors perform a study in which they put the state of the IPO market itself in the spotlight. They find that firms going public in hot IPO markets do not tend to be younger than IPOs in cold markets, thus partially contradicting the popular notion that primarily younger, risky start-ups choose to go public in a hot market. Loughran and Ritter (2004) also investigate the increased level of underpricing in what they call the "bubble period", ultimately deriving the loss in focus on maximising IPO proceeds to the increased emphasis placed on research coverage. The study also highlights differences in underpricing stemming from disparate firm ages, arguing that, in general, younger firms are perceived as riskier, leading these companies to exhibit greater levels of underpricing.

Underpricing is a well-documented phenomenon; however, notoriously difficult to explain. Well-known theories such as The Winner's curse theory (Rock, 1986) and the Signalling theory, developed and elaborated by several researchers, including Allen and Faulhaber (1989), provide some answers to the issue. However, they are not comprehensive. Due to this, several authors have tried to generate additional complementary theories, taking a behavioural approach to explain underpricing. For example, while underwriters benefit from a high offer price, they nonetheless tend to leave money on the table. According to Loughran and Ritter (2002), this is due to two reasons. First of all, it is easier to find potential buyers if the offer price is low, and secondly, it has to do with so-called rent-seeking behaviour, as investors overpay for other services that the underwriter provides in order to improve their allocation in upcoming IPOs.

Moreover, several studies on factors affecting the long-run IPO performance have previously been conducted. Derrien (2005) applies the Buy-and-Hold Abnormal Returns metric to analyse how investor sentiment affects the long-run performance of IPOs. An 18-month time span is applied, as well as industry indexes by which the sample is divided. This methodology, based on a different benchmark and time span, will guide the data analysis for the long-run performance of our sample. Both Ritter (1991), Loughran and Ritter (2002), as well as Derrien (2005) test for the correlation between initial return and long-run performance but do not find any significant explanatory value for the regression coefficient. Therefore, Derrien proposes that firm-specific variables may affect initial returns; however, they do not influence long-run performance. On the other hand, Ritter finds evidence that younger companies generally exhibit worse aftermarket performance. Our study results in terms of firm age affecting underpricing and long run-performance can be set against this background.

In conclusion, there has been a vast amount of previous research dedicated to the field of IPO underpricing as well as the post-IPO long-run performance, which is not surprising given the phenomena's constant and widespread presence in financial markets. Hence, to distinguish our

study from previous literature, we will first focus on the possible implications of underpricing and post-IPO long-run performance stemming from different firm ages. Furthermore, our study combines and extends previous research by emphasising potential differences in underpricing and long-run performance of young vis-a-vis old IPOs launched in different market climates. By applying a different geographical lens through which we perform our study, namely, the well-developed Swedish stock exchanges, we can thus achieve a more all-encompassing, dynamic, and widely applicable result. This is not least due to natural reasons stemming from disparities in composition and size of the US stock market compared to the Swedish ditto. As the lion's share of previous literature on IPO underpricing and post-IPO long-run performance is concentrated in the US, more comprehensive and nuanced knowledge of the currently somewhat fragmented literature on the Swedish IPO landscape is highly called for.

3. Data

This section presents the methods for collecting data and the following variables obtained through these sources. Section 3.1 introduces the reader to our collected sample of IPOs, while more specific data regarding the IPOs, the corresponding databases and the included variables are provided in Section 3.2. Section 3.3 describes and presents various descriptive statistics for our dataset. Finally, Section 3.4 provides information about the index used for the analysis of the long-run performance as well as the corresponding database used for that purpose.

3.1 Dataset

In order to find reliable information regarding IPOs on the Swedish stock market during our selected timeframe, we have used the rigorous database SDC Platinum. While the initial sample was composed of 305 IPOs, several duplicates, preferred shares, listings on foreign exchanges, secondary offerings, and spin-offs were included that we subsequently omitted from the studied sample. Moreover, we precluded IPOs where the database could not produce sufficient or reliable information. The same is true for our other main database of choice, FinBas. Extraordinary results in terms of first-day returns have been compared to readily available public financial information and subsequently excluded if deviant. Thus, after these alterations, a total number of 260 IPOs, listed from 2014 and onwards, forms the basis for the study's statistical analysis. Nasdaq OMX Stockholm, First North, Spotlight (previously Aktietorget), and NGM are the exchanges on which the sample of IPOs are listed.

3.2 Databases - IPOs

To gather data on historical Swedish IPOs, offer price, and firm age, SDC Platinum has been used as a database. SDC Platinum is a comprehensive and reputable database that has been used extensively in previous studies. Furthermore, SDC Platinum has been complemented with FinBas, another prominent database, in order to receive data on the first-day closing prices of the individual stocks and their respective market capitalisations. The complete list of our key

variables, collected from our two aforementioned primary databases, SDC Platinum and FinBas, containing corresponding descriptions, are provided in the appendix (see Appendix 1 and 2).

3.3 Sample Statistics

When reviewing our selected sample of IPOs, the bull market of 2021 with a record amount of listings immediately catches the eye. In sum, 39.23 % of the IPOs in our sample stem from this time period. Furthermore, the year 2017 is also considered to be a hot market according to our classification method, and these two time periods subsequently constitute 56.92 % of the IPOs in our entire sample. Also noteworthy is the temporary cooldown in the markets during the initial stages of Covid-19, where the spring of 2020 underwent without a single IPO, ultimately helping to create a backlog of listings launched during the more optimistic market climate of 2021 instead. The following figure illustrates the number of IPOs per calendar year, divided into young and old firms, as well as the average amount of underpricing per year. As clearly illustrated in the graph, the hot markets of 2021 and 2017 correspond to periods of higher underpricing.

Figure 1: IPO Distribution and Underpricing Per Year (2014-2021)

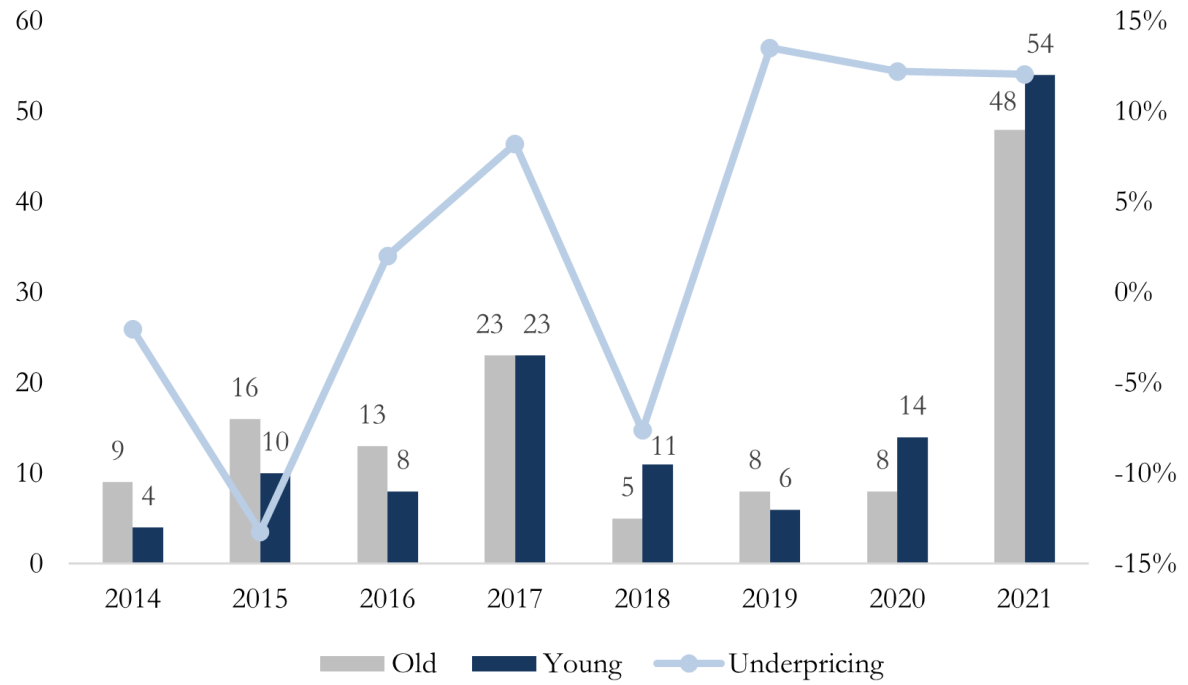

Figure 1 illustrates the distribution of IPOs prevalent in our sample for each year, with the bars displaying the number of offerings for young and old firms, respectively, during each year. The trendline (right axis) illustrates the average level of underpricing for each year.

For the long-run post-IPO performance analysis, as observable in the graph below, the sample size decreases as the BHAR-period extends. The graph illustrates an increase in the average BHAR as the time period prolongs. Moreover, as presented in greater detail in Appendix 8, we can observe a rather substantial difference in terms of the mean BHAR between young and old firms for all time periods.

Figure 2: Long-Run Sample Distribution and Average BHAR Per Time Period

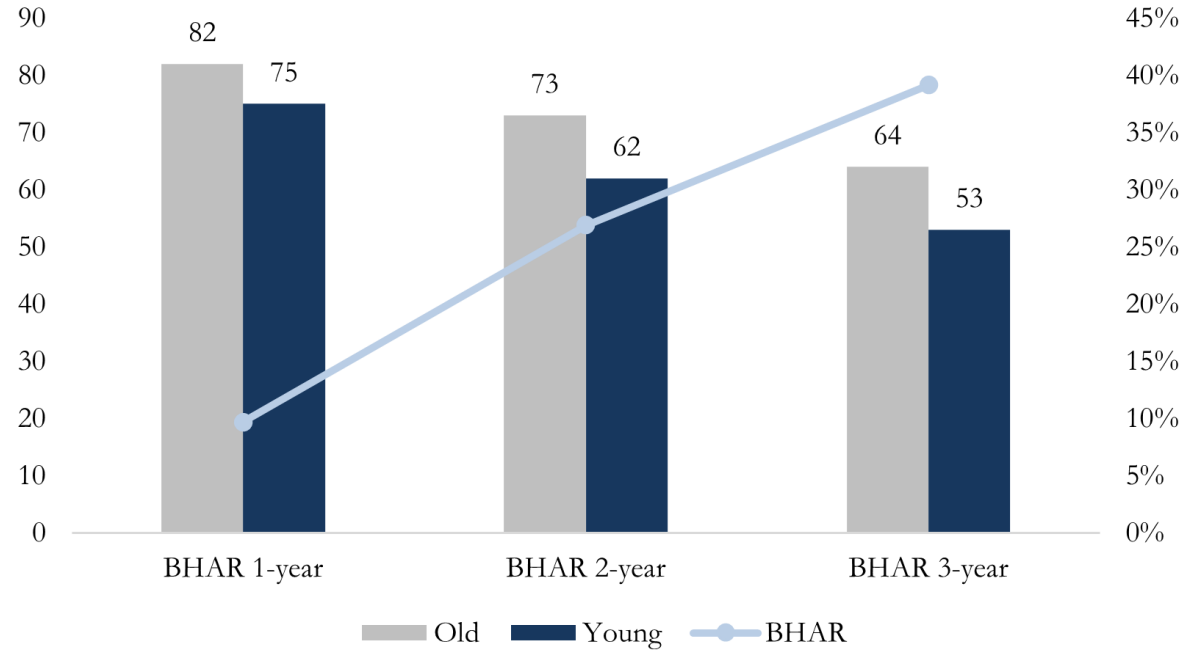

Figure 2 illustrates the average Buy-and-Hold Abnormal Returns ("BHAR") in our sample for the one-, two-, and three-year time periods. The bars indicate the number of firms, divided into young and old, that were included in the calculation for each time series. The trendline (right axis) illustrates the average BHAR for each time period.

The following table summarises various descriptive statistics of the levels of underpricing prevalent in our data set, as well as the corresponding statistics for the Buy-and-Hold Abnormal Returns. More detailed descriptive statistics for our dependent variables, divided into young and old firms, can be found in Appendix 7 and 8. Through these descriptive statistics, we can conclude that underpricing is still a prevalent phenomenon in the Swedish financial markets, with IPOs on average producing an initial return of 6.2 %. However, this is a rather low figure compared to previous literature, such as Ritter (1991), where he finds an average level of underpricing at 16.4 % in the US stock market, perhaps suggesting an improvement in firm quality and a wholly different financial landscape as of today, potentially stemming from a reduction in information asymmetry which is further discussed in Section 6. Also striking is the high variation, evident in the minimum- and maximum figures below, in the long-run performance within our sample. This is also evident in the relatively high standard deviations obtained for the Buy-and-Hold Abnormal Returns, especially for longer time periods, which is illustrated in Appendix 10.

Table 1: Sample Statistics of Underpricing and BHAR

Table 1 illustrates various descriptive statistics of our sample of IPOs for the dependent variables Underpricing and BHAR. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock. "BHAR" is defined as the Buy-and-Hold Abnormal Return of the stock less the benchmark's return during the corresponding time frame. The statistical figures included are the number of observations, the min, 25th percentile, mean, median, 75th percentile, max, kurtosis, and skewness for our dependent variables underpricing and Buy-and-Hold Abnormal Returns.

Variable	*N*	*min*	*25th percentile*	*mean*	*median*	*75th percentile*	*max*	*kurtosis*	*skewness*
Underpricing	260	-82.41 %	-8.25 %	6.20 %	1.74 %	17.45 %	175.56 %	7.20	1.62
BHAR 1-year	157	-111.17 %	-36.14 %	9.69 %	-0.33 %	33.39 %	350.97 %	5.52	1.91
BHAR 2-year	135	-122.89 %	-40.76 %	26.90 %	9.80 %	48.34 %	713.64 %	11.36	2.88
BHAR 3-year	117	-170.72 %	-51.25 %	39.15 %	-0.66 %	61.67 %	917.09 %	9.97	2.83

3.4 Database - Index

We have also used the database Thomson Reuters Eikon. This widely acclaimed database has been used to gather information regarding the price development of the Swedish stock market, namely the index OMXSPI. The gathered data will be used to determine the relative long-run performance of the firms included in our sample. Thomson Reuters Eikon is a reliable database used to supplement our other databases to receive data regarding the stock market's development during the entire time period of our sample. All variables collected from this database and their accompanying descriptions are provided in Appendix 3.

4. Methodology

This section aims to describe the methods and models implemented in our analysis. To begin with, Section 4.1 describes the general delimitations and definitions inherent in our model. Furthermore, to answer our research question, we have used calculations to determine underpricing, which is presented in Section 4.2. The methodology for assessing the long-run performance of the IPOs in our sample, including the Buy-and-Hold Abnormal Returns and the associated benchmark used for determining the relative post-IPO performance, are presented in Section 4.3. Our methodology for classifying companies as young or old is outlined in Section 4.4, while the procedure for classifying market climates is discussed in Section 4.5. Our method for delimiting the Coronavirus is outlined in Section 4.6. The regression that we have performed to answer our research questions is presented and discussed in Section 4.7. Finally, our Mann-Whitney U-test and the associated methodology for performing this nonparametric test are outlined in Section 4.8.

4.1 Delimitations

We have chosen to delimitate the study to capture the IPOs in the Swedish stock market that has taken place between the years 2014 and 2021. This time span has been chosen to be able to clearly distinguish between a hot- and a cold IPO environment and to gather a sufficiently large amount of IPOs to make our statistical analysis meaningful. Moreover, we have included a control variable for the Coronavirus crash. By including an additional time-based variable, besides the dummy variable for a hot market, we can not only control and test for the most significant macroeconomic event during our time frame but also get a better grasp of potential consequences stemming from the pandemic itself.

The stock exchanges that provide the data for our analysis will be Nasdaq OMX Stockholm, First North, Spotlight Stock Market, and the Nordic Growth Market (NGM). The rationale for including smaller and more illiquid stock exchanges is to get a comprehensive understanding of the underpricing prevalent in the Swedish financial markets, as discrepancies could exist both regarding firm age and overall company composition between exchanges and to capture potential effects stemming from different firm sizes. Previous studies have shown that discrepancies in, for example, firm characteristics and size exist between exchanges that might have a meaningful influence on both underpricing and long-run performance (Ritter, 1991). For example, 97 out of 163 IPOs on the smaller exchanges were classified as young companies in our sample. Simultaneously, according to our classification method, only 33 out of the 97 IPOs conducted on Nasdaq OMX Stockholm during our time frame were considered to be young firms. Moreover, in order to distinguish between small and large firms, we have implemented a method in which we divided firms into their respective size-category based on market capitalisation. By analysing all IPOs during our selected time frame, we have identified an average market value of the listed companies and consequently delimited firms based on this threshold level.

4.2 Underpricing

Underpricing is calculated as the difference between the definitive offer price in an IPO and the subsequent first-day closing price, which should be zero according to the efficient market hypothesis (Shiller, 2003). Otherwise, the firm has "left money on the table" and priced its offering below its fair value, leaving investors with a positive initial return. Consequently, an IPO that delivers a negative return on its first day of trading should be characterised as "overpricing".

While most previous papers have treated underpricing and initial returns as the same thing, some scholars, such as Derrien (2005), have made a distinction between the two. However, we will treat underpricing and initial returns as synonyms throughout this study, as they are undeniably interlinked - underpricing, referring to pricing the IPO below its fair value, is a precursor to the initial returns, traditionally defined as the subsequent aftermarket stock development (Derrien, 2005). Thus, the formula for computing underpricing for each security is defined as follows:

$$Underpricing_i = \frac{P_{i,t=0}}{P_{i,\,offer\ price}} - 1$$

4.3 Long-Run Post-IPO Performance

In order to assess the long-run post-IPO performance present in our sample, we will implement a framework known as Buy-and-Hold Abnormal Returns. First, we discuss an alternative measure of long-run performance, which is presented below in Section 4.3.1. In Section 4.3.2, we first introduce the reader to the concept of BHAR, the Buy-and-Hold Abnormal Returns, that will be used to assess the relative long-run performance of the firms in our sample. Then, in Section 4.3.3, we discuss the benchmark used for our research purposes.

4.3.1 Alternative Measure of Long-Run Performance

The Cumulative Abnormal Returns (CAR) is another metric used for analysing the long-run financial performance of IPOs. It is based on the arithmetic mean of the sample (instead of the geometric mean, which is used in the calculation of BHAR) and has been implemented in some previous studies (Ritter, 1991). The following equation describes the formula used for calculating CAR:

$$CAR_{q,\,s} = \sum_{t=q}^{s} AR_t$$

However, the BHAR metric has been shown to provide numerous benefits, especially when the calculation is done on a longer horizon, in comparison to CAR, such as a more accurate measure of investor experience and the elimination of rebalancing bias inherent in CAR, and hence, the BHAR metric will be applied in this analysis (Barber, Lyon, and Tsai, 1999).

4.3.2 Buy-and-Hold Abnormal Returns

The BHAR methodology is a well-known and frequently applied way of determining the long-term comparative performance of an IPO. The rationale behind this method is that it will accurately mirror the return the stock would generate during the time between the IPO and the end of the chosen time period. While different time frames occur throughout the literature, a common method is to measure the stock's performance up to three years after the initial IPO (Ritter, 1991). If applying a shorter time period, we would not be able to include the long-run performance, and if applying a longer time period, the sample would be of marginal interest due to a heavy reduction in size. Thus, we will seek to implement a similar approach to Ritter, measuring the Buy-and-Hold Abnormal Returns for one, two, and three years post the IPO.

While Ritter measured the long-run performance based on the first-day closing price, we have chosen to instead measure the BHAR for the firms in our sample from the definitive offer price. As the market for IPOs has been particularly buoyant during the last few years, with many offerings being oversubscribed by investors influenced by the bullish sentiment, the level of underpricing (as illustrated in Figure 1) has reached relatively high levels. Therefore, we argue that adjusting for the first-day return would make the view of the long-run performance somewhat skewed and biased. Moreover, incorporating the first-day returns into the study of long-run performance aligns with our overarching research purpose and other chosen methodologies. We have defined one year as a calendar year, in other words, 365 days. If the 365th day is a non-trading day, the last tradable day will provide the corresponding data.

The following equation describes the calculation used for determining the BHAR for the IPOs in our sample. The BHAR equation consists of two parts. The first one represents the daily return of the IPO during the specific time period, and the second part represents the return of the benchmark, in this case, the OMXSPI, during the explicit time period. If the subsequent difference, the BHAR, is positive, the IPO has outperformed the OMXSPI and vice versa.

$$BHAR_{i,t} = \Pi_{t=1}^{T}\left[1 + r_{i,t}\right] - \Pi_{t=1}^{T}\left[1 + E(r_{b,t})\right]$$

The data is, as previously mentioned, obtained for the period 2014-01-01 to 2021-12-31, and hence the long-run performance will not be able to include all of the IPOs in our sample. Moreover, due to buyouts, mergers and acquisitions, as well as outright de-listings, some companies will not be able to provide data for all three time periods, thus slightly reducing the overall sample.

4.3.3 Benchmark

In this study, the OMXSPI index will constitute the benchmark for calculating BHAR. The OMXSPI, an index comprising all of the securities listed on the Stockholm Stock Exchange, is one of the most well-known and followed indexes in Sweden that presents a broad and fair overview of the development of the Swedish stock market. While Ritter (1991) inter alia implemented the use of matching firms, i.e., comparing the performance of IPOs to already

listed, comparable companies, he also used slightly modified versions of the well-known NASDAQ Composite and S&P 500 indexes. Derrien (2005), on the other hand, applies industry indexes as benchmarks. Thus, the choice of benchmark is highly subjective. We have chosen to compare the long-run performance of the respective firms with a broad index, in line with previous literature, ensuring an applicable and frictionless test procedure (Ritter, 1991). Given the relatively small size of the Swedish stock market, it becomes difficult to find a sufficient quantity of similar companies for a direct comparison. Thus, as the market portfolio, according to the efficient market hypothesis, is the efficient portfolio, the OMXSPI should serve as a practical and appropriate benchmark for comparing the long-run post-IPO performance of the firms in our sample.

The OMXSPI has performed well during the time period relevant to our study, thus providing a fair and competitive yardstick. Against this background, we believe the OMXSPI is a suitable benchmark to apply in order to capture the development of the Swedish stock market. The time period of the analysis is set to be a one-, two-, and three-year time span, respectively.

Figure 3: OMXSPI Development During 2014-2021

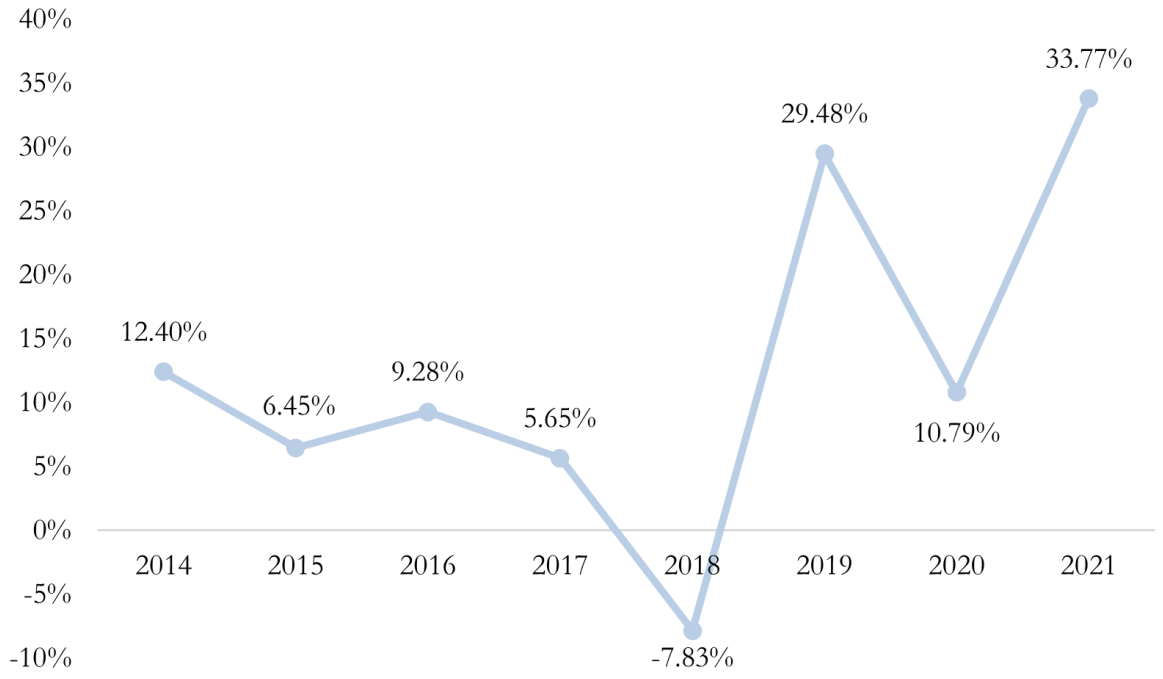

Figure 3 illustrates the development of our benchmark of choice, the OMXSPI index, during the years 2014-2021. The data labels indicate the development of the index during each year. Data for the index is collected from Thomson Reuters Eikon.

4.4 Firm Age Classification

Over time, different methodologies have been implemented to demarcate a young from an old firm when classifying IPOs. While alternative approaches range from subjective measures to dividing companies into different percentiles based on their relative age, we have decided to implement the pragmatic approach of classifying a company as young if the firm is younger than the median age of the entire sample, which in our case is 13 years. This method has been used in

different studies and is a coherent, logical way of determining the relative age of a firm going public (Loughran, Ritter, 2004). As we seek to investigate whether the firm age influences the level of underpricing, it is not the firm's current age but the age of the company at the time of the IPO that is the implemented and examined figure.

4.5 Hot Market

Scholars have historically implemented a few different approaches to separate a hot- from a cold IPO climate within the literature. Some argue in favour of characterising a hot market based on the quality of the firms that go public, with the signalling theory claiming that higher-quality firms tend to be overrepresented in hot markets, as their corresponding offer price should be less affected by adverse selection costs (Welch, 1989). Others argue the opposite (Loughran and Ritter, 1995) due to a documented lower stock return for firms during a hot IPO market, while some argue that the main attribute of a hot market is the ebullient investor optimism also classified as irrationality (Lerner, 1994). We have decided to distinguish between a hot- and a cold IPO environment by studying the IPO activity since 2014 and demarcating between different market climates by using the third (upper) quartile of IPOs during this period as the dividing figure. This is a practical, stringent way of classifying the IPO market, also in line with several scholars' definitions of a hot IPO market (Helwege and Liang, 2004).

4.6 Coronavirus

While there are several ways of depicting the start and end of the pandemic, in order to receive such a universal starting point as possible, we estimate the beginning of the pandemic to be the 11th of March 2020, which is the day when the World Health Organisation declared Covid-19 as a pandemic (Folkhälsomyndigheten, 2020). In contrast, we characterise the pandemic's ending as coinciding with the Swedish stock market indexes retaking their pre-pandemic highs. While not medically correct, since this is a study of the financial markets, we argue that such a classification strategy is most suitable for our research purposes, as it indicates the swift nature of the downturn and the investor sentiment at that particular time.

4.7 Least Ordinary Squares Regression

The multiple ordinary least squares ("OLS") regression is a dominant method in analysing differences in underpricing and long-run performance stemming from firm characteristics in previous literature (Ritter, 1991; Derrien, 2005). The method enables us to control for various exogenous and endogenous factors possibly affecting the dependent variable. Against this background, we have chosen to conduct an OLS regression to answer our research questions. In order to fully capture the potential effects stemming from our main variables of focus, that is, firm age and hot market, as well as to control for the omitted variable bias (OMV) as much as possible, we will run the regression stepwise. First and foremost, we will run the regression exclusively with our main control variable, firm age. After adding the dummy variable for a hot market, we will subsequently include the remaining independent variables. Finally, as our sample displays some level of heteroscedasticity (see Appendix 14), we will implement the use of robust standard errors in our analysis.

The following table illustrates our chosen independent variables, where the firm age is the focal point of our statistical analysis in order to answer our research questions.

Table 2: Description of Independent Variables

Table 2 illustrates our chosen independent variables and their associated descriptions. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. For the dummy variable "Hot market", a value of 1 represents a listing during the time period of either 2021 or 2017, and a value of 0 corresponds to a listing in one of the other years during our time period. For the dummy variable "Coronavirus", a value of 1 represents a listing during the initial stages of the pandemic, and a value of 0 if the listing was completed either before or after that specific time interval. For the dummy variable "Exchange", a value of 1 represents a listing on Nasdaq OMX Stockholm, and a value of 0 represents a listing on either First North, Spotlight, or NGM. For the dummy variable "Firm size", a value of 1 represents a listing where the company is considered large, and a value of 0 if the company is characterised as small according to our classification method.

Dummy variable	***Description***
Firm age ***(1 or 0)***	A positive beta coefficient implies that young firms experience higher levels of underpricing or higher BHAR than old companies, and vice-versa.
Hot market ***(1 or 0)***	A positive beta coefficient implies that firms listed during hot markets experience higher levels of underpricing or higher BHAR than firms listed during cold markets, and vice-versa.
Coronavirus ***(1 or 0)***	A positive beta coefficient implies that firms listed during the Coronavirus experience higher levels of underpricing or higher BHAR than firms not listed during the pandemic, and vice-versa.
Exchange ***(1 or 0)***	A positive beta coefficient implies that firms listed on Nasdaq OMX Stockholm experience higher levels of underpricing or higher BHAR than firms listed on the smaller exchanges, and vice-versa.
Firm size ***(1 or 0)***	A positive beta coefficient implies that larger firms experience higher levels of underpricing or higher BHAR than smaller companies, and vice-versa.

Thus, in conclusion, our regression analysis for underpricing will be implemented as follows:

$$Underpricing_i = \alpha_i + \beta_1(Firm\_Age) + \beta_2(Hot\_Market) + \beta_3(Coronavirus) + \beta_4(Exchange) + \beta_5(Firm\_Size) + \varepsilon_i$$

To analyse the post-IPO long-run performance of our sample of IPOs, the following regressions will be carried out to determine the Buy-and-Hold Abnormal Returns:

$$BHAR_{1\,year,\,i} = \alpha_i + \beta_1(Firm\_Age) + \beta_2(Hot\_Market) + \beta_3(Coronavirus) + \beta_4(Exchange) + \beta_5(Firm\_Size) + \varepsilon_i$$

$$BHAR_{2\,years,\,i} = \alpha_i + \beta_1(Firm\_Age) + \beta_2(Hot\_Market) + \beta_3(Coronavirus) + \beta_4(Exchange) + \beta_5(Firm\_Size) + \varepsilon_i$$

$$BHAR_{3\,years,\,i} = \alpha_i + \beta_1(Firm\_Age) + \beta_2(Hot\_Market) + \beta_3(Coronavirus) + \beta_4(Exchange) + \beta_5(Firm\_Size) + \varepsilon_i$$

4.8 Mann-Whitney U-Test

The collected sample of IPOs is not normally distributed (see Appendix 12 and 13). Thus, to strengthen the analysis of how the parameter firm age affects underpricing and long-run performance and generate additional insights to supplement our regression analysis, we conducted a nonparametric Mann-Whitney U-test. The test does not require the sample to be normally distributed, and hence, it is a suitable course of action to identify any meaningful differences in underpricing and long-run performance between the independent samples of young and old firms. The Mann-Whitney U-test is equivalent to the Wilcoxon Rank-sum test.

The following equations describe the formula used for calculating the Mann-Whitney U-test:

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

$$U = min(U_1, U_2)$$

n_1 and n_2 are the sample size of the respective groups. R_1 and R_2 are the number of ranks for the two groups. If $U < U_{crit}$ the null hypothesis can be rejected, where U_{crit} can be found in the official Mann-Whitney tables list in the case of calculating by hand.

5. Results and Analysis

The following section presents the results obtained from our regression analysis, which was described in Section 4.7 above, as well as the findings obtained from the Mann-Whitney U-test, described in Section 4.8. We will first present the results from our regression analysis on the topic of underpricing in Section 5.1. Section 5.2 describes the results from the regression analysis of BHAR. Next, the following section introduces the reader to our regression analysis conducted on Buy-and-Hold Abnormal Returns, with the statistical results obtained from our three different time periods presented in Section 5.2. We then illustrate the results from the nonparametric Mann-Whitney U-test for the dependent variable underpricing in Section 5.3, subsequently describing the results from the same test performed on the dependent variable BHAR in Section 5.4.

5.1 Regression Analysis - Underpricing

In order to answer our stated research question, we ran a regression analysis. This statistical analysis examines the relationship between underpricing and our control variables which were presented above in Section 4.7. As previously mentioned, the regression will first be conducted using merely our focus variable, that is, firm age. Then, after adding our second variable of focus, the dummy variable controlling for a hot market, the regression will finally be run with all of our independent variables. The results are illustrated in Table 3 down below.

Given the initial results obtained and presented in Table 3, we can determine through the positive Beta-coefficient that a firm being classified as young increased the level of underpricing by 3.8 % on average. However, as illustrated, this result was not statistically significant. The dummy variable for a hot market, on the other hand, was the largest explanatory factor of IPO underpricing within our sample, increasing the level of underpricing by 23.7 % on average with a significance level of <1 %. Also noteworthy is that the dummy variable controlling for the initial stages of the pandemic was significant at a 5 % significance level, indicating greater levels of underpricing for companies listed during this period. However, caution must be applied when interpreting the result from this parameter, given that only 11 IPOs were included in this variable with our chosen methodology. In light of this fairly small sample size, the validity of the statistical significance must be handled vigilantly.

Furthermore, the relatively modest value obtained on the parameter R-squared of 0.058 based on the entire model is of interest, as it indicates that our control variables did not explain that much of the observed variance in the dependent variable. This is nonetheless not particularly surprising, considering the vast amount of components that can affect and influence stock prices, as well as the delimitation inherent in our implemented model. Nevertheless, we can observe a relatively large increase in the value of the R-squared figure when adding the dummy variable for the hot market period to the existing dummy for firm age, indicating that the hot market contains a relatively high explanatory effect. In summary, we do not find that the firm age significantly affects the level of underpricing in our sample of IPOs during our selected timeframe.

Table 3: Regression Results With Underpricing as the Dependent Variable for 260 IPOs During 2014-2021 (OLS)

Table 3 illustrates our multiple regression analysis output, using underpricing as the dependent variable. The sample consists of 260 firms going public on the Swedish stock market between 2014 and 2021. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. For the dummy variable "Hot market", a value of 1 represents a listing during the time period of either 2021 or 2017, and a value of 0 corresponds to a listing in one of the other years during our time period. For the dummy variable "Coronavirus", a value of 1 represents a listing during the initial stages of the pandemic, and a value of 0 if the listing was completed either before or after that specific time interval. For the dummy variable "Exchange", a value of 1 represents a listing on Nasdaq OMX Stockholm, and a value of 0 represents a listing on either First North, Spotlight, or NGM. For the dummy variable "Firm size", a value of 1 represents a listing where the company is considered large, and a value of 0 if the company is characterised as small according to our classification method. "Constant" is the intercept of the regression model, representing the mean value of the dependent variable when all independent variables are equal to zero. The output illustrated in the table are the standardised coefficient estimates, "β", depicting the degree of change in the dependent variable for every unit of change in the corresponding independent variable. "R-squared" measures the amount of variance in the dependent variable that the independent variables explain as a group. The asterisks indicate the level of statistical significance corresponding to the description provided in the table. The parentheses illustrate the robust standard errors.

Variable	R_1	R_2	R_3
Firm age	0.017 (0.038)	0.009 (0.037)	0.038 (0.036)
Hot market	-	0.177*** (0.036)	0.237*** (0.037)
Coronavirus	-	-	0.142** (0.084)
Exchange	-	-	0.056 (0.033)
Firm size	-	-	0.061 (0.038)
Constant	0.057** (0.022)	-0.002 (0.029)	-0.072 (0.041)
R-Squared	0.000	0.031	0.058
Observations	260	260	260

****p<0.01, **p<0.05, *p<0.1*

5.2 Regression Analysis - BHAR

To answer our research question regarding the potential effects of firm age on post-IPO long-run performance, we ran three different stepwise regressions, with the dependent variable being the one-, two-, and three-year Buy-and-Hold Abnormal Returns, respectively. Once again, the regression will first be completed by containing only our main variable of focus, firm age. Then, after adding our other variable of focus, i.e., the dummy for a hot market, all the remaining independent variables will be included. Tables 4 to 6, presented below, illustrate the results from our regression analysis.

Observing Tables 4 to 6, we can conclude that young firms whose IPOs were completed during hot markets have a negative impact on BHAR for all our different time periods, that is, for the one-, two-, and three-year analysis when considering the entire model. Furthermore, being classified as a young firm has a negative impact on all three stepwise regressions for all different time series, illustrating a recurring theme that younger firms perform worse over time than their older counterparts. However, this impact is of marginal nature as the P-values are relatively high, thus not providing any statistical significance. In general, it seems as if the independent variables do not explain much of the observed long-run performance, given the fairly low R-squared values obtained in the regressions. While further discussed in Section 6, this result is not particularly surprising in light of the countless factors affecting stock prices, especially when measured over longer time periods.

Nonetheless, we can observe an interesting pattern where the R-squared value tends to increase as more independent variables are included. However, this does not hold to the same extent for the one-year period, possibly indicating that the somewhat increased underpricing among younger firms and IPOs conducted during hot markets, as illustrated in the previous section, might lead to a suboptimal performance during the first year post the offering. Also noteworthy is that the dummy variable controlling for the Coronavirus was eliminated during the two- and three-year time periods analysed, as that variable, according to our classification method, otherwise would have been treated as a constant in the analysis during these years. In summary, we do not find that the firm age significantly affects the one-, two-, or three-year post-IPO performance, although a pattern of negative stock development for young firms generally can be observed.

Table 4: Regression Results With BHAR 1-year as the Dependent Variable for 157 IPOs During 2014-2020 (OLS)

Table 4 illustrates our multiple regression analysis, using Buy-and-Hold Abnormal Returns ("BHAR") for one year as the dependent variable for our sample of Swedish IPOs between 2014 and 2020. "BHAR" is defined as the Buy-and-Hold Abnormal Return of the stock less the return of the benchmark during the corresponding timeframe. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. For the dummy variable "Hot market", a value of 1 represents a listing during the time period of either 2021 or 2017, and a value of 0 corresponds to a listing in one of the other years during our time period. For the dummy variable "Coronavirus", a value of 1 represents a listing during the initial stages of the pandemic, and a value of 0 if the listing was completed either before or after that specific time interval. For the dummy variable "Exchange", a value of 1 represents a listing on Nasdaq OMX Stockholm, and a value of 0 represents a listing on either First North, Spotlight, or NGM. For the dummy variable "Firm size", a value of 1 represents a listing where the company is considered large, and a value of 0 if the company is characterised as small according to our classification method. "Constant" is the intercept of the regression model, representing the mean value of the dependent variable when all independent variables are equal to zero. The output illustrated in the table are the standardised coefficient estimates, "β", depicting the degree of change in the dependent variable for every unit of change in the corresponding independent variable. "R-squared" measures the amount of variance in the dependent variable that the independent variables explain as a group. The asterisks indicate the level of statistical significance corresponding to the description provided in the table. The parentheses illustrate the robust standard errors.

Variable	R_1	R_2	R_3
Firm age	-0.102 (0.122)	-0.101 (0.124)	-0.101 (0.131)
Hot market	-	-0.016 (0.135)	-0.006 (0.147)
Coronavirus	-	-	0.058 (0.527)
Exchange	-	-	-0.013 (0.158)
Firm size	-	-	0.010 (0.160)
Constant	0.172** (0.009)	0.179* (0.009)	0.164 (0.144)
R-Squared	0.010	0.011	0.014
Observations	157	157	157

****p<0.01, **p<0.05, *p<0.1*

Table 5: Regression Results With BHAR 2-year as the Dependent Variable for 135 IPOs During 2014-2019 (OLS)

Table 5 illustrates our multiple regression analysis, using Buy-and-Hold Abnormal Returns ("BHAR") for two years as the dependent variable for our sample of Swedish IPOs between 2014 and 2019. "BHAR" is defined as the Buy-and-Hold Abnormal Return of the stock less the return of the benchmark during the corresponding timeframe. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. For the dummy variable "Hot market", a value of 1 represents a listing during the time period of either 2021 or 2017, and a value of 0 corresponds to a listing in one of the other years during our time period. For the dummy variable "Coronavirus", a value of 1 represents a listing during the initial stages of the pandemic, and a value of 0 if the listing was completed either before or after that specific time interval. For the dummy variable "Exchange", a value of 1 represents a listing on Nasdaq OMX Stockholm, and a value of 0 represents a listing on either First North, Spotlight, or NGM. For the dummy variable "Firm size", a value of 1 represents a listing where the company is considered large, and a value of 0 if the company is characterised as small according to our classification method. "Constant" is the intercept of the regression model, representing the mean value of the dependent variable when all independent variables are equal to zero. The output illustrated in the table are the standardised coefficient estimates, "β", depicting the degree of change in the dependent variable for every unit of change in the corresponding independent variable. "R-squared" measures the amount of variance in the dependent variable that the independent variables explain as a group. The asterisks indicate the level of statistical significance corresponding to the description provided in the table. The parentheses illustrate the robust standard errors.

Variable	R_1	R_2	R_3
Firm age	-0.050 (0.211)	-0.044 (0.215)	-0.035 (0.201)
Hot market	-	-0.101 (0.195)	-0.095 (0.214)
Coronavirus	-	-	--
Exchange	-	-	0.067 (0.246)
Firm size	-	-	-0.047 (0.274)
Constant	0.324** (0.132)	0.404** (0.151)	0.373 (0.237)
R-Squared	0.003	0.013	0.015
Observations	135	135	135

****p<0.01, **p<0.05, *p<0.1*

Table 6: Regression Results With BHAR 3-year as the Dependent Variable for 117 IPOs During 2014-2018 (OLS)

Table 6 illustrates our multiple regression analysis, using Buy-and-Hold Abnormal Returns ("BHAR") for three years as the dependent variable for our sample of Swedish IPOs between 2014 and 2018. "BHAR" is defined as the Buy-and-Hold Abnormal Return of the stock less the return of the benchmark during the corresponding timeframe. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. For the dummy variable "Hot market", a value of 1 represents a listing during the time period of either 2021 or 2017, and a value of 0 corresponds to a listing in one of the other years during our time period. For the dummy variable "Coronavirus", a value of 1 represents a listing during the initial stages of the pandemic, and a value of 0 if the listing was completed either before or after that specific time interval. For the dummy variable "Exchange", a value of 1 represents a listing on Nasdaq OMX Stockholm, and a value of 0 represents a listing on either First North, Spotlight, or NGM. For the dummy variable "Firm size", a value of 1 represents a listing where the company is considered large, and a value of 0 if the company is characterised as small according to our classification method. "Constant" is the intercept of the regression model, representing the mean value of the dependent variable when all independent variables are equal to zero. The output illustrated in the table are the standardised coefficient estimates, "β", depicting the degree of change in the dependent variable for every unit of change in the corresponding independent variable. "R-squared" measures the amount of variance in the dependent variable that the independent variables explain as a group. The asterisks indicate the level of statistical significance corresponding to the description provided in the table. The parentheses illustrate the robust standard errors.

Variable	R_1	R_2	R_3
Firm age	-0.074 (0.317)	-0.076 (0.336)	-0.110 (0.334)
Hot market	-	0.025 (0.344)	-0.007 (0.371)
Coronavirus	-	-	–
Exchange	-	-	0.018 (0.331)
Firm size	-	-	-0.138 (0.392)
Constant	0.503** (0.188)	0.472** (0.164)	0.788** (0.424)
R-Squared	0.005	0.006	0.019
Observations	117	117	117

****p<0.01, **p<0.05, *p<0.1*

5.3 Mann-Whitney U-Test - Underpricing

In order to augment our understanding of the level of underpricing prevalent in the Swedish financial markets and to complement our regression analysis, we ran a Mann-Whitney U-test to compare two independent groups, that is, young and old firms, against our dependent variable underpricing. Table 7 illustrates the results obtained from our nonparametric Mann-Whitney U-test.

According to the results from this test, there is no significant difference in underpricing stemming from disparate firm ages, evident in the fairly similar mean ranks. Moreover, the Z-score, which is -0.395, indicates that the groups are relatively evenly distributed. Hence, the Mann-Whitney U-test does not support any complementary understanding of potential differences in underpricing between young and old firms.

Table 7: Mann-Whitney U-Test Results With Underpricing as the Dependent Variable for 260 IPOs During 2014-2021

Table 7 illustrates our nonparametric Mann-Whitney U-test conducted on the dependent variable underpricing. The sample consists of 260 firms going public on the Swedish stock market between 2014 and 2021. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. The "Mean rank" captures the actual result from the test. "P-value" is a probability score used to determine the statistical significance of an observed effect. "Z-score" is a test variable calculated by comparing the mean rank of one group to the overall mean rank.

Variable	*Mean rank*	*P-value*	*Z-score*
Old firms	132.34	-	-
Young firms	128.66	-	-
Model	-	0.693	-0.395

5.4 Mann-Whitney U-Test - BHAR

Once again, we used the Mann-Whitney U-test to complement the regression analysis in the pursuit of gaining an even more nuanced and comprehensive understanding of the long-run post-IPO performance in our sample. Tables 8 to 10, presented below, illustrate the empirical findings from our nonparametric Mann-Whitney U-tests for Buy-and-Hold Abnormal Returns.

According to the results obtained from the Mann-Whitney U-test, we can observe a noticeable discrepancy between young and old firms in terms of long-run performance. For the one- and two-year period, the IPOs defined as young generally perform slightly worse than the IPOs defined as old, as evident in the higher mean rank among old firms. For example, in Table 8, a P-value of 0.102 and a Z-score of -1.636 can be observed. This points to a palpable difference in the distribution between young and old firms regarding the one-year post-IPO performance. In Table 9, a P-value of 0.180 and a Z-score of -1.342 can be noted, indicating a similar pattern. Yet, for both the one- and two-year post-IPO performance, the mean ranks of the samples are not

statistically significant. However, in Table 10, a P-value of 0.033 and a Z-score of -2.130 can be observed, which points to a significant difference at a 5 % significance level in mean rank between young and old firms in terms of the three-year post IPO performance. This result is interesting to dig into and differs from the result obtained from the regression analysis of the BHAR, where no significant results could be observed regarding firm age.

Table 8: Mann-Whitney U-Test Results With BHAR 1-year as the Dependent Variable for 157 IPOs During 2014-2018

Table 8 illustrates our nonparametric Mann-Whitney U-test conducted on the dependent variable Buy-and-Hold Abnormal Returns ("BHAR") one-year. The sample consists of 157 firms going public on the Swedish stock market between 2014 and 2018. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. The "Mean rank" captures the actual result from the test. "P-value" is a probability score used to determine the statistical significance of an observed effect. "Z-score" is a test variable calculated by comparing the mean rank of one group to the overall mean rank.

Variable	*Mean rank*	*P-value*	*Z-score*
Old firms	85.23	-	-
Young firms	73.32	-	-
Model	-	0.102	-1.636

Table 9: Mann-Whitney U-Test Results With BHAR 2-year as the Dependent Variable for 135 IPOs During 2014-2019

Table 9 illustrates our nonparametric Mann-Whitney U-test conducted on the dependent variable Buy-and-Hold Abnormal Returns ("BHAR") two-year. The sample consists of 135 firms going public on the Swedish stock market between 2014 and 2019. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. The "Mean rank" captures the actual result from the test. "P-value" is a probability score used to determine the statistical significance of an observed effect. "Z-score" is a test variable calculated by comparing the mean rank of one group to the overall mean rank.

Variable	*Mean rank*	*P-value*	*Z-score*
Old firms	72.16	-	-
Young firms	63.10	-	-
Model	-	0.180	-1.342

Table 10: Mann-Whitney U-Test Results With BHAR 3-year as the Dependent Variable for 117 IPOs During 2014-2018

Table 10 illustrates our nonparametric Mann-Whitney U-test conducted on the dependent variable Buy-and-Hold Abnormal Returns ("BHAR") three-year. The sample consists of 117 firms going public on the Swedish stock market between 2014 and 2018. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. The "Mean rank" captures the actual result from the test. "P-value" is a probability score used to determine the statistical significance of an observed effect. "Z-score" is a test variable calculated by comparing the mean rank of one group to the overall mean rank.

Variable	*Mean rank*	*P-value*	*Z-score*
Old firms	65.08	-	-
Young firms	51.66	-	-
Model	-	0.033	-2.130

6. Discussion

The following section discusses the empirical results illustrated in Section 5. We will first discuss the main results from our study of underpricing, both from the regression analysis and the Mann-Whitney U-test, which is presented in Section 6.1. Then, in Section 6.2, the findings from our study of long-run post-IPO performance are presented. Finally, the limitations of our study, along with suggestions for future research, will be presented in Section 6.3.

6.1 Underpricing

As presented in Table 3, we can conclude that the regression analysis does not indicate any significant relationship between underpricing and firm age, although the positive Beta-coefficient states that a firm classified as young increases the level of underpricing by 3.8 % on average when observing the entire model. The dummy variable controlling for a hot issue market stands out as increasing the level of underpricing by 23.7 % on average at a significance level of 1 %. Moreover, the variable controlling for the Coronavirus also demonstrates significance at a level of 5 %. However, the nonparametric Mann-Whitney U-test did not indicate any significant differences in mean rank between young and old firms, coupled with a Z-score relatively close to zero, implying that the groups were fairly evenly matched.

The hot market phenomenon is a well-documented issue within the literature. For instance, scholars have identified bubble periods with greater levels of underpricing (Loughran and Ritter, 2004) and investigated the connection between firm age and hot markets (Helwege and Liang, 2004). Allen and Faulhaber (1989) developed a model to argue that underpricing is most prevalent at certain times (hot markets) and in certain industries. As previously mentioned, we can, in line with previous literature, observe an increase in underpricing during hot markets. While the findings from the OLS regarding firm age do not provide any statistical significance, we can still observe a pattern of an increased level of underpricing among young firms, in line

with previous studies (Ritter, 1991). One of the most common explanations for why underpricing tends to be elevated among young firms revolves around the fact that they are usually perceived as riskier (Loughran and Ritter, 2004), leading to what Rock (1986) labels as the Winner's curse, where companies find it challenging to attract investors willing to pay a high price, ultimately leading to higher first-day returns. While this explanation might be rational for the US stock market, especially during the 1980s to the early 2000s, when a lot of the seminal studies on IPO underpricing were conducted, it might not be as true for the Swedish financial markets of today.

Several reasons could explain this potential discrepancy, for instance, the structure and composition of the Swedish economy and the firms choosing to go public. Sweden has a well-developed business community, and given the country's reasonably modest size, companies are not seldom forced to internationalise early on in their life cycles to stay competitive. This enables companies to establish resilience. Moreover, the increased transparency and improved infrastructure surrounding the Swedish financial markets in recent years might have made the market more efficient, reducing information asymmetry. This might have helped to decrease the general level of underpricing and increased the scrutiny of younger, smaller firms, which is not least evident in the fact that 2.7 million Swedes own shares directly through the stock market, an internationally competitive figure (Euroclear, 2022).

A more accurate explanation of the still prominent feature of underpricing on the Swedish stock markets might be the theory developed by Welch (1989). He argues that since underpricing inflicts losses on the existing owners, only good firms are able to recoup these losses when future, satisfactory performances are realised. Thus, underpricing the offer could serve as a credible signal to investors that the firm is indeed of high quality. While further studies are needed to validate this hypothesis, underpricing might also partially stem from companies seeking to reissue equity, often several times greater than the initial amount raised in the IPO in the years following the IPO. Rewarding investors with handsome gains in the IPO could thus be a wise move to satisfy investors, making seasoned equity offerings more likely to be successful (Welch, 1989).

While many of the firms classified as young in Ritter's influential study (1991) were active within the oil and gas industry, the industrial landscape, especially in Sweden, looks radically different today. Only one IPO included in our sample is conducted within the natural resources industry. While further discussed in Section 6.3, more research combining firm age and industry in the Swedish financial markets should give rise to new, valuable insights regarding the IPO landscape.

During the hot IPO markets present in our sample, namely 2017 and 2021, 148 IPOs were completed (see Appendix 4). This figure constitutes almost 57 % of all IPOs prevalent in our data set, which is a remarkably high ratio; however, in line with previous literature such as Helwege and Liang (2004), who states that the discrepancy between a hot and cold IPO market lies namely in the number of offerings, not company characteristics. Moreover, as previously noted, these time periods contain high levels of underpricing (as illustrated in Figure 1), also consistent with previous studies (Loughran and Ritter, 2004; Ritter, 1991). When reviewing our sample, it is evident that many young firms decided to go public during these ebullient market

phases, as 77 out of 130 firms classified as young completed their IPOs in either 2017 or 2021. Thus, while not significant, the pattern emerging from our regression analysis of an increase in underpricing from being classified as young can at least partially be attributed to the concepts discussed by Ritter (1991), namely the "fads" explanation and the "window of opportunity." Overoptimistic investors and firms taking advantage of this bullish investor sentiment thus still seem to have a meaningful impact on the Swedish IPO landscape.

6.2 Buy-and-Hold Abnormal Returns

As presented in Tables 4-6, we can observe that the R-squared value for the regression model is low, indicating that the independent variables do not explain the long-run post-IPO performance very well. This is, however, not especially surprising since the factors affecting a stock's performance are extensive, especially during longer periods. In addition, both the independent variables and the index used in calculating the Buy-and-Hold Abnormal Returns do not capture all of the idiosyncratic risks of each IPO. Thus, the almost endless number of factors determining the stock prices of the IPO sample is challenging to capture in a single model.

Interestingly, in line with most previous literature, such as Ritter (1991), we can generally observe a negative impact on the long-run post-IPO performance from being classified as a young company. However, the firm age variable is not statistically significant in our regression analysis, implying that we cannot draw any extensive conclusions regarding the impact of firm age on long-run post-IPO performance. This differs from previous literature (Ritter, 1991) that finds a statistically significant correlation between young firms and generally lower post-IPO performance. For the Mann-Whitney U-test, a generally lower mean rank in terms of post-IPO performance can be observed for young companies compared to old ones. This correlation is statistically significant at a 5 % significance level on a three-year basis. As previously mentioned, the OMXSPI index does not produce a perfect benchmark that captures specific industry-related risks. By using a matching firm as a benchmark (Ritter, 1991), it is reasonable to believe that the result of both the regression model and the Mann-Whitney U-test could differ somewhat from the results obtained in our study. Nonetheless, the main patterns from our empirical findings are broadly in line with previous literature.

Both Ritter (1991) and Derrien (2005) find that noise trader sentiment, that is, factors and decisions not built upon professional advice or financial fundamentals, on average, strongly impact stock behaviour in and after an initial public offering. This phenomenon generally affects the pricing of IPOs and the subsequent level of initial return, a return that is not in line with long-run stock price fundamentals as underwriters and firms take advantage of the bullish sentiment to extract a higher offer price. The findings from our study indicate a generally negative trend regarding the correlation between firm age and long-run stock performance. The opposite correlation can be observed between firm age and underpricing. This result, however, exhibits the greatest strengths when it comes to BHAR, as the impact on long-run performance stemming from firm age was significant for the three-year period on the Mann-Whitney U-test. In other words, the noise sentiment investor demand is consistent with our result in terms of the effect of firm age, where the trend illustrates that younger firms possess a greater level of underpricing and generally worse long-run performance.

6.3 Limitations and Future Research

This study exhibits several limitations. First of all, the sample is of relatively modest size. A larger sample, including additional years and periods of hot- and cold markets, may have provided a more nuanced understanding of the correlation between underpricing, long-run performance and firm age. In addition, the division into the categories of young and old firms is, while based on previous literature, still somewhat subjective, and the definition of the period related to the Coronavirus is also subjective. While some subjectivity is necessary and inevitable when dealing with these kinds of delimitations, a more standardised and universal definition of firm age, and in particular the Coronavirus, might aid in creating a more generalisable result. Finally, to our knowledge, the market size median-based division is not based on any academically proven guideline.

Future scholars could delve deeper into possible correlations between firm age and industry to further our research on IPO underpricing and long-run performance in the Swedish financial markets. While previous papers tend to study either firm age or branch-specific effects on underpricing and long-run performance, a cross-sectional study combining potential insights from these areas could give birth to a more nuanced and comprehensive understanding of the IPO landscape in Sweden. Moreover, while we chose to use a broad market index to measure long-run performance, future research could augment existing knowledge regarding post-IPO performance in the Swedish financial markets by implementing various other methodologies for determining relative stock development. While the comparatively small size of the Swedish stock market could entail some difficulties, using industry-specific indexes or matching firms might enhance the relative comparison of a specific IPOs long-term stock development. To fully capture the differences generated by different benchmarks, we could have, guided by Ritter (1991), applied various indexes on the same sample to obtain a more refined and dynamic perspective of the long-run post-IPO performance.

Future researchers might also find it interesting to examine the possible effects of underpricing and long-run performance between young and old firms based on investor characteristics. Investigating the different types of investors prevalent in various IPOs might yield interesting results in terms of whether young or old companies, in general, tend to be backed by private-, institutional-, private equity-, or venture capital owners and if this subsequently has any influence on the relative stock performance, both short- and long term. In addition, while we included event variables (i.e., the dummies for hot markets and the Coronavirus) as a proxy for fixed year effects, scholars might receive additional insights from having a location-based fixed year effect. This could, for instance, be a dummy variable taking on the value of 0 if the specific company is situated in Stockholm and the value of 1 if the firm is not based in Stockholm.

Further research could also be done regarding the Coronavirus. Given its novelty, not many studies have yet been conducted on the topic; however, the statistically significant result obtained from our regression analysis of underpricing should give rise to new, complementary inquiries. Not only are more statistically focused research of interest, but also descriptive studies could be insightful in order to gain a more enhanced understanding of this phenomenon and the subsequent consequences for the financial markets.

Finally, by extending the time period of the study and adding one or two more exogenous events, such as the financial crisis of 2008, an interesting comparison with the Coronavirus could have been laid out to generate insights into how various causes of stock market declines correlate with the level of underpricing and long-run performance for young and old firms, respectively.

7. Conclusion

Firm characteristics are fundamental in understanding differences in stock performances in the financial markets. In this study, the choice of firm age has been made to shed light on some aspects of the decision regarding when in their life cycle a company should choose to go public. This has been done by analysing differences in initial return, in the form of underpricing, as well as the one-, two-, and the three-year time period following the IPO. By conducting two different statistical tests, namely a regression analysis (OLS) and a nonparametric Mann-Whitney U-test, we have been able to provide some new insights into recent years' stock price behaviours in the Swedish stock market. The data analysis indicates that there are indeed differences in IPO underpricing and long-run stock performance related to disparities in the founding year.

Given that our sample of IPOs is relatively modest, with a large proportion of the offerings occurring during the hot markets of 2017 and 2021 in particular, discretion must be applied before drawing any far-reaching generalisable conclusions from the study. Nevertheless, our general empirical findings, indicating a pattern of increased underpricing and lower post-IPO long-run performance among young firms and the significant impact on underpricing stemming from a hot issue market, might have several explanations. While we have argued that the well-developed Swedish business market of today might point towards an origin more in line with the signalling theory (Welch, 1989) or investor overoptimism (Ritter, 1991) rather than younger firms being perceived as riskier, it is difficult, if not impossible, to determine the most accurate root causes. While the most realistic answer may be a combination of all arguments mentioned above in Section 6, our results nonetheless shed light on interesting financial phenomenons with critical implications for both academics and investors and help advance the body of literature regarding the Swedish IPO landscape.

Looking ahead, the dynamics and characteristics of the financial markets will continue to evolve. As previously mentioned, younger firms have decided to go public to a larger extent in the last few years, generally exhibiting greater underpricing and lower long-run performance than their older counterparts. Whether this trend will be observable, or even heightened, in the future is difficult to tell and thus calls for renewed studies as society changes and new potential explanations, where some may take more of a behavioural approach such as the rent-seeking explanation developed by Loughran and Ritter (2002), are introduced. In addition, the geopolitical turmoil of 2022, coupled with rising rates and spiralling inflation, have so far dramatically reduced the number of IPOs conducted on the financial markets across the globe. Only time can tell if the stage is set for another hot issue market, with the current stalemate merely creating another backlog of future listings, or if we are headed for a more prolonged

period of fewer financial transactions. Nonetheless, studying the characteristics of the firms choosing to go public and their associated stock performance will be as fascinating and insightful as ever.

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Appendix

Appendix 1: Key Variables from SDC Platinum

Appendix 1 summarises the variables collected from the database SDC Platinum, with the corresponding description for each variable included.

Variable	*Description*
Issue date	Pricing date of the issue
Issuer	The name of the issuing company
Main SIC Code	Main SIC code of the issuing company
Primary exchange	The stock exchange where the company's shares is listed
Industry	The main industry each company operates within
Offer price	The initial stock price offered to investors
Date founded	Date when each company was founded
ISIN	International Securities Identification Number

Appendix 2: Key Variables from FinBas

Appendix 2 summarises the variables collected from the database FinBas, with the corresponding description for each variable included.

Variable	*Description*
ISIN	International Securities Identification Number
Name	The name of the issuing company
Market Capitalisation	The company's total market capitalisation
Last	Adjusted last trading price of the stock at the end of the trade day
Currency	Currency equal to the closing price
Date	Date equal to the closing price of each company

Appendix 3: Key Variables from Thomson Reuters Eikon

Appendix 3 summarises the variables collected from the database Thomson Reuters Eikon, with the corresponding description for each variable included.

Variable	*Description*
Index	The closing price of the OMXSPI index, daily basis
Turnover - SEK	Total value of stocks traded, daily basis
Date	The corresponding date

Appendix 4: Observation Count Control Variables

Appendix 4 illustrates the observation count for all of our control variables included in the statistical analysis. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. For the dummy variable "Hot market", a value of 1 represents a listing during the time period of either 2021 or 2017, and a value of 0 corresponds to a listing in one of the other years during our time period. For the dummy variable "Coronavirus", a value of 1 represents a listing during the initial stages of the pandemic, and a value of 0 if the listing was completed either before or after that specific time interval. For the dummy variable "Exchange", a value of 1 represents a listing on Nasdaq OMX Stockholm, and a value of 0 represents a listing on either First North, Spotlight, or NGM. For the dummy variable "Firm size", a value of 1 represents a listing where the company is considered large, and a value of 0 if the company is characterised as small according to our classification method.

Dummy variable	*Obs*
Young firms (1)	130
Old firms (0)	130
Nasdaq OMX Stockholm (1)	97
Other exchanges (0)	163
Corona (1)	11
Corona (0)	249
Hot market (1)	148
Hot market (0)	112
Large firms (1)	130
Small firms (0)	130

Appendix 5: Underpricing - VIF

Appendix 5 illustrates the "VIF", Variance Inflation Factor, for the control variables present in our regression of underpricing, and corresponds to Table 3. The VIF shows the amount of multicollinearity in a set of multiple regression variables. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. For the dummy variable "Hot market", a value of 1 represents a listing during the time period of either 2021 or 2017, and a value of 0 corresponds to a listing in one of the other years during our time period. For the dummy variable "Coronavirus", a value of 1 represents a listing during the initial stages of the pandemic, and a value of 0 if the listing was completed either before or after that specific time interval. For the dummy variable "Exchange", a value of 1 represents a listing on Nasdaq OMX Stockholm, and a value of 0 represents a listing on either First North, Spotlight, or NGM. For the dummy variable "Firm size", a value of 1 represents a listing where the company is considered large, and a value of 0 if the company is characterised as small according to our classification method.

Underpricing	***VIF***
Firm age	1.088
Hot market	1.153
Coronavirus	1.070
Exchange	1.778
Firm size	1.755
Average	1.332

Appendix 6: BHAR - VIF

Appendix 6 illustrates the "VIF", Variance Inflation Factor, for the control variables present in our regression of Buy-and-Hold Abnormal Returns for the 1-, 2-, and 3-year time period, and corresponds to Tables 4,5, and 6. The VIF shows the amount of multicollinearity in a set of multiple regression variables. "BHAR" is defined as the Buy-and-Hold Abnormal Return of the stock less the return of the benchmark during the corresponding timeframe. For the dummy variable "Firm age", a value of 1 represents young firms, and a value of 0 corresponds to old firms. For the dummy variable "Hot market", a value of 1 represents a listing during the time period of either 2021 or 2017, and a value of 0 corresponds to a listing in one of the other years during our time period. For the dummy variable "Coronavirus", a value of 1 represents a listing during the initial stages of the pandemic, and a value of 0 if the listing was completed either before or after that specific time interval. For the dummy variable "Exchange", a value of 1 represents a listing on Nasdaq OMX Stockholm, and a value of 0 represents a listing on either First North, Spotlight, or NGM. For the dummy variable "Firm size", a value of 1 represents a listing where the company is considered large, and a value of 0 if the company is characterised as small according to our classification method.

BHAR 1-year

Underpricing	***VIF***
Firm age	1.146
Hot market	1.108
Coronavirus	1.050
Exchange	2.001
Firm size	1.929
Average	1.449

BHAR 2-year

Underpricing	***VIF***
Firm age	1.132
Hot market	1.089
Coronavirus	--
Exchange	2.141
Firm size	2.039
Average	1.523

BHAR 3-year

Underpricing	*VIF*
Firm age	1.140
Hot market	1.108
Coronavirus	--
Exchange	2.387
Firm size	2.329
Average	1.628

Appendix 7: Descriptive Statistics - Underpricing

Appendix 7 illustrates various descriptive statistics for the underpricing prevalent in our sample of IPOs. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock. The statistical figures included are the number of observations, the min, 25th percentile, mean, median, 75th percentile, max, kurtosis, and skewness for our dependent variable underpricing.

Variable	*N*	*min*	*25th percentile*	*mean*	*median*	*75th percentile*	*max*	*kurtosis*	*skewness*
Young firms	130	-82.41 %	-8.29 %	6.72 %	1.38 %	16.57 %	175.56 %	7.110	1.850
Old firms	130	-68.75 %	-8.52 %	5.69 %	2.54 %	18.44 %	98.87 %	2.597	0.659

Appendix 8: Descriptive Statistics - BHAR

Appendix 8 illustrates various descriptive statistics for the BHAR prevalent in our sample of IPOs. "BHAR" is defined as the Buy-and-Hold Abnormal Return of the stock less the return of the benchmark during the corresponding timeframe. The statistical figures included are the number of observations, the min, 25th percentile, mean, median, 75th percentile, max, kurtosis and skewness for our dependent variable Buy-and-Hold Abnormal Returns.

BHAR 1-year

Variable	*N*	*min*	*25th percentile*	*mean*	*median*	*75th percentile*	*max*	*kurtosis*	*skewness*
Young firms	75	-111.17 %	-47.85 %	1.53 %	-5.91 %	23.65 %	208.40 %	1.185	1.116
Old firms	82	-89.25 %	-29.20 %	17.16 %	3.64 %	42.05 %	350.97 %	7.762	2.446

BHAR 2-year

Variable	*N*	*min*	*25th percentile*	*mean*	*median*	*75th percentile*	*max*	*kurtosis*	*skewness*
Young firms	62	-122.89 %	-57.43 %	20.41 %	2.15 %	52.49 %	713.64 %	14.286	3.276
Old firms	73	-110.04 %	-34.62 %	32.42 %	12.01 %	47.45 %	563.45 %	8.241	2.479

BHAR 3-year

Variable	*N*	*min*	*25th percentile*	*mean*	*median*	*75th percentile*	*max*	*kurtosis*	*skewness*
Young firms	53	-170.72 %	-68.55 %	25.71 %	-18.09 %	35.87 %	917.09 %	11.439	3.144
Old firms	64	-124.52 %	-39.70 %	50.29 %	20.12 %	101.32 %	752.66 %	8.544	2.501

Appendix 9: Standard Deviation - Underpricing

Appendix 9 illustrates the standard deviation of young and old firms, respectively, for our dependent variable underpricing. "Underpricing" is defined as the definitive offer price in the IPO compared to the first-day closing price of the stock.

Underpricing

Variable	*Standard deviation*
Young firms	0.350
Old firms	0.246

Appendix 10: Standard Deviation - BHAR

Appendix 10 illustrates the standard deviation of young and old firms, respectively, for our dependent variable BHAR. "BHAR" is defined as the Buy-and-Hold Abnormal Return of the stock less the return of the benchmark during the corresponding timeframe.

BHAR 1-year

Variable	*Standard deviation*
Young firms	0.724
Old firms	0.809

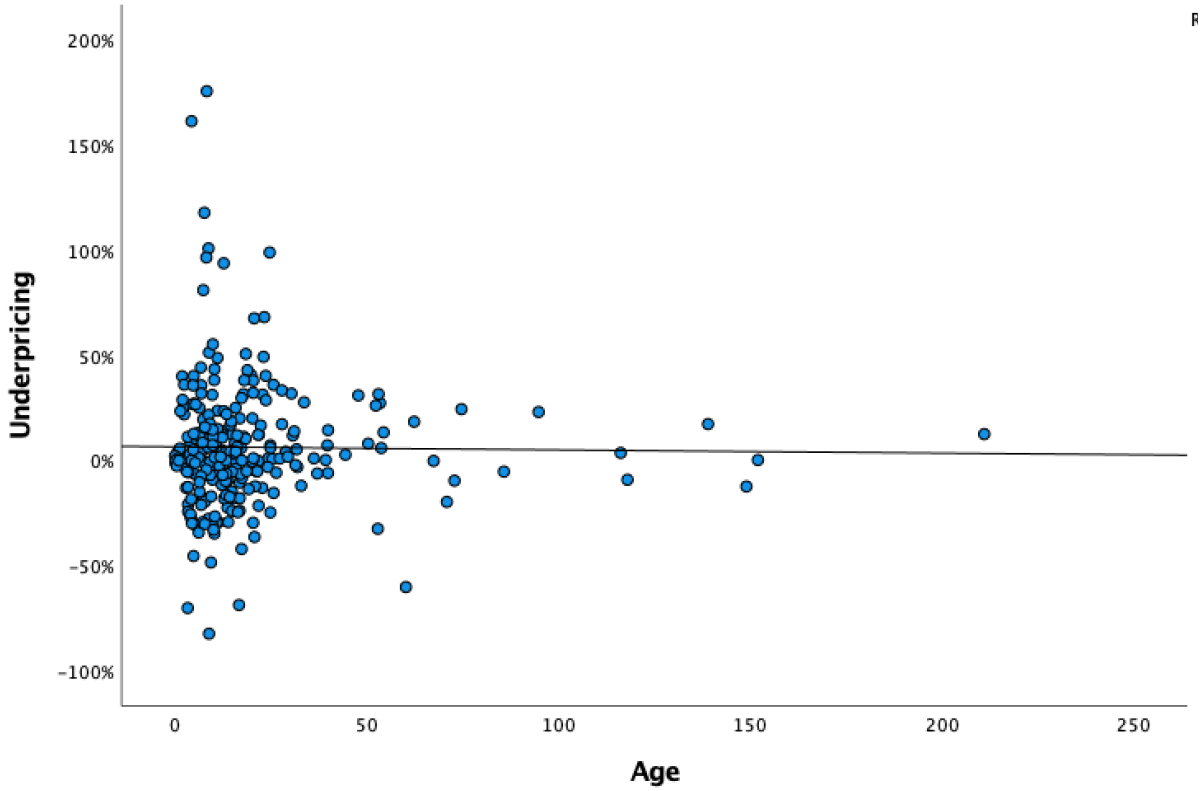
BHAR 2-year

Variable	*Standard deviation*
Young firms	1.290
Old firms	1.118

BHAR 3-year

Variable	*Standard deviation*
Young firms	1.841
Old firms	1.495

Appendix 11: Figure of the Correlation Between Firm Age and Underpricing



Appendix 11 plots our entire sample of IPOs on the Swedish stock market in relation to each firm's age and the corresponding under-/overpricing, illustrating the correlation.

Appendix 12: Test for Normality - Underpricing

Appendix 12 illustrates the findings from two separate tests for normality. Kolmogorov-Smirnov and Shapiro-Wilk are two tests to determine if your sample is normally distributed. As the sig. values for young and old firms in both tests are below the significance level 0.05, it implies that our sample significantly deviates from a normal distribution. Thus, the assumptions underlying a one-sample t-test are not fulfilled, and such a test can not be performed.

Kolmogorov-Smirnov	***Sig***
Young firms	<0.001
Old firms	0.010

Shaprio-Wilk	***Sig***
Young firms	<0.001
Old firms	<0.001

Appendix 13: Test for Normality - BHAR

Appendix 13 illustrates the findings from two separate tests for normality on the dependent variable BHAR for the one-, two-, and three-year time period. Kolmogorov-Smirnov and Shapiro-Wilk are two tests to determine if your sample is normally distributed. As the sig. values for young and old firms in both tests for all different time periods are below the significance level 0.05, it implies that our sample significantly deviates from a normal distribution. Thus, the assumptions underlying a one-sample t-test are not fulfilled, and such a test can not be performed.

BHAR 1-year

Kolmogorov-Smirnov	***Sig***
Young firms	<0.001
Old firms	<0.001

Shaprio-Wilk	***Sig***
Young firms	<0.001
Old firms	<0.001

BHAR 2-year

Kolmogorov-Smirnov	***Sig***
Young firms	<0.001
Old firms	<0.001

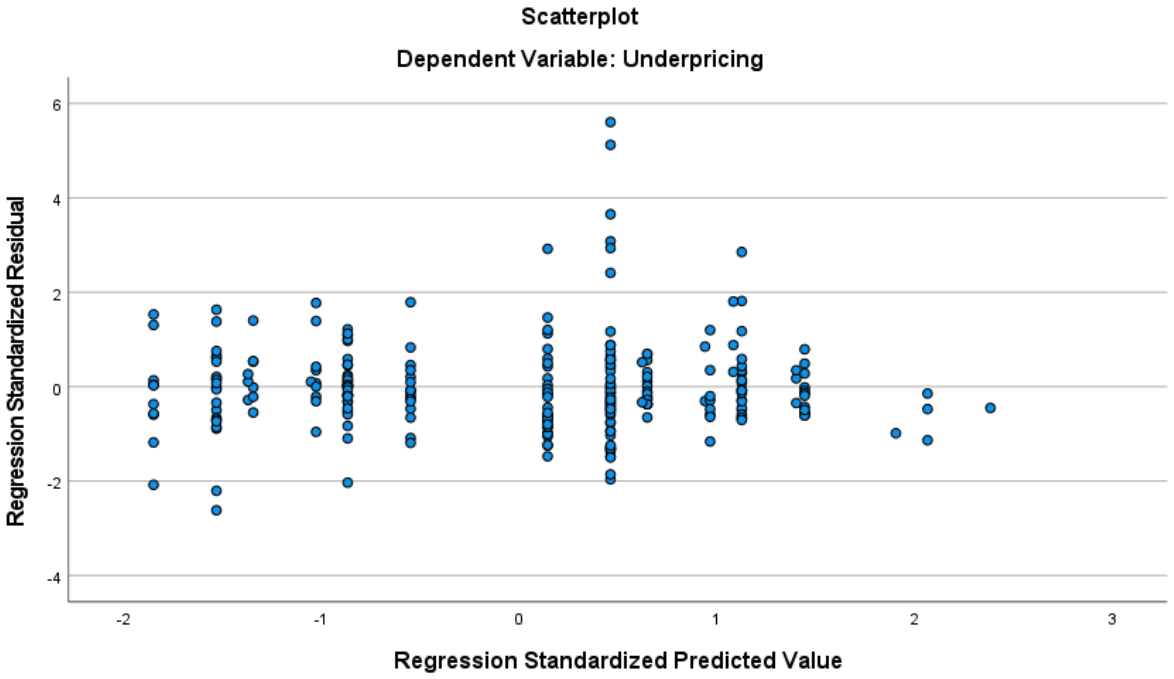
Shaprio-Wilk	***Sig***
Young firms	<0.001
Old firms	<0.001

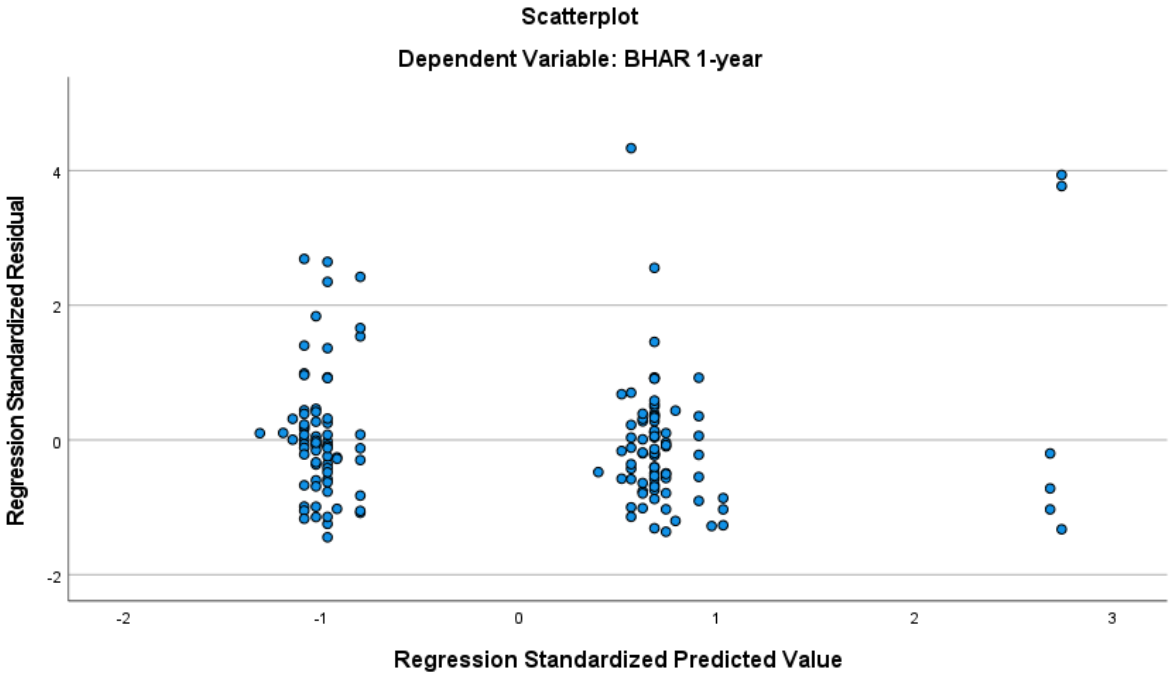
BHAR 3-year

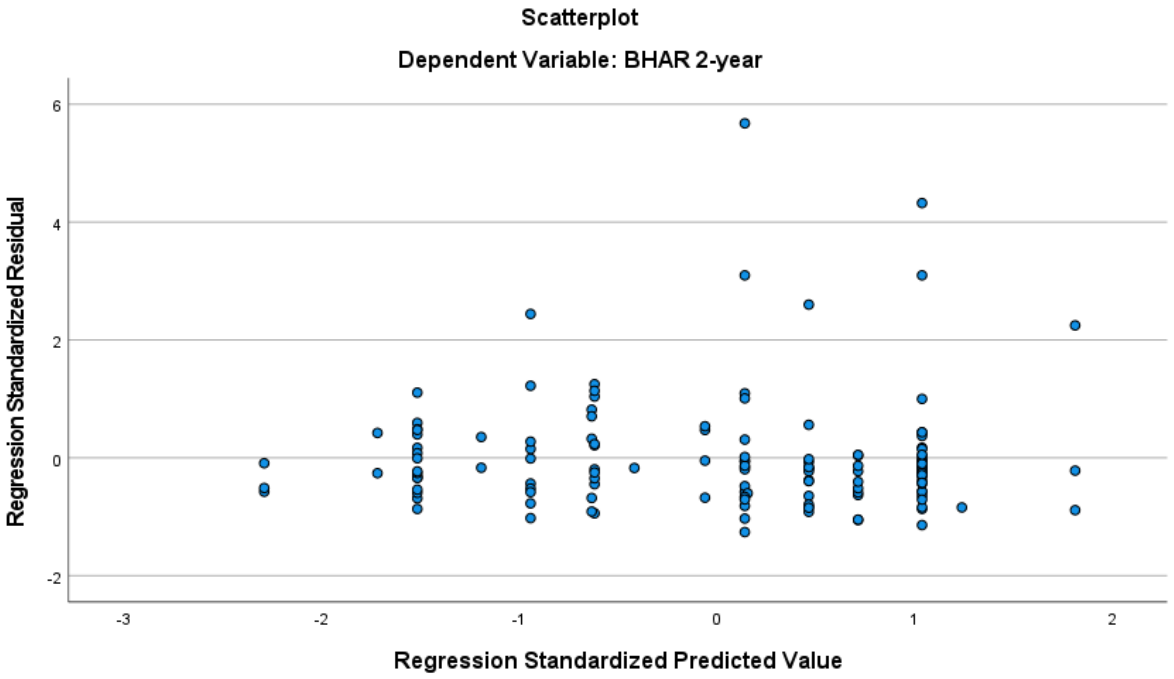
Kolmogorov-Smirnov	***Sig***
Young firms	<0.001
Old firms	<0.001

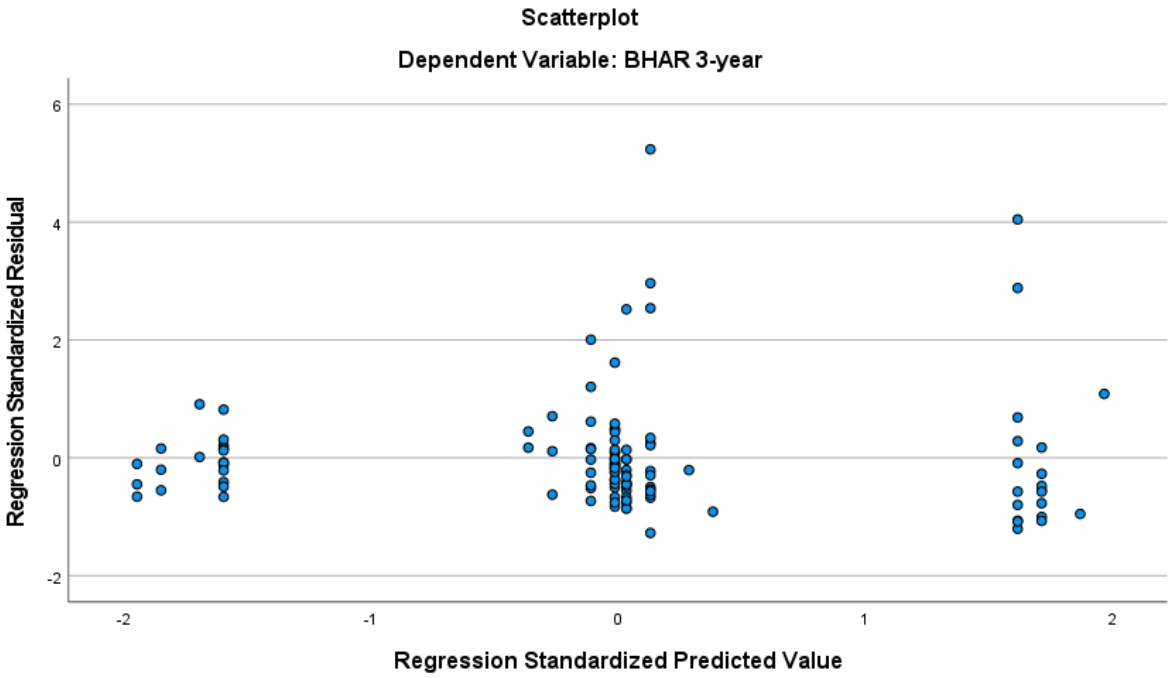
Shaprio-Wilk	***Sig***
Young firms	<0.001
Old firms	<0.001

Appendix 14: Homoscedasticity









Appendix 14 illustrates the level of heteroscedasticity prevalent within our sample of IPOs for our dependent variables underpricing and BHAR for the one-, two-, and three-year time period. Homoscedasticity (heteroscedasticity) refers to whether the residuals are (not) equally distributed.