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Foreword

With this thesis, I conclude my Master's degree in Industrial Economics at the University of Stavanger.

I owe my deepest gratitude to Erlendur Ingi Jonsson, my supervisor at the University of Stavanger, for his support and educational input throughout the process.

Furthermore, I would like to thank Peking House Jørpeland for its inspiring atmosphere and people who work there, best of the best Conny Kwong and Jun Shao, for providing me a lot of encouragement and support throughout my writing.

I would like to thank Roman Madyar for his technical support, endorsement and, believing in me along the way.

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Abstract

An initial public offering or Initial Public Offering (IPO) is one of the ways to attract financial resources not only in foreign but also in domestic markets. There are several phenomena associated with an initial public offering such as initial underpricing, reduced long-term profitability and, cyclical placements. Research on the effectiveness of initial public offerings is a relevant topic since this method is one of the most common ways to attract capital for companies.

This Master`s thesis analyzes the existing research on the topic put forward to study the effectiveness of initial public offerings by Norwegian companies listed on the Oslo Stock Exchange.

Hypotheses were put forward on the influence of firm-specific, offer-specific and, market-specific factors on the initial underpricing and return in the short-term, medium-term and, long-term periods. To investigate this, a graphical analysis was carried out for a full sample of Norwegian companies and a sub-sample of companies divided into sectors. Graphical analysis was also used to determine the cyclicality of the initial public offerings on the Oslo Stock Exchange.

To characterize the influence of the above factors on the return, an empirical analysis was carried out. In the analysis, the dependent variable was a return at different times after the IPO. In total, 6 regression models were built, including returns from the first day to 1 year after the initial public offering.

In the course of the work, the phenomenon of underpricing of initial public offerings was proved, as well as the cyclical nature of offers on the Norwegian market. However, it has been shown that the initial underpricing of shares on the Norwegian market is much lower than the average underpricing on other markets. In addition, it was rejected that the underpricing of high-tech companies is higher than in other sectors. The signs indicating long-term underperformance were found, but not fully proved. The influence of various factors on the return at different time intervals after the companies entered the stock exchange was studied and analyzed. The results obtained confirm the theories of information asymmetry and once again prove the existence of phenomena associated with the initial public offering.

1. Introduction

The main goal of any company is to increase its value. Taking into account that this requires a lot of money, initial public offerings (IPOs) are one of the most reliable and proven ways to increase the financial capabilities of a company. In connection with the rapid development of the economies and the formation of stock markets, there is a tendency for an increase in the number of firms resorting to this source of financing, which indicates the expediency of research in this area from both theoretical and practical points of view. Moreover, the relevance of this issue is also justified by the fact that the IPO process has several specific problems that are very difficult to explain using basic economic theory.

Despite all, analytical reviews illustrate the fact that the IPO issue and the assessment of the effectiveness of its implementation have not been analyzed and explained in full. Thus, this thesis is relevant not only in connection with the fact that the results obtained in it can provide valuable answers to questions regarding the IPO problem and the assessment of the effectiveness of its implementation by Norwegian companies, but also because it will reveal the factors explaining the existence of an IPO.

The purpose of this master's thesis is to assess the effectiveness of an IPO by Norwegian companies. Based on this, an analysis of previous studies on the specific problems inherent in IPOs and assessing the effectiveness of their implementation will be conducted.

The phenomenon of the initial underpricing on the Norwegian market was studied previously. One of the researches was conducted by Boulton, Smart, and Zutter (2011), where Norway is presented among other countries. In this paper, 96 Norwegian companies which went public between 1998 and 2008 have shown the average initial underpricing of 3.74%. It is of interest to investigate what was the average underpricing in the period from 2004 to 2020.

The theory of the ex-ante uncertainty suggested by Ritter (1984) and Rock (1986) will be tested empirically for the Norwegian market. It has been stated that the underpricing is a decreasing function of the company`s age, i.e. the younger the company, the higher is the underpricing. Age was selected as a dummy variable, where 1 stays for companies of 10 years old and older and 0 otherwise.

According to Ritter (1984) and Ibbotson (1994), the initial underpricing is strongly impacted by the IPO cyclicality. It has been suggested that the underpricing is higher during “hot” market conditions and, respectively, lower during “cold” market. This theory potentially explains the long-term underperformance, conditioned by abnormal returns caused by an “overheated” market right after the IPO and declining returns when the market becoming

more adequate after a while. The theory didn't get strong empirical evidence, accordingly, in this work, a dummy variable corresponding to the IPO cyclicality was created to investigate its effect on the returns.

The negative association between the offer size and the underpricing suggested by Banerjee, Dai, and Shrestha (2001) will be also tested using the regression analysis.

The impact of the firms` financials on the underpricing will be analyzed to investigate if the information asymmetry theories are related to the Norwegian market. To summarize, the expected effect of the firms` financials on the underpricing is presented in the table below.

Firms` financials	**Expected effect**
Leverage	↓
Return on assets	↑
Asset turnover	↑
Current ratio	↓
Gross margin	↓
Operating margin	↑
Pre-tax margin	↑
Effective tax rate	↑
EBIT	↑

Table 1: Expected effect of the firms` financials on the returns after the IPO

To analyze the performance of Norwegian companies which have carried out an IPO, the information on initial public offerings from 2004 to 2020 will be gathered and further classified into sector subsamples. For the evaluation of the effectiveness of the IPO by Norwegian companies and possible recommendations for increasing it, an analysis of the phenomena inherent in IPOs in the short, medium, and long term for the whole sample and individual subsamples using econometric and graphical analyses will be carried out.

For a more detailed assessment of the effectiveness of the IPO, this work will investigate not only the initial return after the first day of trading but also the returns in the middle and relatively long term. Additionally, the influence of firm-specific and offer-specific factors not previously presented in the works devoted to the phenomena associated with IPO will be studied.

Finally, this work will look at the statistical significance of the variables utilized to test the theories related to the initial public offering.

The thesis consists of an introduction, background, theory, literature review, methodology, analyses of the hypotheses put forward, discussion, conclusion, a list of used sources, and appendices. The first part is devoted to the key features of the initial public offering. This part will be discussed previously conducted researches on the problems characteristic of this process, as well as an assessment of the effectiveness of its implementation. The further part describes the methodology for studying the effectiveness of IPOs by Norwegian companies. Later, an analysis of the specific problems inherent in the IPO of Norwegian companies will be conducted, as well as an assessment of the effectiveness of this method of increasing the financial capabilities of companies.

1.1. Background

The value of this work lies in the analysis of problems characteristic of the Norwegian stock market and playing an important role, both for theory and practice. The results obtained in the course of this study can be useful both for future scientific work and serve as an explanation for the decisions made by managers regarding the financial policy of companies. Also, IPO analysis is of value to a range of professional groups: issuers – choosing the best moment for going public; investors - when making decisions on portfolio diversification; specialists in the field of regulation of the securities market - about the possibilities of state influence on the issue of IPO.

2. Theory

This part is devoted to the analysis of the main investigated phenomena and the effectiveness of IPOs, namely, a detailed consideration of this method of increasing companies` financial capabilities. A definition of the above-mentioned source of raising funds by firms and also a list of its main features (the parties to the transaction and their interests in the IPO, the reasons, advantages, and disadvantages of the IPO, the placement process itself) will be given in this part. The already implemented studies on this topic will be analyzed, in particular, methods of their implementation and the results obtained. All this will help to move on to the key issues of this master's thesis: to assess the effectiveness of initial public offerings among Norwegian companies in terms of both pricing and profitability.

2.1. Definition and key features

The main goal of any company is to increase its value by for example increasing market share, growing customer base, increasing production capacity, etc. Entering public capital markets represents a transition to a completely new level of development for a company. Such a step for a company not only opens up broad opportunities for the stock market but also contributes to the solution of several specific problems. That is why nowadays the initial public offerings (IPOs) are one of the most reliable and proven ways to increase the financial capabilities of companies and, therefore, allow firms to implement their planned investment projects (Barkhatov, 2012). Figure 1 shows the volume of funds raised during IPOs in different regions of the world in 2020 with growth rates compared to last year, according to The Wall Street Journal.[1]

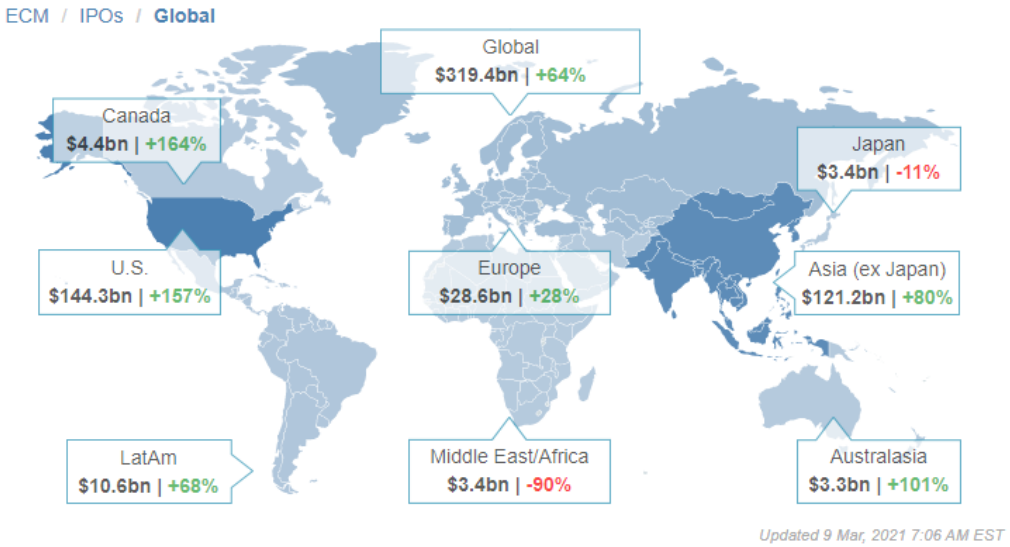

Figure 1:Initial public offerings by nationality of issuer YTD showing percent change year-on-year

What is an IPO? What is the essence of this method of raising funds? The meaning of the term "initial public offering of shares" (IPO) fully correlates with its name: it is "the initial public offering of the company's shares and their listing on the stock exchange." Participants involved in raising funds can be both private investors and large companies, as well as venture capital firms and even the government. However, it is important to note that no matter who takes action to increase their financial capabilities, the process of issuing new securities is always difficult. It requires considerable costs both on the part of the company's management concerning the required time and also from a financial point of view. These

[1] Source: http://graphics.wsj.com/investment-banking-scorecard/

efforts are essential to ensure that the placement is exactly the price that will satisfy both sellers and buyers alike.

There are three main stakeholders in the IPO process: seller, issuing company, and investors, each of which has its own undoubtedly interrelated goals. Let's dwell on them in more detail. It is advisable to single out the following as the key goals the company is facing as one of the participants in the IPO: maximizing income; satisfying the interests of investors due to the growth of the market value of their shares; expansion of the activity scope; facilitating future financing and increasing the company's business reputation through a successful IPO.

However, there are numerous situations, as a result of which the company cannot act as a seller of shares: when selling shares by the founders of the company or third-party investors; with venture capital; when buying back shares using borrowed funds; during the sale of subsidiaries by the parent companies and during privatization. In this case, a seller and a company are two different participants in the IPO process.

The seller as another party to the transaction sets himself/herself the following goals:

- maximizing income;
- maximizing the value of the remaining assets;
- conducting a successful IPO.

Finally, the last stakeholders in an IPO are investors who seek to maximize the profitability of shares and their prices both in the long-term and in the short-term. Another goal of investors is expansion and diversification of the investment portfolio and acquisition of shares in attractive companies.

Thus, it is easy to see that the interests of the listed parties coincide in terms of achieving the maximum share price in the market, which is closely related to the successful performance of a company. This satisfies all parties to the transaction with the IPO price and high liquidity of shares in secondary trading (due to the number of shares in the issue and the number of markets in which they are traded). The other goals of the parties are complementary to each other but in no way identical. The role of the investment bank is precisely to ensure that the balance of interests of all three parties is maintained.

Now, having looked at initial public offerings in general terms, it is expedient to analyze why companies decide to conduct an IPO. There are two main reasons:

1. increase in the company's equity capital;
2. raising funds for existing shareholders, including venture capitalists and government.

Firms raise capital by issuing new shares to improve the financial health of their businesses. This is due to the significant advantages of shares over bank loans and other forms of borrowed capital: there is no need to return borrowed funds, as well as mandatory payments in the form of dividends because they are paid only by the decision of the board of directors. To summarize, it is important to note that companies resort to IPOs to raise funds to expand their activities and to reduce the company's debt burden.

As for the second reason, there are many examples of why companies seek to conduct an IPO. Within the framework of this master's thesis, we will single out a short-term investment horizon to increase the existing yield of securities and diversify the investment portfolio to increase profits or reduce risk.

Like any other method of raising funds, an initial public offering has some advantages and disadvantages. The benefits of an IPO include:

1. The large one-time inflow of capital: an ability to attract significant funds that are not limited in terms of their usage time.
2. Liquidity and share price growth - companies listed on the stock exchange are more expensive than their non-listed competitors. The information contained in the IPO prospectus and subsequent annual reports reduce the uncertainty about the company's performance, which increases its value.
3. Improving the image and raising the prestige. Greater transparency and openness of a company listed on a stock exchange helps to improve its image as well as allows to attract more qualified human resources since work in such organizations is considered more prestigious.
4. Motivation for management and employees. The introduction of rewards in the form of stock options and premiums tends to attract and retain highly qualified employees.
5. Access to alternative sources of capital. Companies whose shares are listed on a stock exchange often have more favorable conditions in the future to attract additional sources of capital. For example, low interest rates and ease of obtaining compared to private companies of the same size.
6. Spin-off benefits. A clear formulation of a business strategy in preparation for an IPO prospectus contributes to the further business success of a company.

Despite such a wide range of advantages, IPOs have certain disadvantages. These include:

1. Greater transparency. An increase in the number of persons with access to a company's financial statements may harm the interests of existing owners and managers.
2. High costs of an IPO. The process of issuing new shares requires significant costs, initially in a form of commissions to investment banks, payment for the services of lawyers and accountants, and also in a form of advertising costs, etc.
3. Separation of ownership and management. Managers act on behalf of the interests of shareholders. Control over compliance with these rules is carried out by the board of directors, which imposes certain kinds of restrictions on the activities of managers.
4. Possible loss of control over the company - transfer of control over time to the broad masses of shareholders.
5. Obsession with short-term results. Choosing a strategy that supports the stock price in the short term, overlooking the company's long-term strategies.
6. The need to meet investors' expectations. Holding meetings to discuss strategies, results, and prospects of a company with current shareholders.

Summing up, it is noticed that the advantages arising from an IPO prevail over the disadvantages. However, it is important to keep in mind the weaknesses characteristic of this process, since under certain circumstances they can be very significant.

It is important to emphasize that a company is ready for an initial public offering only if it has a significant investment reputation. Investment positioning includes many factors, the main is a qualification of management personnel; a financial history of a company; position in the industry, main competitors; industry prospects; appraisal of a company's value.

The higher are qualifications of management personnel, the more successful will be the financial performance of a company (growth of cash flows and profits). The more influential is a company's position in an industry, the more significant is a company's investment reputation, and, therefore, it is better prepared for an initial public offering.

2.2. IPO process

The process of issuing shares consists of five main stages. These stages follow in a certain sequence. These five stages are as follows [2]:

1. Corporate Actions. At this stage, the directors and shareholders of a company are determined by the corporate structure and jurisdiction of the company. The schedule for shares placement is formed by the board of directors and certain employees of the company. Besides, shareholder agreements are received for a moratorium and the sale of shares.
2. The structure of the placement. This stage of the issue of the shares implies a selection of a stock exchange for listing and a site for selling issued shares. These can be both local and international placements, it all depends on the goals of a company and its priorities.
3. Regulatory authorities and documentation. This stage includes the preparation of the necessary documentation for both potential investors and regulatory bodies.
4. Marketing. This stage consists of three components:

a) pre-marketing - development of investment positioning, preparation of a market, and company management.
b) marketing - determination of an offering price range, publication of a preliminary issue prospectus, preparation of participants in the transaction for the sale of shares, meetings with management and investors, collection of information about the market, and the formation of an order book.
c) determining the price and allocation of shares - setting prices, allocation of shares, and their stabilization.

[2] Source: https://www.pwc.no/no/publikasjoner/kapitalmarkedstjenester/ipo-guide-2014.pdf

5. Secondary circulation after the IPO. Determination of how well the shares are trading after their initial public offering, and whether the company has been able to raise the funds it needs.

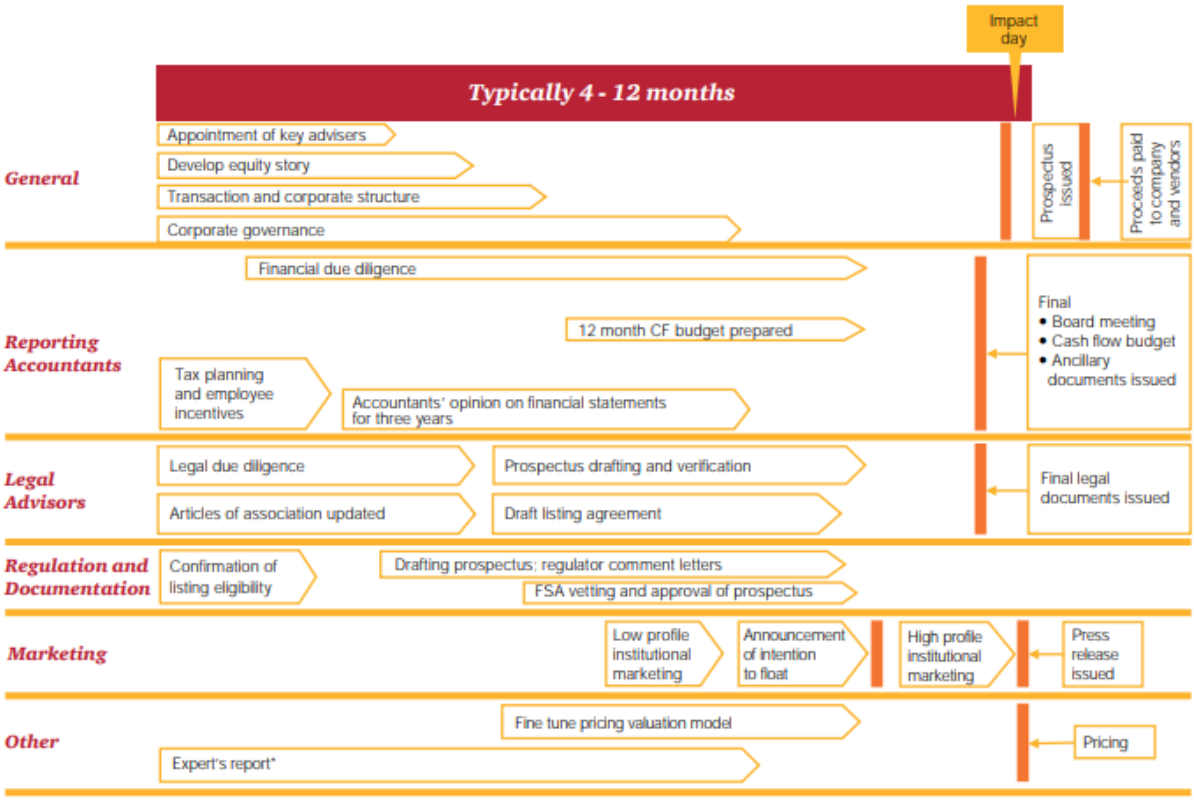

Figure 2:IPO process

Summarizing the above, it is noticed that the process of the initial public offering of shares is quite laborious for the companies conducting it, both from a financial and managerial point of view. However, a desire of firms in a modern economic environment for growth and development contributes to the widespread use of IPOs as a way to increase their financial capabilities.

2.3. Oslo Stock Exchange (Oslo Børs)

The Oslo Stock Exchange (OSE) is considered the smallest stock exchange in the Scandinavian countries. It is oriented towards the energy sector and therefore shows great opportunities. Large companies with a high share of liquidity and high capital also participate in the trading operations of the exchange. The Oslo Stock Exchange is not completely dependent on the government.

There are about 200 companies listed by OSE, 34 of which are foreign firms. Bonds, stocks, indices, options are traded on the exchange. The total capital share of all companies is

$ 353 billion. The average position of the trade turnover per day on the stock exchange is 600 thousand dollars, and the average number of transactions is about $ 73 800 per day.[3]

Oslo Stock Exchange was founded in 1818. And already in the 20s of the XIX century, a petition was drawn up to open a special institute of trading. A year later, the exchange opened its doors to its first visitors.[4]

In the early years of the exchange, trading in currencies and bills lasted only 2 hours, from 11 a.m. to 1 p.m. With the first money raised, the administration of the exchange began to build its building for trading. It took 6 years.

As mentioned earlier, the trading floor was occupied only by currency transactions. But already in 1881, it was decided to introduce the circulation of securities - shares into trading. The first sellers were railway companies.

The new development of the country became possible only in 1980, after the renewed course of economic support for the country. At the end of the 20th century, the exchange was fully automated, which gave an active impetus to attract not only new issuers but also new trading industries. And by 2000, the Oslo stock exchange had no competitors, since all other stock exchanges began to act under the same auspices of the Oslo Stock Exchange.

Nowadays mainly highly specialized companies associated with heavy industry and energy are listed on the Oslo Stock Exchange.

For example, the share of companies whose main industry is oil production account for about 23% of the total number of companies, and the market capitalization of these companies exceeds 50%.[5]

3. Literature review

Having described the key features characteristic of the IPO process, we will further consider the main investigated phenomena inherent in IPOs. After analyzing these, an assessment of the effectiveness of the initial public offering will follow.

The issues inherent in the IPO process are traditionally viewed from three points of view: from the side of investors, a company, and an investment bank. Within the framework of this master's thesis, it was decided to focus on the analysis of the IPO phenomena from the

[3] Source: https://www.oslobors.no/(year)/
[4] Source: https://en.wikipedia.org/wiki/Oslo_Stock_Exchange
[5] Source: https://www.euronext.com/nb/markets/oslo

perspective of investors due to its great popularity and increased interest from researchers at present. It is customary to distinguish the three most common phenomena inherent in an IPO:

- initial underpricing - the phenomenon of a significant increase in stock prices after their placement.
- reduced long-term profitability. Shares of companies that have gone through an IPO show lower profitability in the long-term time horizon compared to shares of similar companies that did not go through an IPO.
- IPO waves (cyclical placements).

The presence of such phenomena has attracted the attention of a large number of researchers for the following reasons. First, the initial underpricing of shares and their subsequent abnormal returns call into question the fulfillment of the efficient market hypothesis. According to this hypothesis, all available information is reflected in the share price instantly, and therefore shares with a similar level of risk should have the same return. Secondly, due to the lowered long-term profitability of shares purchased during the IPO, the question arises about the advisability of such investments for investors who invest for a long period. Finally, numerous IPOs during periods of overheated capital markets, when IPO stocks are overpriced due to heightened optimism on the part of investors, generates another branch of thought in the academic research environment. Table 2 provides a list of theories related to the IPO phenomena.

IPO underpricing theory	**Author**
Information Asymmetry theories	
Signaling	(Allen & Faulhaber, 1989), (Grinblatt & Hwang, 1989), (Welch, 1989), (Ljungqvist A. , 2007)
Ex-ante uncertainty	(Jenkinson & Ljungqvist, 2001), (Ritter J. , 1984), (Rock, 1986), (Banerjee, Dai, & Shrestha, 2001)
Book-building	(Benveniste & Spindt, How Investment Bankers Determine the Offer Price and Allocation of New Issues, 1989), (Benveniste & Wilhelm, 1990), (Degeorge, Derrien, & Womack, 2007)

Winner`s curse	(Rock, 1986), (Habib & Ljungquist, 2001), (Carter & Manaster, 1990)
Institutional explanations	
Lawsuit avoidance	(Logue, 1973), (Ibbotson R. , 1975), (Lowry & Shu, 2002), (Hensler, 1995)
Price stabilization	(Booth & Smith, 1986), (Benveniste, Busaba, & Wilhelm, 1996)
Tax argument	(Rydqvist, 1997), (Taranto, 2003), (Guenther & Willenborg, 1999)
Ownership and control reasons	
Entrenchment managerial control	(Jenkinson & Ljungqvist, 2001), (Habib & Ljungquist, 2001), (Shleifer & Vishny, 1989)
Behavioral explanations	
Informational Cascades	(Welch, 1992), (Jegadeesh, Weinstein, & Welch, 1993)
Long-run underperformance theories	(Miller, 1977), (Ritter R. , 1991), (Loughran & Ritter, The New Issues Puzzle, 1995), (Loughran, Ritter, & Rydqvist, 1994), (Gregory, Guermat, & Fawaz, 2010), (Jewartovski & Lizinska, 2012), (Stehle, Ehrhardt, & Przyborowsky, 2000), (Shen, Coakley, & Insterfjord, 2013), (Schultz, 2003), (Gompers & Lerner, 2003), (Otchere, Owusu-Antwi, & Mohsni, 2013)
IPO Cyclicality theories	(Lucas & McDonald, 1990), (Choe, Masulis, & and Nanda, 1993), (Ritter & Welch, 2002), (Lowry M. , 2003), (Boeh & Dunbar, 2014), (Gregoriou, 2008)

Table 2: Classification of theories related to IPO phenomena

To be used in further analysis, several scientific works devoted to specific IPO problems were selected. After analyzing them it is possible to conclude the effectiveness of

this process. The following is a more detailed discussion of each of the IPO-specific phenomena mentioned above and the research already conducted on this topic.

3.1. Initial IPO underpricing

The phenomenon of initial underpricing of an IPO is that the placement of shares occurs at undervalued prices, which leads to a significant increase in prices on the first day of trading. That is why this problem has become widespread among researchers.

Underpricing is the positive difference between the closing price on the first day of trading and the offer price, as defined in their studies by Stoll and Curley (1970), Logue (1973), Ibbotson and Jeffery (1975).

The underpricing of shares in the IPO of a certain company can be calculated using the following formula:

$$U = \frac{P1-P0}{P0} \quad (1)$$

where U is the underpricing of shares on the first day of the IPO;

P_1 - closing price on the first trading day;

P_0 - offer price.

The first scholarly works on the initial underpricing of IPOs were studies by Stoll and Curley (1970), Logue (1973), Reilly (1973), and Ibbotson and Jeffery (1975). The authors attempted to explain the significant rise in stock prices during the first day of trading. As a possible interpretation of the abnormally high return on the first day, they suggested the following: at the time of the placement of shares, they were undervalued in comparison with the market.

The most popular theories explaining this phenomenon are those in which the initial underpricing is viewed as a consequence of an information asymmetry. The incomplete information is twofold: investors are better aware of the demand for the issuer's shares, while the issuers themselves have more information about the activities of their companies.

The first group of theories, linking initial underpricing with information asymmetry, is focusing on the idea that investors have a better knowledge of the true demand for the issuer's shares than the issuer himself. In other words, during the placement of shares, the issuer does not have complete information about how much the market is willing to pay for his share.

The most common and illustrative studies within this approach are the works of Rock (1986) and Benveniste and Spindt (1989). The authors analyzed a model in which some investors owned more information than others. As a result, it was noted that the IPO

underwriter often receives applications for an amount significantly exceeding the volume of placement. That is, it is the underwriter who distributes the corresponding shares between investors (a large share goes to institutional investors under providing the underwriter with information about the current demand for shares). Thus, institutional investors have private (insider) information and know the true value of a share, while less-informed investors make their decisions based on expectations, which results in the initial underestimation.

As an alternative explanation, it is advisable to mention the scientific work of Welch (1992). The work is based on the so-called "information chains" approach, which means that investors make decisions about the acquisition of shares, taking into account the actions of those investors who have negotiated with underwriters a little earlier. Based on this, an untruly overestimated price may cause the IPO to fail due to the refusal of the first investor to place. Thus, the author explains the initial underestimation as an attempt to avoid the failure of the IPO.

The approach proposed by Benveniste and Wilhelm (1990), which associates underestimation with the issuer's ignorance of the market demand for shares, is most convincing in the first group of theories related to information asymmetry. The authors also take into account the activities of investment banks acting as underwriters of the IPO. Investment banks, during negotiations with potential investors, are trying to determine the market demand for the issuer's shares. However, potential investors are well aware that if they agree to purchase shares at a high price, then such a price will be set. Therefore, investment banks must offer something in return for honest disclosure of information regarding acceptable prices by investors. The authors suggest that it is an underestimation and it acts as payment for truthful disclosure of information on the part of potential investors.

The second group of theories, in which the initial underestimation is seen as a consequence of information asymmetry, is based on a better awareness of an issuer about the company's activities compared to an investor. This brings into focus the problem of the "lemons" market (Grinblatt & Hwang, 1989). Its essence lies in the fact that there are issuers of different quality on the market, which investors cannot always correctly identify from the outset. This is due to the ability of "low quality" companies to signal their "high quality" while incurring so-called "imitation" costs. Welch (1989) in his study mention oil and gas firms as a confirming example, where a "low-quality" company builds a high-tech oil pipeline. Even though the pipeline has a lower return on investment compared to "high-quality" companies, this allows the "low-quality" company to position itself in the market as a "high-quality" company. Consequently, firms with low quality give the market the appearance

of large-scale and efficient operating activities. Based on this, the initial underestimation of shares in the framework of this approach is precisely the additional cost of "imitation" for low-quality companies, which helps to reduce the desire of firms to give false signals.

At the same time, "high quality" companies are characterized by a lower underpricing of shares during the placement to confirm their high status.

It is important to emphasize the fact that even bearing some of the costs associated with the initial underestimation, "high-quality" firms in the future receive some benefits that "low-quality" companies are not able to take advantage of. In support of this statement, Allen and Faulhaber (1989) in their scientific work say that the initial underestimation contributes to a more significant positive assessment of dividends by the market, and therefore increases the value of the company. When it comes to "low-quality" firms, it is very difficult for them to generate enough cash flow to pay dividends and cover the costs of underestimation.

As an addition to the above group of studies, it is advisable to include a scientific publication by Ljungqvist (2003), in which it is assumed that the motivation of insiders and key persons of firms regarding the placement price and reduction of underestimation is influenced by their participation in this transaction, and also IPO results for the well-being of existing shareholders (insiders). The authors conclude that agency problems become more severe when insider ownership of a company decreases compared to the pre-IPO period. Habib (2001) also notes the influence of the volume of insider sales on the level of underestimation. The more shares the owners sell, the more they are concerned about underestimation and, accordingly, the less the degree of agency conflict.

However, Wasserfallen (1994), on the contrary, concluded that the larger the share of ownership remains with insiders, the lower the underestimation.

Thus, even though this group of theories has been subjected to significant criticism due to the lack of a unified and final conclusion among researchers, it allows explaining the reason for the choice by some firms of the initial underpricing of stocks.

Summarizing the theories that explain the initial underestimation as a consequence of information asymmetry, it can be concluded that more transparent companies are characterized by less uncertainty about the future prices of their shares, and, therefore, a lower underestimation.

Studies devoted to the analysis of country-specific features and their impact on the initial underestimation of the IPO are also of considerable interest in the study of this IPO phenomenon. The earliest research in this area is the one by Loughran, Ritter, and Ridqvist (1994). The authors found that all the 25 countries studied, both developed and developing,

are characterized by an initial underpricing of stocks. At the same time, the higher the degree of government intervention, the faster the fixed offer price is established. And the riskier the company is, the higher the profitability. It is also worth noting that, on average, developed countries are underestimated by 10-15%, while developing economies recorded values of and above 60%, which can be explained by political factors ((Jenkinson & Ljungqvist, 2001); (Ritter J. , Differences between European and American IPO Markets, 2003); (Jenkinson T. M., 2004); (Ritchie, 2013); (Sapian, 2013)).

Thus, Banerjee, Dai, and Shrestha (2001), examining 8,700 IPOs in 36 countries, including developing countries, showed that the initial underestimation of shares is more significant in those countries where information asymmetry is higher, less effective control mechanisms over the execution of contracts and a higher degree of legal protection for investors.

As a supplement to the previous work, it is advisable to cite the study of Groh and Liechtenstein (2011), where the authors associate the initial underestimation of shares with the level of corruption in the country. In more corrupt countries, both investor protection and public confidence are extremely low, indicating a high level of risk aversion, and hence a high-risk premium, which, in turn, is reflected in the initial underestimation.

Finally, the most recent work in terms of cross-country differences is the study by Hopp and Dreher (2013), who analyzed the differences in the institutional and legal systems of countries. They concluded that countries with stronger investor protection tend to have higher levels of underestimation. The authors explain this by the desire to maximize the number of shareholders to maintain control over the company. And a high underestimation just contributes to the growth of demand for shares and an increase in the number of owners. Moreover, Hopp and Dreher showed that more efficient stock markets, which are characterized by high liquidity and low capital costs, are less undervalued.

Summarizing the studies discussed above, it should be emphasized that although the authors had the same task - to analyze the reasons for the existence of the initial underpricing of shares as a result of the IPO, and, as a consequence, their abnormally high profitability on the first day of trading, they formulated different hypotheses. Some took into account only the factor of information asymmetry, while others considered several factors in aggregate. However, for the most part, their results were similar: the initial underestimation of shares as a result of an IPO occurs in both developed and emerging markets, and information asymmetry is the most significant and popular factor in explaining its existence. Many researchers also agreed that, in addition to information asymmetry, other factors, such as

institutional and legal systems characteristic of certain countries, as well as the efficiency of the stock market, affect the existence of the initial underestimation of stocks.

3.2. Long-run underperformance

The phenomenon of lowered long-term stock returns in IPO companies has been a hotly debated issue in academia in recent decades. Its essence lies in the fact that the company's shares after the initial public offering do not meet the expectations of investors and bring returns in the long term lower than the shares of similar companies that did not carry out an IPO.

However, despite the presence of a large number of studies, the question of the reasons for the existence of the phenomenon of low long-term stock returns remains not fully resolved to this day. One of the most common and recognized ways of explaining it is the presence of periods in the capital market when investors are overly optimistic.

Miller (1977) is a first attempt at explaining the lower long-term return on IPOs. According to the author, as a result of the initial public offering, shares are purchased by the most optimistic investors who offer the highest price for them. Meanwhile, over time the valuation of shares of the most optimistic investors tends to the market average due to the understanding of the true situation. This leads to a decrease in quotations, and, consequently, lower long-term profitability. It is important to note that the reasoning used in Miller's work does not answer the question regarding the time intervals during which the IPO demonstrates reduced profitability.

This problem is given close attention in the next fundamental work on this topic - the work of Ritter (1991). As the sample under study, he considered 1526 initial public offerings carried out in the period from 1975 to 1984 in the USA. The main analysis tools were excess and cumulative excess returns on stocks. In the course of the study, it was revealed that "the average profitability of an IPO for three years was 34.47%, while the profitability of similar companies that did not carry out an IPO was 61.86%." Initially, Ritter cites the following three factors explaining this phenomenon:

i. wrong system of risk management in the company
ii. presence of a random component
iii. increased optimism on the part of investors.

However, the author notes that only for 5 out of 10 years of the analyzed period, IPOs demonstrate lower returns than the benchmarks selected for comparison. Based on this, it can

be concluded that the hypothesis of excessive optimism of investors who overestimate share issues is confirmed. That is, the mood in the capital market is one of the possible explanations for the existence of the phenomenon of low long-term IPO returns.

As a supplement to the previous work, it is advisable to cite the study of Loughran and Ritter (1995). The authors analyze the performance of stocks of companies that had IPOs in the United States from 1970 to 1990, that is, they consider a significantly larger sample compared to Ritter's previous work. As a result, the researchers found the following: the problem of reduced profitability makes itself felt after the first 6 months from the date of issue and reaches its peak in the next 18 months. But after 5 years, the difference in profitability between the companies that carried out the IPO and their peers practically disappears. In their paper, the authors explain lower long-term stock returns through misconceptions of investors that overestimate the future flows of small companies that initially grow at a high rate. It is important to note that systematic errors due to the excessive optimism of investors do not fully explain the phenomenon of the reduced long-term profitability of shares of companies that have carried out an IPO.

The problem of lowered long-term profitability is inherent not only in the United States, which was confirmed by previously analyzed works but also in other developed and developing countries as well. Research by Loughran, Ritter, and Ridqvist (1994) is proof of this. The authors carried out an analysis for 9 countries, both developed and developing, and illustrated the reduced long-term stock returns. The lower is the profitability, the more risky the activity of the company that has carried out the initial public offering of shares and the more optimistic the expectations of investors at the time of the placement. More recent studies confirming the existence of lower long-term yields for other countries, in particular for the UK, Poland, Germany, and China, are the works of Gregory, Guermat, Al-Shawawreh (2010), Jewartowski and Lizinskaya (2012), Stehle (2000), and Shen (2013). The reasons for this phenomenon are based on the hypotheses proposed by Miller and associated with investor sentiment in the capital markets.

Schultz (2003) in his study also explains lower long-term stock returns in terms of issuance activity. He developed a model whereby companies conduct an initial public offering at a time when their shares are valued especially high. It is important to note that the issuers themselves do not realize that the quotes have reached their peak values. If prices continue to rise, the number of IPOs will increase. It is easy to understand that under such conditions the excess IPO return will be negative due to the subsequent return of prices to the market average values. Thus, we can conclude that in the case of an absolute correlation between the

IPO return and the market index, the peak of stock prices would coincide with the peak of the market index, and, therefore, the excess stock return would be equal to zero. Consequently, the phenomenon of reduced long-term profitability would not take place. On the contrary, the more significantly the dynamics of stock prices differ from the dynamics of the market index, the lower the excess return. The volatility of excess returns is just the indicator that characterizes these deviations.

The works of Gompers and Lerner (2003) and Otcher (2013) act as a refutation of the conclusions obtained in the previously reviewed fundamental studies of reduced long-term IPO returns. The authors use a different approach to calculating returns, namely cumulative excess returns. They emphasize that when assessing excess returns, stock returns do perform lower than the benchmarks chosen for comparison. However, when cumulative excess stock returns are applied, there is no diminished long-term return on the IPO. According to the authors' calculations, over a long-time horizon IPOs show returns at the market level or even higher. Thus, depending on the analysis tools used, the conclusions may be the opposite. The question is to justify the application of a particular method of researching this phenomenon.

Summarizing the above studies, it should be emphasized that the majority of researchers, using an impressive amount of empirical data, have shown that shares of a company that have carried out an IPO most often show a yield lower than the yield of a market portfolio, which is traditionally chosen as a market index of similar companies.

3.3. IPO cyclicality (hot issue markets)

The issuing activity of companies is subject to significant fluctuations from year to year, which is expressed in a large number of placements in some years and much less in others. This fact suggests that there are so-called “window opportunities” in the capital market and the cyclical nature of initial public offerings.

Studies reviewed earlier have shown that there are indeed times when investors tend to overestimate a company's stock, which serves as an incentive for firms to enter the market (Ritter (1984); Ibbotson (1994); Ritter (2003)). This is beneficial for the company from the point of view that it can attract significantly more funds than what it can claim. Based on the above, the company's valuation can be either overestimated or underestimated in a certain period, depending on investor sentiment.

The earliest work to explain the phenomenon of cyclical IPOs is the study of Lucas and McDonald (1990). The author developed a model based on the theory of unfavorable

selection (managers decide to hold an IPO when the market revalues their company). The basic premise of this model is that managers are more aware of the activities of their companies in comparison with the market. And the main task of managers is to maximize shareholder wealth. The model illustrates that if the above prerequisite is met, the company's management is waiting for such sentiments from investors that will allow them to get the highest price per share, and only then they conduct an IPO.

Choe, Masulis, and Nanda (1993) continue to develop adverse selection theories to explain the cyclical nature of IPOs. They analyzed over 5,000 placements on the US market from 1971 to 1991 using business cycle indicators. The authors found a connection between the emission activity of companies and the stages of the business cycle: during the economic recovery, profitable investment opportunities open up for companies, therefore, more firms seek to attract additional financial resources, which increases the number of IPOs and also exacerbates the problem of unfavorable selection. However, due to the existence of lucrative investment opportunities, the firm will agree to bear the adverse selection costs associated with the issue of shares.

An interesting observation was noted by Ritter and Welch (2002) regarding the emission activity of companies. They discovered that there is a so-called time lag between the improvement in the financial market and the IPO boom. The authors attributed some of the delays in IPOs to partial rationality on the part of investors. It consists of the fact that when making decisions, investors evaluate the company, guided by their internal ideas about its activities. That is, they cannot immediately react to a change in opinion on the part of the market.

Empirical studies also confirm the fact that the cyclical dynamics of the number of issues and high initial profitability take place for a fairly long period, but the relationship between them remains rather unclear. Lowry (2002) found a relationship between the monthly number of initial public offerings and the average initial return. The authors noted that the volume of IPOs was significantly positively influenced by previous periods of high yields, that is, increased underestimation. Taking into account the fact that companies are trying to attract as much money as possible, this behavior on their part seems very strange. In connection with this observation, Lowry (2003) suggested that investor sentiment is another determinant of IPO volume in addition to firm capital requirements. Thus, companies are timing their IPOs during periods of over-optimism by investors, thereby reducing their costs of converting to a public limited company. The most recent scientific work supporting the above is the study by Boeh and Dunbar (2014).

As a kind of generalization of the theories described above, it is advisable to cite Wegner's study of initial public offerings on the NASDAQ exchange at the peak of the market in 2000 (Greg N. Gregoriou (2008)). This paper examines NASDAQ IPOs during the pre-peak Internet bubble (hot markets) and subsequent cold markets. As a result of the analysis, it was revealed that the short-term return on IPOs is higher during periods of "hot" capital markets, while the long-term return on IPOs during "hot" and "cold" markets is practically the same. Thus, this study reaffirms the commitment to IPOs by companies during "overheated" capital markets.

The studies reviewed above allow us to conclude that stock markets are influenced by investor sentiment, and such a significant event as an initial public offering is no exception. This fact plays an important role in explaining the phenomena characteristic of IPOs.

At the end of this part, the following has been noticed: an initial public offering is a very popular way to increase the financial capabilities of companies in the modern economic world. However, this process is characterized by certain phenomena, the analysis of which has been devoted to a huge amount of research. When explaining the phenomenon of underpricing, theories of information asymmetry are used most often. The increased transparency of the company helps to reduce the uncertainty about the future value of their shares, which leads to a reduction in underestimation. As for the phenomenon of low long-term stock returns, most researchers explain it by the presence in the capital market of optimistic investors who are inclined to overestimate company stocks. And finally, the cyclical nature of IPOs is again interpreted based on the vulnerability of stock markets to investor sentiment. Thus, it is concluded that the three key IPO phenomena are closely interconnected. Evaluation of the effectiveness of initial public offerings follows from the analysis of the phenomena inherent in IPOs.

4. Data

Within the scope of this master's thesis, Norwegian companies which went public on the Oslo Stock Exchange between 2004 and 2020 will be considered. In total 163 Norwegian companies went public within this period. Over the past few years, the following Norwegian companies have become public: Cyviz, Pasient Sky, Zaptec, Sparebanken Telemark, Sparebank 1 Østlandet, Salmon Evolution Holding, and others.

The number of companies that have completed an initial public offering varies from year to year. This is due to the cyclical nature of the market caused by financial crises and

vice versa by market ups. More details on the number of companies that have become public for each year from 2004 to 2020 can be found in Figure 3.

The figure shows that the IPOs peak was in 2005-2007. In 2008, only 3 companies went public, and in 2009 there were no such companies at all.

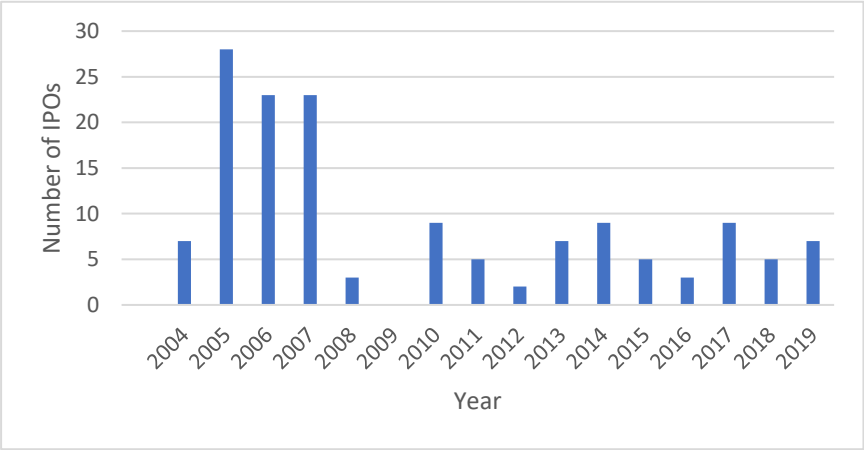

Figure 3: Number of Norwegian IPOs listed on the Oslo Stock Exchange per year

The largest number of IPOs carried out by Norwegian companies was observed in 2005-2007, which is undoubtedly due to the "overheated" capital markets at that time due to the overestimated expectations of investors and the presence of a bubble in the financial market on the eve of the global financial crisis. This was followed by a significant decline in the number of companies conducting IPOs, due to the downturn in the economy as a whole. In 2008, only 3 companies went public, and in 2009 there were no such companies at all. The reason for the new decline in the number of offers can be attributed to the Norwegian oil crisis of 2015-2016. Thus, the number of offers began to grow again along with the market recovery. A new peak in IPOs came in 2020 when 18 Norwegian companies went public. Based on this, it is important to note that the cyclical nature of IPOs is indeed typical for Norwegian companies, and it can be interpreted in terms of the connection with business cycles, which has already been noted in the academic research environment.

Next, we will consider the distribution of companies that have gone public by sector. The division into sectors has already been presented by analysts from the Thomson Reuters Data Stream. In this work, we used their method of assigning companies to certain sectors.

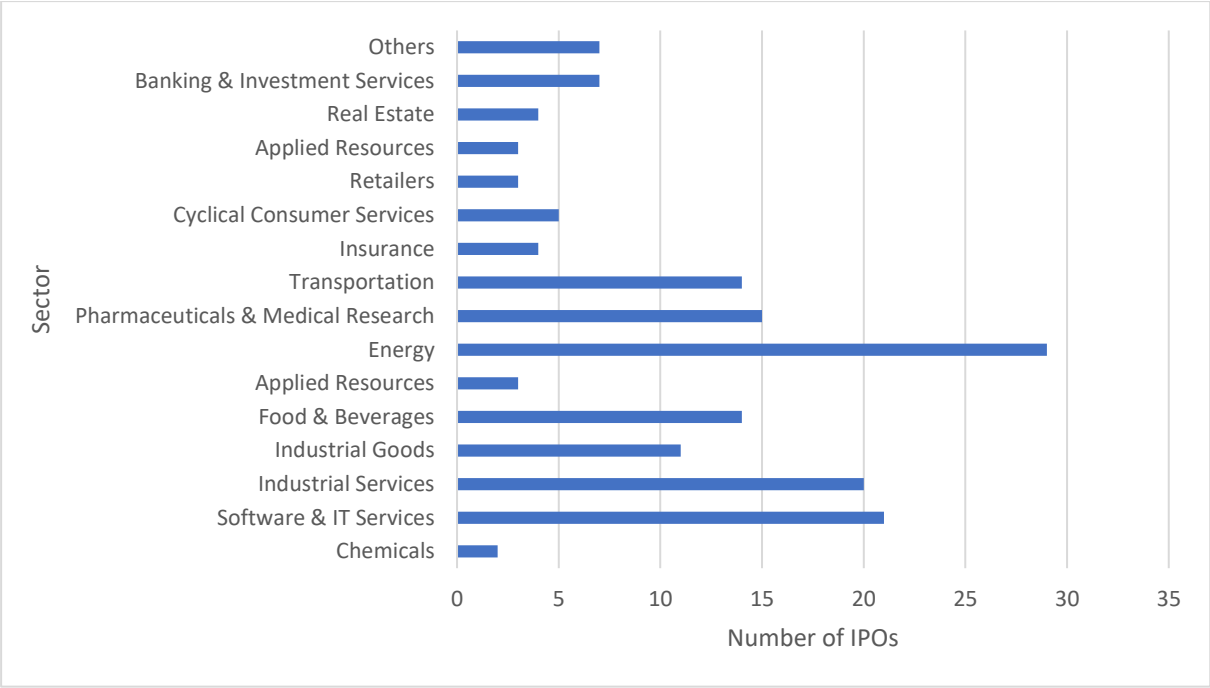

Figure 4: Norwegian IPOs listed on the Oslo Stock Exchange divided into sectors

Figure 4 shows the shares of various sectors in the total volume of all completed IPOs of Norwegian companies listed on the Oslo Stock Exchange in the period from 01.01.2004 to 31.12.2020. The energy sector dominates, accounting for 18% of all placements.

For a more substantiated and in-depth analysis, a regression model will be built. However, before proceeding to build a model, it is necessary to decide on the primary data for analysis. The list of the Norwegian companies which went public on the Oslo Stock Exchange offer price, prices of shares at different periods, sector, bookrunner information, and some of the financials were found using Thomson Reuters Datastream (deals screener). Missing financials were found in companies` balance sheets available on morningstar.no.

The data on Norwegian companies that have carried out IPOs on the Oslo Stock Exchange in the period from 01.01.2004 to 31.12.2020 was collected. Initially, there were 163 such companies. Further, the number of companies in the initial sample decreased to 84 for several reasons:

1. Companies with missing closing prices on the first day of trading were excluded (48 companies)
2. Also excluded are companies for which it was not possible to find balance sheets for the pre-IPO period (31 company)

5. Hypotheses put forward

To put forward hypotheses, studies previously conducted on this topic were studied in detail. Further, the necessary data presented earlier were obtained. Based on the earlier studies and the data obtained, the hypotheses presented below were put forward. Testing of the hypotheses will determine whether the public offering of shares is an effective method of raising funds in the Norwegian market.

- Hypothesis 1: Initial underpricing of shares is non-zero and is typical for Norwegian companies that have carried out IPOs.
- Hypothesis 2: Underpricing on the first day of trading is higher among Norwegian companies in the high-tech sector.
- Hypothesis 3: Long-term underperformance exists and is typical for Norwegian companies that have carried out IPOs.
- Hypothesis 4: Firm-specific variables such as leverage, gross margin, return on assets, current ratio, and age of a company have a negative impact on the underpricing, while asset turnover, effective tax rate, EBIT, operating margin, and pre-tax margin have a positive impact.
- Hypothesis 5: Market-specific variable related to “hot” and “cold” market has a negative impact on the underpricing.
- Hypothesis 6: Offer specific variables such as size-to-book-runner-share ratio and number of book-runners have an impact on underpricing and initial offer size has a positive impact on underpricing in a short term and negative in a long term.

6. Methodology

This part will describe the methodology used to research in this master`s thesis. In more detail, the hypotheses put forward in this work, methods of their verification, and stages of implementation will be formulated.

Turning to the main issue of this master's thesis, namely, the assessment of the underpricing of the IPOs of Norwegian companies, it is necessary to describe the research methodology that will be used further. This thesis will carry out an analysis similar to the studies reviewed in the scientific article (Hanley (1993)).

The graphical analysis will be used to determine if the underpricing of IPOs is characteristic of the Norwegian market. This analysis will be used for the whole sample as well as a sub-sample by sector to establish which economic sector is most prone to underpricing of IPOs. Examining underperformance over the long term, a graph will be drawn up for post-IPO share price changes. This analysis will be carried out for the full sample and individual subsamples to confirm or disprove the hypotheses put forward.

When conducting an econometric analysis of the underpricing of the Norwegian IPOs a regression analysis was used.

Regression analysis is a technique for examining the statistical relationship between one quantitative dependent variable on one or more quantitative independent variables. The dependent variable in regression analysis is called the resulting variable, and the variable factors are called predictors or explanatory variables.

The relationship between the mean of the resulting variable and the mean of the predictors is expressed as a regression equation. A regression equation is a mathematical function that is selected based on the original statistical data of the dependent and explanatory variables. Regression analysis is very closely related to correlation analysis. Correlation analysis examines the direction and closeness of the relationship between quantitative variables. Regression analysis investigates the form of the relationship between quantitative variables. Those. in fact, both methods study the same relationship, but from different angles, and complement each other. In practice, correlation analysis is performed before regression analysis. After proving the existence of a relationship by the correlation analysis, one can express the form of this relationship using regression analysis.

The goal of regression analysis is to use a regression equation to predict the expected mean of the resulting variable.

During the study, 6 regression models were built. The resulting variable for each model was the return on shares at different times after the public offering.

The purpose of this study is to identify the relationship between stock returns at different time intervals and the explanatory variables determined before the public offer.

6.1. Explanatory variables

To test hypotheses, it is necessary to identify the factors that may influence the value of the underestimation. The factors were identified based on research on theories of

underpricing, summarized in the previous chapter. The following factors were identified for the construction and analysis of the regression model:

1. Leverage - a variable denoting the financial leverage ratio. The indicator is calculated by dividing total debt by equity. Long-term and short-term debt, as well as equity, are taken from the latest pre-IPO balance sheet.
2. ROA - return on assets. Calculated as the ratio of net income to current assets. The data is calculated in Excel for each company based on information taken from the balance sheets for the last quarter before the placement.
3. AT – asset turnover. Financial indicator of the use of the entire set of assets. This indicator is used to analyze the effectiveness of the management of the property and liabilities of the firm. Calculated as a ratio of sales revenue divided by total average assets. To calculate the average annual value of assets, find their amount at the beginning and end of the year and divide by 2. A higher turnover of assets is desirable. Low turnover may indicate insufficient efficiency in the use of assets.
4. CR - current liquidity ratio is a measure of the organization's solvency to repay the organization's current liabilities. The current liquidity ratio is calculated as the ratio of current assets to current debt. The higher the value of the current liquidity ratio, the higher the liquidity of the company's assets. Optimally, the value of the coefficient equals 2 or more. However, it is allowed to reduce this indicator for some industries to 1.5. The value of the ratio below 1 indicates the probable difficulties in repaying the company its current liabilities.
5. GM – gross margin is the percentage of the company's profit that remains after the direct costs of producing goods. All other expenses (including dividends from shareholders) are excluded from this indicator. All this makes gross margin a good indicator for assessing the profitability of a company. Calculated by the following formula:

$$GM = \frac{Net\ Sales - Cost\ of\ Goods}{Net\ Sales} \quad (2)$$

6. OM - operating margin is a measure of income after deducting expenses incurred in operating activities related to income. The economic indicator is calculated as the ratio of profit or loss to the amount of income (sales).

7. PTM – pre-tax margin is a financial accounting tool used to exploit the efficiency of a company. This is the ratio that tells what percentage of sales turned into profit, in other words, how many cents of profit the business made for every dollar of sales before taxes.
8. ETR - in scientific literature, the effective tax rate concerning taxes on profits (incomes) is understood as the average tax rate that reflects the real share of tax payments from the taxpayer's amount of profit or income for a certain period. Calculated by the following formula:

$$\text{ETR} = \frac{Total\ Tax\ Expense}{Earnings\ Before\ Taxes} \quad (3)$$

9. EBIT – earnings before interest and tax.
10. Age - age of the company expressed in whole years at the time of listing. The date of the foundation was taken for each company separately.
11. Field - dummy variable, where "1" - companies in the innovative and hi-tech sector, and "0" - companies in all other sectors. According to Hecker (2005) companies within "Software and IT services", "Telecommunications", "Chemicals", " Pharmaceuticals and Medical Research" sectors were classified as innovative and hi-tech.
12. Frequency – dummy variable indicating "hot" and "cold" market. It was decided to let "1" be for a year when the total number of Norwegian companies which went public on the Oslo Stock Exchange exceeds 10 and "0" otherwise.
13. BRR – bookrunner-to-offer-size ratio is calculated as the total principle amount per book-runner divided by the initial offer size and indicates how big is the book-runners amount compared to the initial offer.
14. NBR – number of bookrunners a company had when making an initial public offer. Often there is only 1 bookrunner per company, however, some companies use two or even more bookrunners forming a syndicate. It was suggested by Derrien and Womac (2003) that bookrunners reputation can be determined according to the number of IPOs conducted. In this paper, in the opposite, the dependence of the number of bookrunners is examined.
15. Size – initial offer size, calculated as offer price multiplied by the initial number of shares offered in this market.

The explanatory variables were divided into the following groups:

- Firm-specific variables: leverage, return on assets, asset turnover, current ratio, gross margin, operating margin, effective tax rate, pre-tax margin, EBIT, age of a company, and sector dummy.
- Market-specific variables: market frequency dummy.
- Offer-specific variables: book-runner-to-offer-size ratio, number of underwriters and offer size.

6.2. Regression analysis equations

To assess the dependence of the IPO underestimation value on factors and the general influence of factors on the share price during the initial public offering, a regression mode was constructed. Natural logarithms of asset turnover, current ratio, operating margin, age of a company, book-runner-to-offer-size ratio, and initial offer size were taken to achieve normality.

Model 1:

$$\text{Return1d} = \beta_0 + \beta_1*\text{ROA} + \beta_2*\text{GM} + \beta_3*\text{ETR} + \beta_4*\text{EBIT} + \beta_5*\ln(\text{Age}) + \beta_6*\text{D(Frequency)} + \beta_7*\ln(\text{NU}) + \beta_8*\ln(\text{Size}) + \varepsilon \quad (4)$$

Where Return1d stays for the first-day return and is calculated by the equation (1). Similarly, five more models have been constructed with resulting variables of 7 days, 1 month, 3 months, 6 months and 1 year (Return7d, Return1m, Return3m, Return6m, and Return 1y) returns.

Model 2:

$$\text{Return7d} = \beta_0 + \beta_1*\text{Leverage} + \beta_2*\text{ROA} + \beta_3*\ln(\text{AT}) + \beta_4*\ln(\text{CR}) + \beta_5*\text{GM} + \beta_6*\ln(\text{OM}) + \beta_7*\text{ETR} + \beta_8*\text{EBIT} + \beta_9*\text{D(Field)} + \beta_{10}*\text{D(Frequency)} + \beta_{11}*\ln(\text{NU}) + \varepsilon \quad (5)$$

Model 3:

$$\text{Return1m} = \beta_0 + \beta_1*\text{ROA} + \beta_2*\ln(\text{AT}) + \beta_3*\ln(\text{CR}) + \beta_4*\text{GM} + \beta_5*\text{PTM} + \beta_6*\text{EBIT} + \beta_7*\ln(\text{Age}) + \beta_8*\text{D(Field)} + \beta_9*\ln(\text{BRR}) + \beta_{10}*\ln(\text{NU}) + \beta_{11}*\ln(\text{Size}) + \varepsilon \quad (6)$$

Model 4:

$$Return3m = \beta_0 + \beta_1*Leverage + \beta_2*ROA + \beta_3*\ln(AT) + \beta_4*\ln(CR) + \beta_5*GM + \beta_6*\ln(OM) + \beta_7*ETR + \beta_8*EBIT + \beta_9*\ln(Age) + \beta_{10}*D(Field) + \beta_{11}*D(Frequency) + \beta_{12}*\ln(BRR) + \beta_{13}*\ln(NU) + \beta_{14}*\ln(Size) + \varepsilon \quad (7)$$

Model 5:

$$Return6m = \beta_0 + \beta_1*Leverage + \beta_2*ROA + \beta_3*\ln(AT) + \beta_4*\ln(CR) + \beta_5*GM + \beta_6*\ln(OM) + \beta_7*ETR + \beta_8*EBIT + \beta_9*\ln(Age) + \beta_{10}*D(Field) + \beta_{11}*D(Frequency) + \beta_{12}*\ln(BRR) + \beta_{13}*\ln(NU) + \beta_{14}*\ln(Size) + \varepsilon \quad (8)$$

Model 6:

$$Return1y = \beta_0 + \beta_1*ROA + \beta_2*GM + \beta_3*ETR + \beta_4*EBIT + \beta_5*\ln(Age) + \beta_6*D(Field) + \beta_7*D(Frequency) + \beta_8*\ln(BRR) + \beta_9*\ln(NU) + \beta_{10}*\ln(Size) + \varepsilon \quad (9)$$

It is necessary to make sure that the assumptions of the linear regression model are met, namely, to check the model for the absence of autocorrelation and homoscedasticity.

6.3. Breusch-Pagan test

The Breusch-Pagan test was used to analyze heteroscedasticity. It is a widely applicable statistical test for checking the presence of heteroscedasticity of random errors in the regression model. It is used if there is reason to believe that the variance of random errors may depend on a certain set of variables. In this case, this test checks the linear dependence of the variance of random errors on a certain set of variables.

6.4. Durbin-Watson test

Next, the data has to be checked for the absence of autocorrelation. The Durbin-Watson test is used to detect autocorrelation that obeys a 1st order autoregressive process. It is assumed that the value of the residuals ε_t in each t^{th} observation does not depend on its values in all other observations. If the autocorrelation coefficient ρ is positive, then the

autocorrelation is positive, if ρ is negative, then the autocorrelation is negative. If ρ = 0, then there is no autocorrelation.

The classic Durbin-Watson test is going to look at successive error terms. The Durbin-Watson statistics are limited within 0 and 4 with 2 being in the middle. If the Durbin-Watson value is around 2, this means that the successive errors are uncorrelated. The closer it gets to 4, the more negatively autocorrelated the errors are, and the closer it gets to 0, the more positively autocorrelated they are.

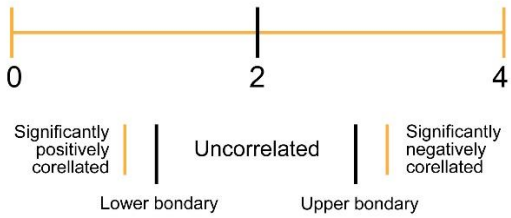

Figure 5: Scale of Durbin-Watson statistics

To avoid generality, a structure for a test is set up where the boundaries are created. The boundaries are dependent on the number of observations and the number of x variables in the model. By using statistical tables, one can find the upper and lower boundaries of the uncorrelated area.

6.1. Methodology summary

Having determined the hypotheses, designating the factors, collecting the data, a regression analysis was carried out.[6]

At the end of this part, the following is noted: in modern economic science there are a lot of different methods used to assess the effectiveness of an initial public offering, however, within the framework of this master's thesis, it was decided to focus on certain types of analysis outlined above. Having considered the many available studies on this topic, the above methods of analysis are the most universal and frequently used ones, as well as allowing for the most complete and meaningful analysis of the effectiveness of an IPO.

[6] All calculations were conducted in the statistical package R.

7. Evaluation of the IPO efficiency by Norwegian companies

This part will focus on assessing the effectiveness of IPOs by Norwegian companies in the short, medium, and long term.

7.1. Initial underpricing

Due to the high prevalence of the phenomenon of initial underpricing during IPOs in both developed and emerging markets, it was very interesting to analyze whether this phenomenon is typical for Norwegian companies. The calculation of the initial underpricing for all Norwegian issuers included in the sample was carried out according to the formula (1). As a result of the analysis, it was revealed that the initial underpricing of the IPOs of Norwegian companies exists, that is, the offer price is lower than the closing price of the first trading day, which is clearly illustrated in Figure 5.

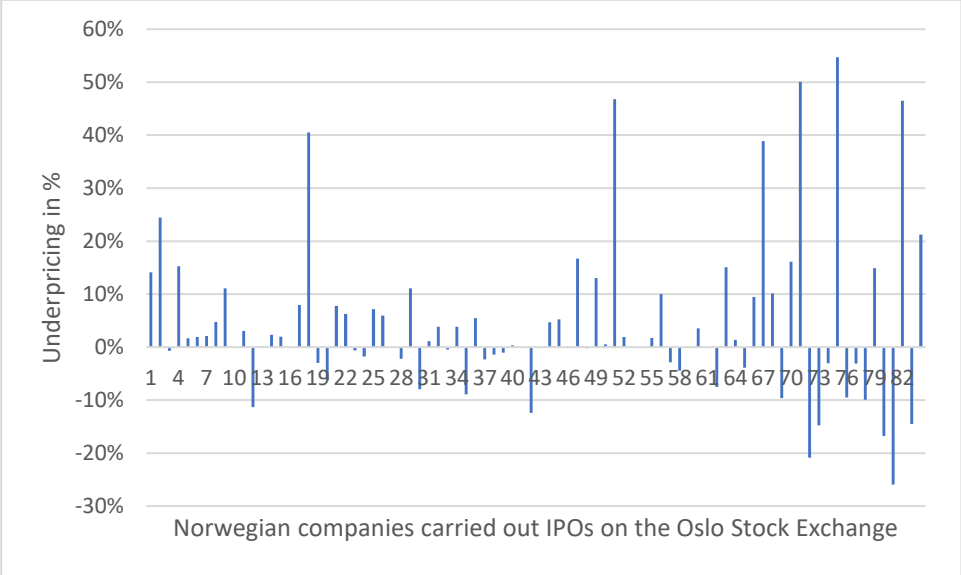

Figure 6: Initial shares underpricing of Norwegian companies which have carried out an IPO on the Oslo Stock Exchange between 01.01.2004 and 31.12.2020

Mean and median values of the initial underpricing of Norwegian IPOs were calculated both for the whole sample, the most significant sectors, and for companies indicated as high-tech companies. Also, calculations were made of the minimum and maximum values of the initial level of underpricing. The results are shown in Table 3.

Sector	Mean	Median	Min	Max
Energy	0.030	0.019	-0.039	0.153
Industrial goods and services	0.064	0	-0.259	0.465
Food and beverages	0.141	0.029	-0.096	0.547
High Tech	0.005	-0.001	-0.209	0.389
Whole sample	0.043	0.008	-0.259	0.547

Table 3:Initial IPO underpricing of Norwegian companies from 2004-2020 for the whole sample and by sectors

Based on the data obtained in Table 3, the initial IPO underpricing for Norwegian companies listed on the Oslo Stock Exchange between 2004 and 2020 exists and on average equals 4.3%. It is important to emphasize the fact that the initial IPO underpricing is quite low compared to the level of 10%-15% typical of developed countries and 20%-60% typical of emerging countries. For a more detailed approach, descriptive statistics of the initial returns concerning each year are presented in Appendix, Table 26.

Concerning the assessment of the phenomenon of initial underpricing for individual sectors, the following results were obtained: the largest initial underpricing is characteristic of the food and beverages sector, industrial goods and services, as well as the energy sector. This can be explained by the fact that these sectors represent the largest and most successful companies in the Norwegian financial market. The mean of the high-tech companies` initial return equals 0.5% which is lower than the initial return of other sectors and the whole sample.

7.2. Evaluation of a short-term efficiency

For a short-term assessment of efficiency, the profitability of shares of companies that carried out an IPO was calculated for 1, 2, and 7 days after it was carried out following Equation 1. The following dynamics were obtained:

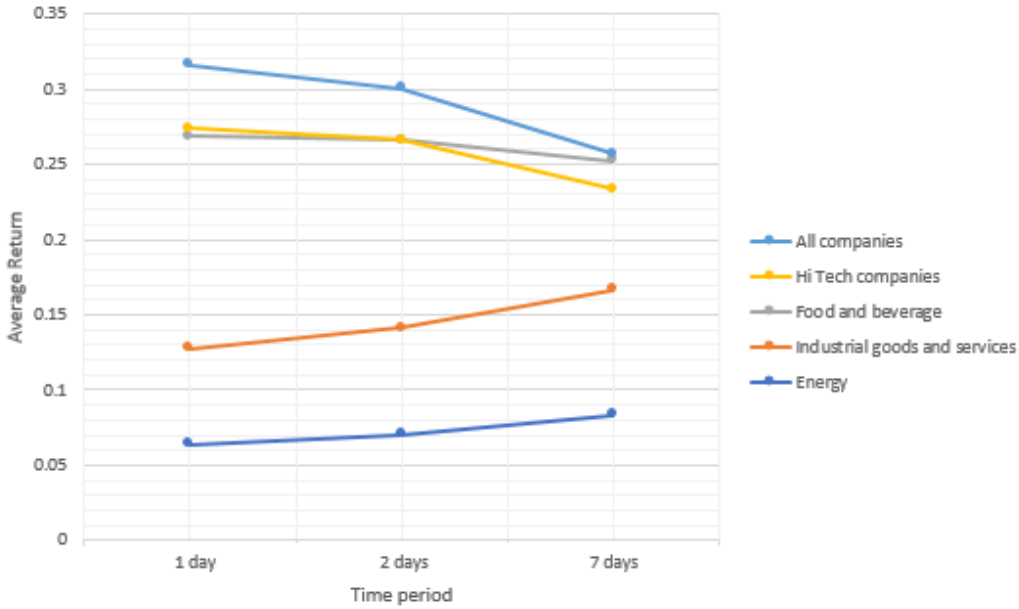

Figure 7: Dynamics of the short-term shares profitability of all and divided into sectors Norwegian companies that have carried out IPOs between 2004 and 2020

Based on the chart above, it can be seen that the short-term stock returns of the whole sample are showing negative dynamics within 7 days of the IPO but remain positive. The results obtained are fully consistent with the studies carried out for both developed and developing countries.

The dynamics of short-term profitability of stocks of companies divided into groups under the sectors of the economy were also investigated. Energy and industrial goods and services sectors show positive dynamics but the lowest returns in the short-term time horizon. This circumstance can be interpreted from the point of view of the greatest optimism of investors regarding companies belonging to these sectors of the economy, due to their leading position in Norway. The food and beverages sector and also high-tech sector shows the highest returns over short-term periods, but negative dynamics similar to the one of the whole sample.

7.3. Evaluation of a medium-term efficiency

To assess the medium-term effectiveness of Norwegian IPOs periods of 14 days, 1 month, and 2 months from the date of their implementation were selected.

The following results were obtained regarding the average-term stock return:

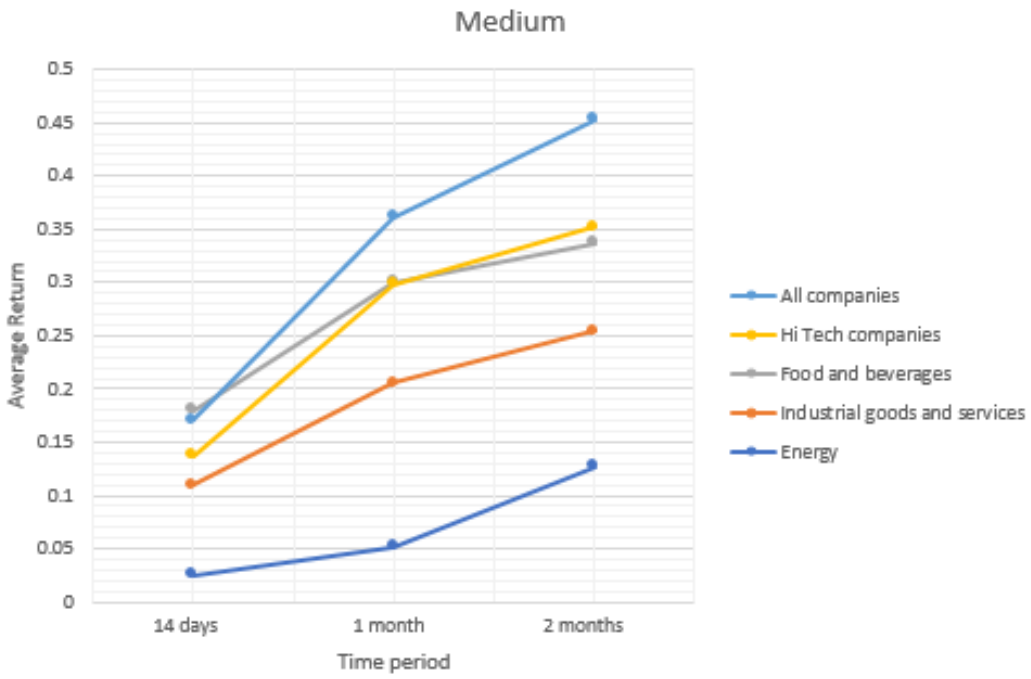

Figure 8: Dynamics of the medium-term shares profitability of all and divided into sectors Norwegian companies that have carried out IPOs between 2004 and 2020

The above graph demonstrates the increase in the average-term stock returns for the whole sample during the first 2 months. Furthermore, it is important to note that the medium-term stock returns are higher than the short-term ones, which partly denies the existence of the phenomenon of low long-term returns on the Norwegian stock market.

When analyzing medium-term efficiency in the context of individual sectors of the economy, energy, industrial goods and services, food and beverages, and high-tech sectors were selected. The results obtained are shown in Figure 8. In the medium-term time horizon stock returns show increased returns in all sectors and again medium-term stock returns are higher than short-term returns.

7.4. Evaluation of a long-term efficiency

When assessing the long-term effectiveness of the Norwegian IPOs, periods of 3 months, 6 months, and 1 year after the IPO were selected. The final sample includes companies that carried out an initial public offering between 2004 and 2019.

For the whole sample and also for the divided into sectors one, the following results were obtained regarding average stock returns:

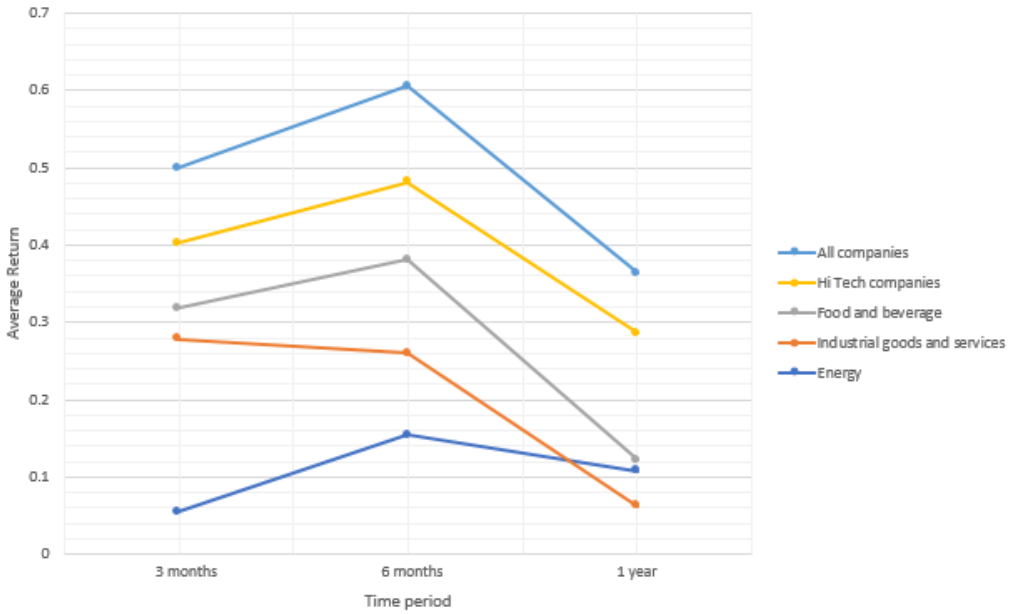

Figure 9: Dynamics of the profitability of the long-term shares of all and divided into sectors Norwegian companies that have carried out IPOs between 2004 and 2020

Figure 9 presented above clearly illustrates the fact that in the long-term time horizon the phenomenon of reduced long-term profitability is not inherent in Norwegian companies. The average return of the whole sample increases after 3 months and declines after 6 months, which coincides with the studies discussed earlier. The most convincing explanation for the fact that the shares of Norwegian companies that have carried out an IPO show a high return in the long-term period is that the initial underpricing of shares during the IPO was not very high for most of the companies.

When analyzing long-term efficiency in the context of economic sectors same companies from the most representative sectors of the economy (energy, industrial goods and services, food and beverages, and high-tech) were taken.

There is strong evidence of positive dynamics of returns from the first day until 6 months and negative dynamics from 6 months to 1 year. This might indicate the long-term underperformance, however, the time horizon obtained in this paper is rather short to conclude on the existence of long-term underperformance in general for Norwegian companies which went public on the Oslo Stock Exchange.

7.5. Regression analysis results

Before proceeding to the analysis, a correlation matrix was built to identify the relationship between the factors. The result of the study, namely, values of the correlation

between various factors, are presented in Appendix, Table 27. As one can see, there is no strong correlation between the factors, therefore, there is no need to additionally exclude any factors.

7.6. Regression model 1

First, we will consider the results of an analysis in which the dependent variable is the stock return at the end of the first day of trading. Independent variables are listed in the previous chapter. The values of descriptive statistics for each of the variables are presented in Appendix, Table 25. Using the regression analysis and the least-squares method, the results presented in Table 4 were obtained.

Residuals:				
Min	**1st quarter**	**Median**	**3rd quarter**	**Max**
-0.18609	-0.07515	-0.02055	0.07374	0.37471
Coefficients:				
	Estimate	**Standard error**	**t-value**	**Pr(>|t|)**
Intercept	-2.007e-01	2.475e-01	-0.811	0.42264
ROA	2.829e-02	1.787e-02	1.583	0.12187
GM	-1.129e-01	5.746e-02	-1.965	0.05690 **.**
ETR	1.030e-02	1.924e-02	0.536	0.10520
EBIT	3.919e-07	2.359e-07	1.661	0.00534
NU	-2.599e-01	8.781e-02	-2.960	0.04916 **
Size	3.477e-02	1.695e-02	2.034	0.28859 *
Frequency	-4.287e-02	3.981e-02	-1.077	
F-statistic	2.331			
R^2	0.306			
Adj. R^2	0.1747			
p-value	0.04476			

Table 4: Model 1 (1-day returns regression analysis results)

The significance of the regression analysis can be evaluated using the Fisher test. In Table 4, Fisher's test is F-statistic, the p-value is less than the specified 5% significance level, therefore, the equation can be trusted.

In the case of evaluating multiple regression, it is also important to consider the R^2 indicator, which in this case takes the value 0.306. The coefficient of determination shows the

proportion of the variance of the dependent variable, namely, the initial underpricing explained by the given model. R^2 in this study is not high, which is explained by the small sample (only 84 companies), as well as the absence of other factors that could explain the initial underpricing. It should be noted that backward elimination was used to improve the model. Leverage, asset turnover, current ratio, operating margin, pre-tax margin, bookrunner-to-offer-size ratio, and field dummy were excluded as they have shown the lowest coefficients during the preliminary analysis.

To determine whether the model is homoscedastic, the Breusch-Pagan test was performed. According to the null hypothesis, there is heteroscedasticity in the model if the p-value is less than a given significance level. In this study, the p-value is taken as 0.05. The p-value is greater than the predetermined significance level of 0.05; therefore, there is no heteroscedasticity in the model.

Moreover, there is no autocorrelation of successive error terms in the model. The Durbin-Watson value of 2.2114 is within the permissible interval. The results of both tests are presented in Table 5.

Breusch-Pagan value	6.7193
p-value BP test	0.4587
Durbin-Watson lower boundary	1.685
Durbin-Watson upper boundary	2.315
DW value	2.2114

Table 5: Breusch-Pagan and Durbin-Watson test results of Model 1

In this model, significant variables are gross margin, number of bookrunners, and the initial offer size. The results are presented in Table 6:

Variable	Impact
Gross margin	Negative
Number of bookrunners	Negative
Initial offer size	Positive

Table 6: Significant variables of Model 1

7.7. Regression model 2

Similarly, the regression model of the return after 7 days was built. In this model, the dependent variable is the return after 7 days (Return7d). The eliminated variables are pre-tax margin, bookrunner-to-offer-size ratio, age, and offer size. These results are more significant

than the previous according to the R-values, here R^2 equals 0.454, and adjusted R^2 equals 0.272. In this model, the p-value is lower than in the 1st-day model and equals 0.02093. According to the results obtained, the model can be trusted. The results of model 2 are presented in Table 7:

Residuals:				
Min	**1st quarter**	**Median**	**3rd quarter**	**Max**
-0.17529	-0.04268	-0.00725	0.04215	0.26430
Coefficients:				
	Estimate	**Standard error**	**t-value**	**Pr(>|t|)**
Intercept	-2.252e-01	9.485e-02	2.374	0.0236 *
Leverage	-6.896e-03	5.243e-03	-1.315	0.1975
ROA	2.870e-02	1.583e-02	1.813	0.0790 .
AT	2.665e-02	2.281e-02	1.168	0.2511
CR	-1.460e-02	1.829e-02	-0.798	0.4304
GM	-5.705e-02	5.096e-02	-1.119	0.2711
OM	-7.603e-02	3.750e-02	-2.028	0.0507 .
ETR	8.466e-03	1.660e-02	0.510	0.6134
EBIT	2.995e-07	2.096e-07	1.429	0.1625
NU	-9.527e-02	6.037e-02	-1.578	0.1241
Frequency	-5.191e-02	3.895e-02	-1.333	0.1918
Field	-4.418e-02	3.670e-02	-1.204	0.2373
F-statistic	2.494			
R^2	0.454			
Adj. R^2	0.272			
p-value	0.02093			

Table 7: Model 2 (7-days returns regression analysis results)

Heteroscedasticity is not presented in this model, which is proven by the Breusch-Pagan test with the p-value of 0.7947. According to the Durbin-Watson test, there is no autocorrelation in the model. The DW value is 2.1036 and it falls within the permissible range. More results are presented in Table 8:

Breusch-Pagan value	7.0543
p-value BP test	0.7947
Durbin-Watson lower boundary	1.803
Durbin-Watson upper boundary	2.197
DW value	2.1036

Table 8: Breusch-Pagan and Durbin-Watson test results of the Model 2

Only 2 variables are significant on the 5% level of significance. These are return on assets and operating margin. Table 9 shows the significant variables and the impact of these:

Variable	Impact
ROA	Positive
Operating margin	Negative

Table 9: Significant variables of the Model 2

7.8. Regression model 3

Next, the dependence of the return after 1 month after the IPO on the independent variables mentioned earlier will be considered. The results of the regression analysis are presented in Table 10. Eliminated variables are leverage, operating margin, effective tax rate, and frequency dummy. R^2 and adjusted R^2 slightly lower this time, being 0.4012 and 0.2405 respectively. The p-value equals 0.01667, which means that the model can be trusted.

Residuals:				
Min	**1st quarter**	**Median**	**3rd quarter**	**Max**
-0.29868	-0.10516	-0.01042	0.06996	0.46331
Coefficients:				
	Estimate	**Standard error**	**t-value**	**Pr(>|t|)**
Intercept	-2.276e-01	3.709e-01	-0.614	0.54290
ROA	2.861e-02	2.993e-02	0.956	0.34476
AT	2.837e-02	3.458e-02	0.821	0.41662
CR	2.212e-02	2.382e-02	0.929	0.35858
GM	-1.290e-01	3.531e-02	-3.652	0.00073 ***
PTM	-2.928e-03	1.974e-03	-1.483	0.14565
EBIT	4.378e-07	3.409e-07	1.284	0.20635
BRR	5.397e-02	3.368e-02	1.602	0.11675
NU	-2.121e-01	1.150e-01	-1.844	0.07241 .
Age	-1.464e-02	2.184e-02	-0.670	0.50636
Size	2.534e-02	2.360e-02	1.074	0.28924
Field	-5.498e-02	5.822e-02	-0.944	0.35047
F-statistic	2.497			
R^2	0.4012			
Adj. R^2	0.2405			
p-value	0.01667			

Table 10: Model 3 (1-month returns regression analysis results)

According to the Breusch-Pagan test, there is no heteroscedasticity in the model. The p-value is 0.1335 and is higher than 0.05. The successive errors are not autocorrelated, which is proved by the Durbin-Watson test. The DW value of 1.8707 lies within the permissible interval. The results are presented in Table 11:

Breusch-Pagan value	16.21
p-value BP test	0.1335
Durbin-Watson lower boundary	1.803
Durbin-Watson upper boundary	2.197
DW value	1.8707

Table 11: Breusch-Pagan and Durbin-Watson test results of the Model 3

Significant variables are gross margin and the number of bookrunners, their impact on the return after 1 month is presented in Table 12:

Variable	Impact
Gross margin	Negative
Number of bookrunners	Negative

Table 12: Significant variables of the Model 3

7.9. Regression model 4

Another regression model was built to distinguish the impact of independent variables on the return after 3 months. The results obtained are presented in Table 13. The model can be trusted as the p-value, which is 0.03872, is less than the predetermined 0.05. R^2 is 0.568 and adjusted R^2 is 0.3159 and thus the results are more significant than in previous analyses.

Residuals:				
Min	**1st quarter**	**Median**	**3rd quarter**	**Max**
-0.25655	-0.06527	-0.01037	0.04970	0.34486
Coefficients:				
	Estimate	**Standard error**	**t-value**	**Pr(>|t|)**
Intercept	-1.276e-01	4.068e-01	0.314	0.75646
Leverage	-3.571e-02	1.115e-02	-3.202	0.00382 **
ROA	-1.624e-01	6.855e-02	-2.368	0.02626 *
AT	9.973e-02	4.267e-02	2.337	0.02811 *
CR	8.606e-02	3.706e-02	2.322	0.02905 *
GM	-1.742e-01	9.286e-02	-1.876	0.07280 .
OM	1.201e-01	7.137e-02	1.683	0.10536
ETR	7.655e-02	2.564e-02	2.986	0.00642 **
EBIT	3.370e-07	3.485e-07	0.967	0.34324
BRR	8.130e-02	4.769e-02	1.705	0.10114
NU	5.336e-01	1.797e-01	2.970	0.00667 **
Age	9.636e-03	2.424e-02	0.397	0.69451
Size	-5.281e-02	2.885e-02	-1.830	0.07996 .
Frequency	1.419e-01	7.914e-02	1.794	0.08549 .
Field	-7.766e-02	6.447e-02	-1.205	0.24013
F-statistic	2.254			
R^2	0.568			
Adj. R^2	0.3159			
p-value	0.03872			

Table 13: Model 4 (3-months returns regression analysis results)

Null-hypothesis of homoscedasticity is confirmed as according to the Breusch-Pagan test the p-value is 0.669 and is higher than 0.05. The Durbin-Watson value of 2.0912 is close to the upper boundary but within the interval. Hence, there is no autocorrelation in the model. The results are presented in Table 14.

Breusch-Pagan value	11.216
p-value BP test	0.669
Durbin-Watson lower boundary	1.898
Durbin-Watson upper boundary	2.102
DW value	2.0912

Table 14: Breusch-Pagan and Durbin-Watson test results of the Model 4

This regression analysis has shown that there are many significant variables. Leverage, return on assets, asset turnover, current ratio, gross margin, effective tax rate, number of bookrunners, offer size and frequency dummy affect the return after 3 months being public. The only eliminated variable is the pre-tax margin. The impact of each variable is shown in Table 15.

Variable	Impact
Leverage	Negative
ROA	Negative
Asset turnover	Positive
Current ratio	Positive
Gross margin	Negative
Effective tax rate	Positive
Number of bookrunners	Positive
Size	Negative
Frequency	Negative

Table 15: Significant variables of the Model 4

7.10. Regression model 5

Regression analysis of the return after 6 months post-IPO has also shown significant results with R^2 and adjusted R^2 of 0.613 and 0.3842 respectively. The model can be trusted according to F-statistic and p-value which is 0.0201. Pre-tax margin and field dummy were eliminated to improve the model as these variables have shown the lowest coefficients during the preliminary analysis. The results of the regression analysis are shown in Table 16.

Residuals:				
Min	**1st quarter**	**Median**	**3rd quarter**	**Max**
-0.42802	-0.11226	-0.00496	0.10923	0.33672
Coefficients:				
	Estimate	**Standard error**	**t-value**	**Pr(>|t|)**
Intercept	-8.712e-01	6.165e-01	-1.413	0.17162
Leverage	-3.918e-02	1.709e-02	-2.293	0.03180 *
ROA	-3.753e-01	1.058e-01	-3.546	0.00181 **
AT	1.833e-01	6.013e-02	3.049	0.00589 **
CR	1.510e-01	5.705e-02	2.646	0.01474 *
GM	-2.261e-01	1.438e-01	-1.572	0.13022
OM	1.714e-01	1.086e-01	1.578	0.12892
ETR	7.645e-02	3.863e-02	1.979	0.06043 .
EBIT	-5.229e-07	5.496e-07	-0.952	0.35168
BRR	1.750e-01	7.372e-02	2.374	0.02673 *
NU	9.022e-01	2.716e-01	3.322	0.00310 **
Age	4.920e-02	3.710e-02	1.326	0.19839
Size	-3.958e-02	4.325e-02	-0.915	0.37005
Frequency	3.902e-01	1.226e-01	3.182	0.00431 **
F-statistic	2.68			
R^2	0.613			
Adj. R^2	0.3842			
p-value	0.0201			

Table 16: Model 5 (6-months returns regression analysis results)

According to the Breusch-Pagan test, there is no heteroscedasticity in the model. The p-value is 0.4748 and is higher than 0.05. There is no autocorrelation in the model, however, the Durbin-Watson value of 2.1146 is very close to the upper boundary of 2.134. This indicates a possibility of a negative autocorrelation in the model, but the model is still regarded as acceptable and trustable. The results are shown in Table 17:

Breusch-Pagan value	12.655
p-value BP test	0.4748
Durbin-Watson lower boundary	1.866
Durbin-Watson upper boundary	2.134
DW value	2.1146

Table 17: Breusch-Pagan and Durbin-Watson test results of Model 5

Significant variables found in this model are leverage, return on assets, asset turnover, current ratio, effective tax rate, book-runner-to-offer-size ratio, number of bookrunners, and frequency dummy. The impact of the significant variables on the return after 6 months is presented in Table 18.

Variable	Impact
Leverage	Negative
ROA	Negative
Asset turnover	Positive
Current ratio	Positive
Effective tax rate	Positive
BRR	Positive
Number of bookrunners	Positive
Frequency	Positive

Table 18: Significant variables of the Model 5

7.11. Regression model 6

The results of a 1-year return after the IPO are not as significant as the results of previously conducted analyses. Lowest achieved p-value is 0.07229, which is higher than the 0.05 predetermined level of significance. The model can be still accepted on the 10% level and regarded as significant with R^2 of 0.4041 and adjusted R^2 of 0.2135. The results obtained are shown in Table 19:

Residuals:				
Min	**1st quarter**	**Median**	**3rd quarter**	**Max**
-0.46107	-0.21866	-0.03187	0.11649	0.80354
Coefficients:				
	Estimate	**Standard error**	**t-value**	**Pr(>|t|)**
Intercept	-1.063004	0.406043	-2.618	0.0148 *
ROA	-0.293581	0.115894	-2.533	0.0180 *
GM	-0.309116	0.187237	-1.651	0.1113
ETR	-0.002733	0.059858	-0.046	0.9639
BRR	0.187405	0.085750	2.185	0.0384 *
NU	0.432334	0.241362	1.791	0.0854 .
Age	0.100127	0.052855	1.894	0.0698 .
Frequency	0.246644	0.144612	1.706	0.1005
Field	0.366159	0.155035	2.362	0.0263 *
F-statistic	2.12			
R^2	0.4041			
Adj. R^2	0.2135			
p-value	0.07229			

Table 19: Model 6 (1-year returns regression analysis results)

Heteroscedasticity is not presented in this model, which is proven by the Breusch-Pagan test with a p-value of 0.4673. Successive errors are not autocorrelated as the Durbin-Watson value of 1.8498 lies within the interval. The Breusch-Pagan and Durbin-Watson test results are presented in Table 20:

Breusch-Pagan value	7.6605
p-value BP test	0.4673
Durbin-Watson lower boundary	1.714
Durbin-Watson upper boundary	2.286
DW value	1.8498

Table 20: Breusch-Pagan and Durbin-Watson test results of the Model 6

The following variables were eliminated from the model: leverage, asset turnover, current ratio, operating margin, and pre-tax margin. Several significant variables affect the return, these are listed in Table 21 with their impact.

Variable	Impact
ROA	Negative
BRR	Positive
NU	Positive
Age	Positive
Field	Positive

Table 21: Significant variables of the Model 6

7.12. Results summary

To summarize, the impact of the independent variables on returns at different time points are presented in Table 22:

Return / Variable	1 day	7 days	1 month	3 months	6 months	1 year
Leverage	Eliminated	Insignificant negative	Eliminated	Negative	Negative	Eliminated
ROA	Insignificant positive	Positive	Insignificant positive	Negative	Negative	Negative
AT	Eliminated	Insignificant positive	Insignificant positive	Positive	Positive	Eliminated
CR	Eliminated	Insignificant negative	Insignificant positive	Positive	Positive	Eliminated
GM	Negative	Insignificant negative	Negative	Negative	Insignificant negative	Insignificant negative
PTM	Eliminated	Eliminated	Insignificant negative	Eliminated	Eliminated	Eliminated
OM	Eliminated	Negative	Eliminated	Insignificant positive	Insignificant positive	Eliminated
ETR	Insignificant positive	Insignificant positive	Eliminated	Positive	Positive	Insignificant negative
EBIT	Insignificant positive	Insignificant positive	Insignificant positive	Insignificant positive	Insignificant negative	Eliminated

Age	Eliminated	Eliminated	Insignificant negative	Insignificant positive	Insignificant positive	Positive
Field	Eliminated	Insignificant negative	Insignificant negative	Insignificant negative	Eliminated	Positive
Size	Positive	Eliminated	Insignificant positive	Negative	Insignificant negative	Eliminated
BRR	Eliminated	Eliminated	Insignificant positive	Insignificant positive	Positive	Positive
NU	Negative	Insignificant negative	Negative	Positive	Positive	Positive
Frequency	Insignificant negative	Insignificant negative	Eliminated	Negative	Positive	Insignificant positive

Table 22: Summary of the impact of the explanatory variables on the returns at different time points post IPO

To proceed to the discussion of the results, it is necessary to confirm or reject the previously put forward hypotheses. In the course of the analyzes, many significant results were obtained, which now need to be interpreted in terms of previously put forward hypotheses. To illustrate the results for subsequent discussion, Table 23 was built. This table presents the hypotheses put forward and a short commentary on each of them.

Hypothesis 1	Initial underpricing of shares is non-zero and is typical for Norwegian companies that have carried out IPOs.	Confirmed
Hypothesis 2	Underpricing on the first day of trading is higher among Norwegian companies in the high-tech sector.	Rejected
Hypothesis 3	Long-term underperformance exists and is typical for Norwegian companies that have carried out IPOs.	Cannot be determined
Hypothesis 4	Firm-specific variables such as leverage, gross margin, return on assets, current ratio, and age of a company have a negative impact on the underpricing, while asset turnover, effective tax	Confirmed/Rejected

	rate, EBIT, operating margin, and pre-tax margin have a positive impact.	
Hypothesis 5	Market-specific variable related to "hot" and "cold" market has a negative impact on the underpricing.	Confirmed/Rejected
Hypothesis 6	Offer specific variables such as size-to-book-runner-share ratio and number of book-runners have an impact on underpricing and initial offer size has a positive impact on underpricing in a short term and negative in a long term.	Confirmed/Rejected

Table 23: Hypotheses check summary

This study shows that the initial underpricing is typical for Norwegian companies which went public on the Oslo Stock Exchange between 2004 and 2020. The average initial underpricing for these companies is 4.3%, and, therefore the Hypothesis 1[7] is confirmed, meaning that the initial underpricing exists.

Hypothesis 2[8] is rejected after obtaining the results of the graphical analysis. It has been shown that the initial underpricing of high-tech companies is lower than for companies in other sectors. For research and comparison, the 3 most significant sectors for the Norwegian economy were selected: energy, industrial goods and services, food and beverages. The underpricing of companies in these sectors was compared to the underpricing in the high-tech sector. The results obtained completely do not coincide with the studies done earlier. Thus, the underpricing in the high-tech sector, 0.05%, turned out to be the lowest of all studied. The highest underpricing is found in the food and beverages sector, 14.1%.

There is a tendency of declining returns after 6 months, which might indicate the existence of long-term underperformance. However, the data in this Master`s thesis included returns only for 1 year-long period, and hence, it is difficult to determine if the actual long-

[7] Hypothesis 1: Initial underpricing of shares is non-zero and is typical for Norwegian companies that have carried out IPOs.
[8] Hypothesis 2: Underpricing on the first day of trading is higher among Norwegian companies in the high-tech sector.

term underperformance exists. Hypothesis 3[9] tends to be confirmed, but the results obtained are not significant enough to fully confirm it.

Hypothesis 4[10] is confirmed for some firm-specific variables and rejected for others. It is important to mention that not all variables were significant and, therefore, their impact on the returns at different time points exists but does not affect the returns much.

It was stated in the hypothesis that leverage has a negative impact and it was confirmed for the 7 days model, 3- and 6-months models. Leverage plays a significant role only for 3- and 6-months models, in the 7 days model it is insignificant. It was removed from other models due to low coefficients during the preliminary analysis.

Return on assets was assumed to have a negative impact also. However, it shows a positive impact from day 1 to 1 month but with low significance (it is positive and significant only in 7 days model with a 5% level of significance). It has a negative impact on returns, as it was stated in Hypothesis 4, in 3 months, 6 months, and 1-year models with 1%, 0.1%, and 1% level of significance respectively. That is why it can be concluded that ROA generally has a negative impact on the returns.

Gross margin has a negative impact on the returns in all 6 models, but has a significant impact only in 1 day, 1 month, and 3 months.

During the preliminary analysis, the current ratio was excluded from the 1 day and 1-year models due to its low coefficients. For the 7 days model, the current ratio shows an insignificant negative impact, while in the 1-month model it has an insignificant positive impact. Further, the current ratio shows a significant positive impact in 3- and 6-months models, both at a 1% level of significance. It was assumed in Hypothesis 4 that the current ratio will have a negative impact on the return. However, taking into account the significance of the results obtained, it can be stated that the current ratio is affecting returns positively and, hence, at this point Hypothesis 4 breaks.

It was suggested by Hypothesis 4 that firms' age has a negative impact on underpricing. However, the age variable was eliminated from the initial underpricing model and 7 days return model. It has an insignificant negative impact on the return after the 1-

[9] Hypothesis 3: Long-term underperformance exists and is typical for Norwegian companies that have carried out IPOs.
[10] Hypothesis 4: Firm-specific variables such as leverage, gross margin, return on assets, current ratio, and age of a company have a negative impact on the underpricing, while asset turnover, effective tax rate, EBIT, operating margin, and pre-tax margin have a positive impact.

month model, an insignificant positive impact in the 3- and 6-months models, and a significant positive impact on the 1-year returns model. Even though the results differ, according to the significance level it can be stated that the age of a firm has a positive impact on the returns.

Asset turnover was assumed to have a positive impact on the returns and, indeed, it shows its positive significance in the 3 and 6 months returns model. The variable was eliminated from the 1 day and 1-year models because of low coefficients during the preliminary analysis. Besides, asset turnover has an insignificant positive impact on the returns in 7 days and 1-month models.

According to Hypothesis 4[11], the effective tax rate is also supposed to have a positive impact on the returns. As the results of regression analysis show, it indeed has a positive impact on the returns after 3 and 6 months of trading. The effective tax rate has a negative impact on the return after 1 year, but due to its insignificance, it is concluded that the effective tax rate generally is positively affecting the returns.

The results show that EBIT and the pre-tax margin did not have any significant impact on the returns in any of the tested models. None of the results obtained is significant.

Regarding the operating margin, it has a significant negative impact on the return after 7 days post IPO and an insignificant positive impact on the returns after 3 and 6 months. Hypothesis 4 breaks again here as it was stated that the operating margin is supposed to have a positive impact on the returns.

Moving next to Hypothesis 5[12], it is rather difficult to decide whether it is confirmed or rejected. Market-specific variable known as frequency is related to "hot" and "cold" periods of the market and is assumed to have a negative impact on the returns. According to the regression model results, it has a significant negative impact on the return after 3 months and an insignificant negative impact on the initial underpricing and the return after 7 days post IPO. However, it shows a significant positive impact on the return after 6 months and an insignificant positive impact on the returns after 1 year. Considering only significant results, Hypothesis 5[13] cannot be confirmed or rejected.

[11] Hypothesis 4: Firm-specific variables such as leverage, gross margin, return on assets, current ratio, and age of a company have a negative impact on the underpricing, while asset turnover, effective tax rate, EBIT, operating margin, and pre-tax margin have a positive impact.
[12] Hypothesis 5: Market-specific variable related to "hot" and "cold" market has a negative impact on the underpricing.
[13] Hypothesis 5: Market-specific variable related to "hot" and "cold" market has a negative impact on the underpricing.

Offer specific variables such as size-to-bookrunner-share ratio and number of bookrunners were tested for presence or absence of impact on returns as such. These variables both show considerable results. The size-to-bookrunner-share ratio is positively affecting the returns after 6 months and 1 year of trading. This ratio was not discussed in previous studies, that is why in Hypothesis 6[14] it was assumed to have any kind of impact without specifying whether is it positive or negative. According to the results obtained, it has a significant positive impact on the 2 models mentioned earlier (both at a 1% level of significance). The number of underwriters variable has shown contradictory results, having a significant negative impact in 1-day model and 1-month model (also insignificant negative impact in 7 days model) and significant positive impact on the returns after 3, 6 months, and 1 year of trading. Hypothesis 6 also assumes that the initial offer size has a positive impact on the returns. The results show that the initial offer size indeed has a positive impact on the initial underpricing. However, it shows a significant negative impact on the return after 3 months post IPO. From this, it follows that the large initial offer size has a positive effect on the short-term returns but is also fraught with the returns decline in the longer term.

8. Discussion

The company's listing on the stock exchange is a very popular way to raise funds in the modern world. However, the process of the initial public offering is characterized by certain phenomena. A huge number of works in the field of finance are devoted to the analysis of these.

Previous studies on the specific problems inherent in IPOs, and the assessment of the effectiveness of its implementation following from their analysis, it should be emphasized that there are three most common anomalies inherent in initial public offerings: initial underestimation, reduced long-term profitability, and cyclical placements. When explaining the phenomenon of underestimation, researchers most often resort to theories of information asymmetry. The increased transparency of the company helps to reduce the uncertainty about the future value of their shares, which leads to a reduction in the initial underestimation. As for the phenomenon of low long-term stock returns, most researchers explain it by the presence in the capital market of optimistic investors who are inclined to overestimate

[14] Hypothesis 6: Offer specific variables such as size-to-book-runner-share ratio and number of book-runners have an impact on underpricing and initial offer size has a positive impact on underpricing in a short term and negative in a long term.

company stocks. And finally, the cyclical nature of IPOs is again interpreted based on the vulnerability of stock markets to investor sentiment. Thus, we can conclude that the three key IPO phenomena are closely interconnected, which has been repeatedly confirmed by previous studies.

In this Master's thesis, the goal was to assess the effectiveness of initial public offerings by Norwegian companies listed on the Oslo Stock Exchange. The results of the study are as follows.

The initial underestimation of the IPO of Norwegian companies takes place for most of the IPOs in the sample under study. To conduct a more complete and thorough assessment of the phenomenon of the initial underestimation of the IPO, it was decided to analyze the multivariate regression model. As a result of the regression analysis, firm-specific, market-specific, and offer-specific factors have their impact on the returns at different times after an IPO. Firm-specific factors such as leverage and gross margin show a strong negative impact on the returns during the first year of trading, while asset turnover and current ratio have a positive impact. The market-specific factor known as frequency has a positive impact, while the initial offer size shows a positive impact on the initial returns and a negative later on.

The effect of the firms` financials on the underestimation that has not been studied previously, was examined in this Master`s thesis. The table below shows the expected and actual effect of a firms` financials on the underpricing at different times.

		Actual effect:					
Firms` financials	Expected effect	1-day returns	7-days returns	1-month returns	3-months returns	6-months returns	1-year returns
Leverage	↓	-	↓	-	↓	↓	-
Return on assets	↑	↑	↑	↑	↓	↓	↓
Asset turnover	↑	-	↑	↑	↑	↑	-
Current ratio	↓	-	↓	↑	↑	↑	-
Gross margin	↓	↓	↓	↓	↓	↓	↓
Operating margin	↑	-	↓	-	↑	↑	-
Pre-tax margin	↑	-	-	↓	-	-	-
Effective tax rate	↑	↑	↑	-	↑	↑	↓
EBIT	↑	↑	↑	↑	↑	↓	-

Table 24: Expected versus actual effect of the firms` financials on the returns after the IPO

According to the data obtained on the influence of the company's financial indicators on underestimation, it can be stated that the obtained indicators largely coincide with the expectation for a short period (up to 1 month). Further, financial indicators, such as return on assets and current ratio, change their sign to the opposite. These are financials that are worth paying attention to and an important conclusion both for long-term investors and for the company itself, which seeks to increase profitability over the long term.

The hypothesis that high-tech companies are prone to more underestimation has not been confirmed. Companies belonging to this category, on the contrary, have the lowest underestimation, and the highest underestimation is inherent in the food and beverages sector.

As for the short-term dynamics of the profitability of the shares of the companies that carried out the IPO, it tends to slightly decrease over the first week but remains positive.

Companies belonging to the industrial goods and services sector as well as energy sector have slight increase during the first week.

Regarding assessing the medium-term effectiveness of an IPO by Norwegian companies, it is worth noting that most companies are characterized by increased medium-term profitability in 14 days-2 months after the IPO.

Analyzing the long-term dynamics of the returns on the shares of the companies that carried out the IPO, the presence of the phenomenon of reduced long-term returns were revealed.

The cyclical nature of IPOs has also been confirmed for Norwegian companies and can be interpreted in terms of its link to the economic sector, which has been previously noted in the academic research environment.

9. Conclusion

The process of initial public offerings in Norway is characterized by both widespread phenomena and specific features characteristic of the Norwegian stock market. Evaluation of its effectiveness depends on the time of the IPO and the industry affiliation, however, in general, in the short term, companies that have carried out an IPO are characterized by increased profitability, and in the long term - decreased, which fully correlates with the results obtained earlier in developed and developing countries.

The average underpricing after the first day of trading of 4,3% is relatively greater than the underpricing found by Boulton, Smart, and Zutter (2011) for their sample of Norwegian companies, which went public between 1998 and 2008.

The ex-ante uncertainty theory suggested by Ritter (1984) and Rock (1986), where the underpricing is presented as a decreasing function of age, is rejected as the age variable has no significant effect on the return.

The negative association between the offer size and the underpricing suggested by Banerjee, Dai, and Shrestha (2001) has been found for the long-term returns, but not for the initial return.

Significant results obtained for the firm-specific factors` impact on the returns indicate the presence of the information asymmetry and once again prove the theories suggested previously.

Possible recommendations for increasing the effectiveness of the IPO include the following: even distribution of information among the main participants in the IPO process (high requirements for information disclosure and developed legislative acts on the use of insider information); setting a fairer and more efficient placement price by attracting several investment banks; providing guarantees regarding price support after the start of trading for a certain period.

Thus, the identification and analysis of the determinants characterizing the IPO phenomena contribute to a better understanding and better assessment of the effectiveness of the implementation of this process.

This work is of practical relevance for any party involved in decision-making regarding the initial public offering in Norway. Companies are given the opportunity to compare their firm-specific, offer-specific, and market-specific factors with those presented in this thesis to have an idea of how these factors will affect their returns after going public. Furthermore, this work is valuable for investors, giving them the opportunity for literate capital investments or to diversify their portfolios. In the course of empirical analysis, significant data were obtained that, according to the author, can reduce the asymmetry of information between companies and investors, thereby making the initial public offering process more transparent and predictable. In addition to the Norwegian market, this work is relevant for those countries where the market system and dominant economic sectors are similar to Norway. Investigation of the long-term underperformance existence on the Norwegian market, as well as the effect of the suggested firm-specific, offer-specific, and market-specific factors in the long-term, is left to the future research.

Based on all of the above, we can conclude that this Master`s thesis is useful for future research analyzing the IPO issues and assessing the effectiveness of its implementation, both from a theoretical and practical point of view.

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11. Appendix

Variable	Mean	Std.Dev	Min	Median	Max	Skewness	Kurtosis
Return1d	0.043	0.146	-0.259	0.008	0.547	1.521	3.075
Return7d	0.024	0.151	-0.252	0.000	0.587	1.744	4.271
Return1m	0.064	0.251	-0.351	0.014	1.674	3.805	21.433
Return3m	0.098	0.403	-0.365	0.027	2.911	5.120	33.535
Return6m	0.124	0.349	-0.493	0.048	1.636	1.798	4.768
Return1y	0.082	0.417	-0.701	0.060	1.387	0.786	1.550
Leverage	1.665	3.035	-6.928	0.982	17.628	1.703	9.194
AT	1.468	8.331	0.000	0.001	72.087	7.755	63.403
CR	10.311	48.577	0.002	1.379	336.667	6.317	39.265
ROA	0.558	1.028	0.004	0.161	6.459	3.887	17.783
Field	0.321	0.470	0.000	0.000	1.000	0.765	-1.415
Age	20.738	34.675	0.000	8.000	174.000	2.826	8.298
Size	72217281	105357834.5	693000	35823760	672850307.248	3.121	12.632
Gross Margin	0.505	0.696	-3.260	0.648	1.000	-3.391	15.509
Operaing Margin	3.186	8.709	0.016	1.000	51.442	4.619	20.854
Pre Tax Margin	-3.152	13.396	-80.037	0.022	22.073	-4.100	19.543
Effective Tax Rate	0.343	0.854	-0.796	0.258	5.827	4.668	25.052
EBIT	31266.4	152257.8	-207634	-35.200	1197000.000	5.630	39.520
Frequency	0.512	0.500	0.000	1.000	1.000	-0.049	-2.047
BRR	19.516	34.674	1.724	11.233	287.364	6.220	44.230
NU	2.357	1.087	1.000	2.000	6.000	1.111	1.200

Table 25: Descriptive statistics of all variables

Year	Number	Mean	Std.Dev	Min	Max	Skewness	Kurtosis
2004	7	0.133	0.10417891	-0.0071414	0.24460388	-0.7932093	1.79644302
2005	28	0.017	0.06243956	-0.1134	0.1111	-1.032603	3.35707262
2006	23	0.025	0.03241333	-0.0007573	0.0794	1.66670774	3.01076302
2007	23	0.054	0.12272875	-0.0625223	0.40525524	2.36918679	6.75676289
2008	3	-0.079	-	-0.0792	-0.0792	-	-
2009	0	-	-	-	-	-	-
2010	9	0.015	0.02166483	-0.0042988	0.03850921	0.77821348	-
2011	5	0.001	0.07878076	-0.0892965	0.0546	-1.6483546	-
2012	2	-0.019	0.00607704	-0.023	-0.0144058	-	-
2013	7	-0.003	0.00708086	-0.0102233	0.00367	-0.9565116	-
2014	9	-0.005	0.07124223	-0.1243	0.05262324	-1.5834075	2.74958304
2015	5	0.075	0.08626459	-0.002	0.1674	0.15370652	-5.0476502
2016	3	0.243	0.31756166	0.0189	0.468	-	-
2017	9	0.007	0.05056357	-0.0445955	0.10007222	1.42185736	2.63209328
2018	5	0.012	0.02049417	-0.00028	0.0354	1.73141914	-
2019	7	0.029	0.09316843	-0.0748869	0.15066502	0.33195214	-1.7747653
2020	18	0.069	0.25964117	-0.2591185	0.54713183	0.69007203	-0.8499539

Table 26: Descriptive statistics: initial return by years

GM	CR	AT	ROA	Leverage	Return6	Return1y	Return3	Return1	Return7d	Return	
0.063	0.185	0.062	-0.048	-0.044	0.357	0.395	0.099	0.534	0.834	1	Return1d
-0.064	0.139	0.071	0.014	0.022	0.375	0.418	0.469	0.607	1		Return7d
-0.490	-0.006	0.009	-0.050	0.022	0.305	0.291	0.410	1			Return1
0.061	-0.006	0.037	0.344	0.021	0.542	0.452	1				Return3
0.003	0.162	0.053	0.015	0.083	0.750	1					Return1y
0.038	0.361	0.083	0.071	0.010	1						Return6
0.160	-0.039	0.056	0.212	1							Leverage
0.070	-0.077	0.100	1								ROA
0.029	-0.0332	1									AT
-0.17877	1										CR
1											GM
											OM
											PTM
											ETR
											EBIT
											BRRatio
											NU
											Age
											Size
											FreqDu
											FieldDu

FieldDummy	FreqDummy	Size	Age	NU	BRRatio	EBIT	ETR	PTM	OM
-0.178	0.051	0.070	0.121	-0.046	-0.052	0.034	-0.024	0.063	-0.171
-0.197	0.086	0.069	0.130	-0.048	-0.042	0.045	0.014	0.177	0.111
-0.183	0.145	-0.014	0.047	-0.091	-0.033	-0.015	-0.009	-0.091	-0.025
-0.022	0.168	0.046	-0.023	-0.056	0.010	0.001	0.181	0.126	0.407
0.128	0.034	0.157	0.138	0.053	0.037	-0.015	0.010	0.131	-0.274
-0.044	0.306	0.101	0.116	-0.043	0.017	0.018	0.099	0.202	-0.249
-0.078	-0.231	-0.028	0.083	0.353	0.345	0.273	0.146	0.135	-0.062
0.068	0.112	-0.008	-0.097	0.081	-0.020	0.001	-0.020	0.140	-0.039
0.215	-0.14333	0.043	-0.02186	-0.0011	-0.00725	0.014	0.023971	0.053	-0.07026
-0.10914	0.005	-0.03187	0.087	0.007016	-0.00888	-0.04177	-0.0164	0.060	-0.09542
0.162044	-0.050	0.027	0.017	0.132	0.045023	0.136	0.160	0.044	0.095
-0.110	0.110	0.063	-0.07191	-0.06124	-0.07671	-0.12781	-0.04023	-0.2863	1
-0.28113	0.259028	0.098953	0.057046	0.206	0.125	0.152	0.016	1	
0.124	0.057	-0.04173	-0.067	0.018	0.11399	-0.00258	1		
-0.16232	-0.1089	0.354	0.655	0.125045	-0.0409	1			
-0.13484	-0.13461	0.012	0.167	0.399	1				
-0.062	-0.336	0.591	0.226	1					
-0.17491	-0.29448	0.382	1						
-0.06349	-0.16566	1							
-0.042	1								
1									

Table 27: Correlation matrix