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Master Thesis, Economics

IPO Underpricing and the effect of information asymmetries

This research investigates underpricing on the modern European IPO market. The relevance of information asymmetry theories in explaining the level of underpricing is tested. Initial first-day returns are the highest in periods when firms come to the market in clusters, leading to extraordinary investment opportunities. The results for the European market are compared with American-based studies. In both markets, mostly younger firms with high profits and/or high market capitalization are engaged in IPO underpricing. The positive influence of underwriter reputation on underpricing disappears when controlled for the endogeneity bias of this explanatory variable. Overall, information asymmetry theories are explaining only a small part of the level of underpricing on the European stock market. The theory on hot and cold market periods is the most convincing theory in this research field. All models improved when controlled for cross-country differences. The results could be useful for investors when considering investments in IPO shares, as the period an IPO is offered in and firm characteristics could be worthy to take into account during the decision-making process.

Keywords: European IPO market, underpricing, information asymmetry, hot and cold market periods, firm characteristics

Name: Jelle Smalbraak

Student ID: s4609905

Supervisor: Dr. D.J. Janssen

Specialization: Corporate Finance & Control

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1. Introduction

When a company is selling shares to the public for the first time in their history, this is called an initial price offer (IPO). Accordingly, the firm becomes publicly listed for the first time. This process of going public is often handled by an underwriter, most common an investment bank. The trading price set by the underwriter is often yielding some anomalies. The most common anomaly is the *underpricing effect.* This effect occurs when the initial offer price is significantly lower than the closing price at the end of the first trading day, such that the price has risen noticeably during this first trading day. A very recent example of the underpricing of an IPO is the public offering of kids gaming app Roblox in March 2021 at the New York Stock Exchange. Roblox began trading at $64.50, and closed the first trading day on $69.50. The NYSE set a reference price of $45, based on a private trading offer in January (CNBC, 2021). This kind of differences in prices are suggesting that information asymmetries are present. Rock (1986) already elaborated the existence of informed investors and on the other hand uninformed investors. Ljungqvist (2007) even mentioned asymmetric information theories as the best established first-order theory of underpricing. In the Roblox example, the upward trend in stock price not only raises the question if the asymmetries are present, it also proposes further research in whether information asymmetries are the story behind underpriced IPOs.

Underpricing often leads to a lot of 'money left on the table', which is the difference between the initial offer price and the first-day-closing-price times the number of shares issued (Loughran & Ritter, 2002). For example, Loughran & Ritter found that American companies going public leaved in total $27 billion on the table between 1990 and 1998. These results show clear evidence that there are a lot of profit opportunities for institutional investors in the IPO market. And underpricing is a worldwide phenomenon, as Loughran & Ritter (2004) found. They concluded that IPO underpricing is happening on a regular basis, not only over continents but also over time. Underpricing effects where already found to be relevant in the 1960's and 1970's, as Ibbotson (1975) and Ritter (1984) examined. Ritter & Welch (2002) found that the average first-day return in the American market between 1980 and 2001 was 18.8%, significantly higher than the average daily stock return of 5% during that period of time. Loughran & Ritter (2004) thereby concluded that the underpricing effect is changing over time, and searched for reasons why in certain periods the initial (first-day) returns of newly publicly listed stocks were higher than in other periods. They distinguished 'hot'-issue periods and 'cold'-issue periods, where offers in periods with a high number of IPOs (IPO-boom) are 'hot' and offers in periods of relatively few IPOs are 'cold'-items. Also, hot market issues are related to high first-day returns. A hot issue market example is the so called 'Internet bubble'[1] around 1999-2000, when the total amount of European IPOs reached its top level with 843 in 2000. After this bubble, a cold issue period occurred as the number of IPOs decreased in the first years of the new century (Gajewski & Gresse, 2006). During 'hot-issue' markets firms experience many incentives to go public and the demand for IPOs is high. In

[1] In this period the internet was introduced, which leaded to an economic expansion with lots of investments and public offerings due to digitization.

these periods, the average first-day return is often relatively high compared to 'cold'-periods. During 'Internet bubble' times these initial returns exceeded all historical levels with first-day returns being on average 65% (Loughran & Ritter, 2004). This effect is suggesting that in periods of IPO-booming underwriters and issuers face incentives to strongly underprice the shares. This is suggesting that information asymmetries are more relevant in hot market periods compared to cold market periods. This theorem will be discussed in more detail later in this paper.

Back to information asymmetries and initial public share offerings. There are a number of incentives to set a lower price than the fair value of the share would predict. The most popular theories in this field are information asymmetries, as the explanation of underpricing is found to be related to the existence of many parties in the IPO process. The issuing firm, investors and underwriters (investment banks and other financial specialists) all bring their own interests into the process (Ritter & Welch, 2002). One explanation could be that investors want a compensation for the risk they bear when buying a share for the first time. This compensation could be reflected in a lower price than the intrinsic value of the share, whereat investors face a lower amount of risk. As Rock (1986) already examined, investors will not buy the share if they think the initial price is higher than the fair, fundamental value of the share. The availability and providence of information about the issuing is key in this process. But how much information investors have available and to what extent they can rely on this information differs from firm to firm. As Beatty & Ritter (1986) said, the degree of underpricing is related to uncertainty about the firm. The more uncertainty, the more uninformed investors are, the more risk they perceive, the less money they are willing to pay for the share. This trade-off could be influenced by the reputation of a firm, which is related to for example firm age, market capitalization, historical results, the industry in which the firm is doing business, and other factors (Chan et. al, 2004).

Underwriters on their own also have an incentive to make the shares as less risky as possible, by making sure that investors buy the share. Underwriters main goal is to fully sell the shares offered, as they don't want to be left with shares in their pocket at the end of the issue period. Investors on their own want low risk profiles and profit opportunities. This combination of concerns could lead to underpricing and for the firm suboptimal amounts of shares to be sold (Baron, 1982). So next to information asymmetry between investors and the firm going public, also information asymmetry between underwriters and the firm itself is relevant in this research field.

This research will analyze the European IPO market. As the historical literature is mainly American-based (Loughran & Ritter, 2004), the European market has still a leaping gap in the literature to jump into. In the last couple of years, the European market was larger in terms of number of IPOs than the American IPO market (234 to 219 offers for 2019), leading to the conclusion that the European IPO market is very relevant in today's world (EY, 2019). Furthermore, an average 22% of underpricing was found in Europe (Gajewski & Grassi, 2006) between 1995 and 2004. In this study, the sample period will be between 1994 and 2019, as we also seek to find evidence for difference in underpricing effects during IPO-boom-periods and periods with relatively less IPOs. Analyzing this time effect, we will divide the sample in 'hot'-issues and 'cold'-issues as mentioned above, using a dummy variable. Also, hypotheses will be formulated on asymmetric information proxies and the underpricing effect. By testing these hypotheses, we can examine if the mentioned information asymmetry theories are an explanation for underpricing. The information asymmetries are measured with proxies for uncertainty level, as uncertainty is very much related to both information conflicts and underpricing. The more information asymmetries are present, the more uncertainty a firm or market is expected to be involved in. The proxy variables for uncertainty are: firm age, market capitalization, historical profits, underwriter reputation and an industry fixed effect (technology dummy). These variables are used as dependent variables in a formal OLS-regression analysis (Chambers &, 2009 ; Loughran & Ritter, 2004), with initial first-day return being the independent variable. The fundamental focus will be on the following research question:

To what extent do information asymmetries explain the underpricing effect in the European IPO-market?

The most relevant evidence of this research is that the expectation of high initial returns during hot market periods is supported. During the IPO-booms underpricing was on average 6.6% higher compared to other periods, making this theory the most relevant information asymmetry explanation when it comes to IPO underpricing. Investors can use these findings in their favor by investing in IPOs during hot market periods. Welch (1989) already stated that on the American IPO market only a number of firms can afford the risk of setting relatively low prices. These companies are mainly profitable firms with high market capitalization. The same conclusions are drawn for the European market in this research. Support is also provided for the litigation risk hypothesis and the information production model, although these theories are less dominant in explaining IPO underpricing. Reputable underwriters seem to have a positive influence on the level of underpricing. However, the results are not robust to the endogeneity of underwriter reputation, as a control for the endogeneity bias is leading to insignificant results.

This research will contribute to the existing literature by providing a broad view of the European IPO market, which is the market that taillight when it comes to historical research quantity with respect to the American and Asian market. At the same time, historical figures on European data show that this market is one of the highest ranked IPO markets both in terms of quantity and value, making the evidence in this research a very relevant contribution to the current state of literature. This study could also contribute to more equality on the investment markets, as uninformed investors may become better informed about price-setting strategies by underwriters and firms.

This paper will continue with an overview of the most relevant literature about this topic in section 2. The most important theories will be elaborated briefly, including comparisons between different conclusions drawn by researchers. In section 3 the research method will be outlined, where the data sample, all variables and the research method will be explained. The next section will contain the results of the research, comparing the relevance of different theories based on the numerical findings. The conclusion, discussion and suggestions for further research are part of the last summarizing sections of this paper.

2. Literature Overview

In this literature section, an overview of the most relevant information asymmetry theories will be outlined and linked to IPO underpricing theory. Different theories will be compared and multiple research results will be analyzed to come to the formulation of six hypotheses. This review will include signaling theory (*2.1*), uncertainty theory *(2.1*), underwriter theory (*2.2*), theory on IPO cycles (*2.3*), and other well-known theories in the world of initial public offerings.

2.1 Signaling theory and theories on uncertainty

One of the main information asymmetry theories that is used in historical literature to explain IPO underpricing is *signaling* theory. The signaling theory suggests that the issuer is more and/or better informed about the share value than investors. When the investors lack information about the risk and potential returns of a company's issued shares, the company tries to convince them about the value and quality of the firm (Yu & Tse, 2006). High-quality firms and low-quality firms both want to give a good signal about their quality to the market (Hutagaol, 2005). When first-day returns are high, this can be seen as a 'good signal', so underpricing can be a strategy of signaling. But bad-quality firms run the risk that their true type of quality will eventually be revealed to the public before they can take the advantage out of the low initial price setting and high foregone costs will occur, as investors will probably never invest in them anymore (Grinblatt & Hwang, 1989). Following this, Welch (1989) concluded that only firms that are truly of high quality can afford the risk of setting a low share price at first hand. Low-quality firms could just copy the behavior of the high-quality firms; however, their risk is of such high proportions that they are not likely to do so. If this risk is crowding out all low-quality firms, underpriced shares are an indicator for high-quality. When the price eventually appreciates overnight and on the long-run shows stable growth patterns, the company will benefit in later rounds of equity issues: the so-called seasoned equity offerings (SEO's). At the end, high-quality firms will earn back the initial cost of the signal of underpricing and attract investors in SEO's. So issuers that leave some (or a lot of) money on the table will experience a loss in wealth on the first hand, but when they compare it to the gains in later market stages they overall experience positive wealth. Therefore, underpricing can be used as a credible signal of good quality (Allen & Faulhaber, 1989 ; Ritter & Welch, 2002). Empirical research on IPOs in the 1980's by Jegadeesh, Weinstein & Welsh (1993) showed that the size and likelihood of successful SEO's, conform to expectations, were both positively related to IPO underpricing.

High-quality or good performance could in advance be identified by investors. There are many components that could characterize high-quality firms. For example, high-quality firms are recognized by low uncertainty levels about their performance. Uncertainty about a company plays a role in almost all historical studies. Uncertainty levels are measured by investor confidence and other proxies, for example the proxies used in this research whom will be further outlined during this chapter. Uncertainty causes the investors to ask for certain compensation in exchange for the risk they bear when buying the share. This compensation could be a lower initial offer price than the market would suggest. Beatty and Ritter (1986) stated that uncertainty has a positive relationship with IPO underpricing, as more uncertainty (as in lower investor confidence about the firm's long term stock performance) leads to a lower willingness to pay a certain price amongst investors. The theory of Beatty & Ritter (1986) has its foundation in The winner's curse model of Rock (1986). Rock (1986) distinguished informed investors and uninformed investors, where (logically) informed investors have a significant lead in information availability about the fundamental value of the share. A as result, informed investors will only bid for underpriced shares due to profit opportunities. Uninformed investors do not have the information about the fair value, and do not know if a share is underpriced. They will bid for all shares. At the end, informed investors are allocated to the undervalued shares and the uninformed investors will be crowded out to the loss domain. A lemon's problem[2] occurs (Akerlof, 1978). Rock (1986) argues that the expected returns of uninformed investors must be zero or higher to attract them to the market. This is needed because not enough informed investors are bidding to allocate all issued shares in the market. As a consequence, prices must drop to make all investors go to the market and fully sell all shares supplied. This is an incentive for all firms to underprice their shares. Beatty & Ritter (1986) state that because informed investors only buy shares that are underpriced, information availability is directly related to the level of underpricing. The more uncertain investors are about the value, the less they are willing to pay for the share. Then underpricing is needed to attract investors to bid for the share.

As already explained, a firm's reputation and specific characteristics are directly related to uncertainty. Firm age could be such a firm specific risk characteristic used as a measure for uncertainty. The older firms are, the longer their history is and potentially the more information is available for the public. These firms are often more analyzed by financial specialists and media and have a relatively large database of financial statements. In general, since older firms have more information available, they represent less information asymmetry and uncertainty (Engelen & Van Essen, 2010).[3] Older firms are not by definition also high-quality firms, but one could argue that when a firm holds a position in the market for a long period that can be an achievement itself. This insinuates that companies need some level of stability and financial sustainability to withstand over a longer timeframe. Older firms represent a certain level of quality since their business model is relevant in the long-run (Ljungqvist & Wilhelm, 2003). The argumentation could be two-fold. The signaling theory suggest that underpricing could be an indicator for good quality, while Engelen & van Essen (2010), amongst others, stated conflictingly that firm age related to a stable level of financial quality could be an indicator of less underpricing.

Many studies used firm age as a proxy variable for uncertainty, while we are going to provide a direct link between firm age and IPO underpricing, suggesting that investors could get relevant information just by looking at how old a firm is at the moment of first issuance. Based on the statements above, the following hypothesis is formulated:

H1: There is a negative relationship between the age of the firm going public and IPO-underpricing.

[2] The lemon's problem here is that uninformed investors will be crowded out of the underpriced shares. As uninformed investors know they will be allocated to the highest priced shares, they will not take the risk of investing at all. The informed investors will solely remain in the market.

[3] Engelen & Van Essen support their findings with similar evidence from Loughran & Ritter (2004). Ljungqvist & Wilhelm (2003) found evidence during the 'Internet bubble' (1996-2000), while Zou & Lao (2012) had significant results for the Chinese market.

Market capitalization can be another signal of high-quality, according to Boubaker & Mezhoud (2011). They found that firms with a high market cap are expected to be more underpriced than firms with smaller market cap at moment of first issuance, due to the high-quality indication and the signaling theory of Allen & Faulhaber (1989). Market capitalization refers to the total value of the firm in the stock market, so the stock price times the number of shares outstanding after the IPO. Therefore, market capitalization is often linked to offer size as in the number of shares issued. Habib & Ljungqvist (2001) argued that issuers use large offerings as a way of information signaling. Large offers with high market capitalization indicate stability and therefore high-quality, which is a trigger for investors to buy the shares. These companies are less risky, and therefore are not in a need to compensate investors with cheap shares. This is conflicting with the research of Boubaker & Mezhoud (2011), as they found a positive relationship between market cap and underpricing. The signaling theory of Allen & Faulhaber (1989), which states that underpricing is used as a signal for good quality, conflicts with what Miller & Reilly (1987) said. The latter examined that smaller firms with more riskier profiles have more uncertainty and therefore compensate investors for this risk with cheaper underpriced shares. Smaller firms have smaller offerings and a smaller market capitalization. More established firms with higher market capitalization are less risky and can offer higher share prices, since they are not in need to compensate investors (Megginson & Weiss, 2001 ; Yu & Tse, 2006). As Beatty & Ritter (1986) stated: the more uncertainty, the more firms are incentivized to underprice. The following hypothesis is formulated:

H2: There is a negative relationship between market capitalization and IPO-underpricing.

This statement is interesting, as it is not supported by all existing literature. Next to the (hypothesis supporting) literature as mentioned above there is historical evidence that bigger firms with larger shares issues and high levels of market capitalization were positively related to IPO-underpricing, in contrast with our hypothesis (Bundoo, 2007 ; Sohail & Raheman, 2011). This is in line with what Allen & Faulhaber (1989) would expect with the signaling theory. Big firms with high market caps could use underpricing as a signal for good-quality.

Another measurement that is related to the theory of uncertainty of Beatty & Ritter (1986) is historical financial numbers, such as historical profits. This part of the research field is somewhat yielding a gap in the literature. By historical profits we mean the profits of the company before they were making way to the stock market. Higher historical profits are related to stable growth companies and low uncertainty levels, but could also indicate higher share prices at first hand when information about the profits is reflected in the price.

The *litigation risk hypothesis* plays a role in this field. This hypothesis states that underpricing is used by underwriters and issuers to avoid lawsuits, called the insurance effect (Lowry et. al, 2002). Stakeholders could sue companies when they feel fooled or disappointed about the stock performance of the issuing company. When shares are underpriced, the overall stock performance is expected to be better and the risk of disappointed stakeholders suing the company decreases. Lowry et. al (2002) found evidence that companies that face litigation risk by shareholders and/or government used underpricing as a signal, because after underpricing the price will eventually rise which is a good signal to stakeholders about firm value and profit opportunities. Underpricing is often used by firms with high historical profits to insure against litigation risk, as these companies can bear the costs of lower share prices because they have relatively high reserves compared to firms with lower profits. On the other hand, this underpricing is leading to lower litigation costs, which is called the deterrence effect. Again, high-profit companies are more able to bear the risk of underpricing as Welch (1989) already concluded.

This theory is yielding a gap in country-terms, as it's US-based in the literature. European countries in most cases face relatively less lawsuit risks (Jenkinson, 1990). It is interesting to see if the explanation differs from European companies to US-firms. Beforehand, it is argued that high-quality firms can only bear the costs of underpricing, so they are more likely to offer shares for a relatively low price (Welch, 1989). High profit firms could underprice their shares, as they are expected to have more liquidity in the company to bear the higher (litigation) costs. On the other hand, firms with high historical profits have less incentives to underprice in terms of signaling to investors. Also higher historical profits could already be reflected in relatively high share prices. Investors interpret the shares of these firms as low-risk profiles and are willing to pay a higher price than for low-profit firms. We stand with the first philosophy of Lowry et. al (2002), as we expect high-profit companies to have more financial liquidity possibilities in hand to insure against litigation risks. Underpricing is used as insurance for litigation risk, while we expect historically high profitable firms have the best potential to bear the costs and risks of underpricing.

H3: Historical profits of the firm going public are positively related to IPO-underpricing in the European stock market.

High technology firms normally have costlier projects with higher production costs than non-tech firms. Expensive projects are uncertain of outcome in terms of success. So high technology firms are expected to underprice the shares in an IPO relatively more compared to other companies (Chemannur, 1993). Chemannur exploited the *information production model*, which is based on insider information. Firms incentivize insiders to reproduce the insider information they have in hand, to signal quality to the broad public via these insiders. Insiders want a compensation for this 'information production', which could again be cheap share offers. As high-tech companies have more detailed and comprehensive information, it is often only available for insiders. So high-tech companies are expected to compensate investors more than low-tech companies. In this study, the sample will be divided into certain industries whereafter these industries are separated by high-tech and low-tech industries. This dummy variable can then be analyzed on underpricing differences between high-tech and low-tech firms.

H4: IPO-underpricing is significantly more present in high-tech industries than in low-tech industries.

All of the four above stated hypotheses are related to Beatty & Ritter's (1986) theory on uncertainty. Underpricing is a result of the uncertainty that investors face. The hypotheses H1 to H4 all include variables that represent uncertainty and information asymmetries in a different manner. Age of the firm going public, market capitalization after the first stock market entrance, historical profits and high-technology indications are all of a sudden estimators for uncertainty. These variables could therefore be predictors of underpriced IPOs.

2.2 Underwriter's information advantage

Underwriters are hired by firms going public to bring the shares to the market. For example investment banks use their knowledge, experience and relationships to smoothly facilitate the process of IPO issuance. Baron (1982) argued that this process is yielding a classic principal-agent problem, as investment banks know more about the capital market and can issue shares less costly than regular issuing firms. The greater the difference in knowledge about the market between both parties, the greater the importance of underwriters will be. The underwriters will have incentives to underprice the shares, as their motive is to fully sell the capital in hand. Furthermore, lower prices lead to lower marketing costs for underwriters, as investors are already triggered by the low price-setting (Loughran & Ritter, 2002). When underwriters have much more information available then issuers, underwriters tend to make more use of their incentives to underprice. Underwriters are more likely to behave in their own interest, which could lead to lower prices than issuers desire and sub-optimal amounts of shares to be sold. The theory therefore is that greater information asymmetry between firms and underwriters causes underpriced IPOs, as underwriters make use of their information advantage.

On the other hand, underwriters that have more information available, could have better alignment in a firm's interests in terms of long-term performance.[4] When investors observe that a firm is handling through a high-ranked reputable underwriter, portfolio managers are more likely to invest in a firm's shares (Loughran & Ritter, 2004). This *changing issuer objective function model* states that firms who hire high-ranked underwriters prioritize coverage by analysts. The book building process[5] is therefore influenced by the reputation of an underwriter, where a positive relationship with IPO-underpricing is suggested by the model of Loughran & Ritter (2004). This theory works as follows. The reputation of the firm is often positively influenced by the choice of an underwriter with high-reputation in analysts' rankings. Reputable underwriters demand higher fees, resulting in lower share prices (underpricing) as compensation. Loughran & Ritter (2002) found that underpricing is used as an indirect underwriter fee because investors are willing to pay underwriters to gain from the most profitable IPOs, which are the offers that leave high amounts of money on the table.

The analyst lust hypothesis by Loughran & Ritter (2004) established that issuing firms indeed select underwriters on analyst coverage of investment banks. Just as in the *changing issuer objective function* model, underwriters are chosen based upon a ranking provided by financial analysts. Furthermore, if analysts cover investment banks with a high-rank, they are more involved in IPOs processes and will have an increased capital market share (Dunbar, 2000 ; Clarke et. al, 2003). Low ranked investments banks with less analyst coverage will

[4] Underwriters with a lot of reliable information about the market in hand are referred to as reputable. But the way they use this information is also important for their reputation. If an underwriter only behaves in own interest, the issuing firm will signal this to the market, which is bad for the reputation of the underwriter. Therefore, underwriters with a lot of information available, also have incentives to behave in the interests of the firm in the long-run to insure their reputation in the market. Underwriters receive high-ranks in reputation classifications when they are working in line with the interest of the firms resulting in positive results for the firms itself (Loughran & Ritter, 2004).

[5] Book-building is the process by which companies are determining the share price of an IPO. Often underwriters are hired to handle the process. Reputable underwriters have relatively superior ability in price-setting mechanisms.

eventually be crowded out of IPO processes (Loughran & Ritter, 2004). Cliff & Denis (2004) found evidence that firms having a so-called all-star analyst ranked underwriter in the process of initial share offering were experiencing 16.3% higher first-day returns than firms with lower ranked underwriters (US-based). These firms are therefore associated with higher initial underpricing. *Analyst lust theory* suggests that high-ranked underwriters are related to higher level of IPO underpricing.

Underwriter discretion can be useful to eliminate non-regular investors. Regular investors are investors that on a regular basis buy-and-hold shares. These investors are more likely to engage in future share offerings. If there is excess demand for an IPO, underwriters can allocate the shares to the most regular investors. These regular investors are capable in producing information to other stakeholders as they are more experienced and are most likely to buy shares in later rounds of equity offerings. So allocation of shares to regular investors leads to more certainty in selling later SEO's and to overall better-informed investors in the market due to information reproduction by these regular investors. We assume underwriters to behave in line with the interests of the issuing firm, as underwriters will build on their reputation by doing so and underwriters will receive certain fees for proper allocation of shares (Loughran & Ritter, 2004). Consequently, this allocation is profitable in the long-run for both issuing firms, underwriters and regular investors. Issuing firms will be certain to sell shares in the future. Underwriters will build on their reputation and receive fees. Regular investors will remain involved in the process of future share offerings. Underwriters are better informed about the status of an investor in terms of regularity of investment than issuers. Contrasting to earlier arguments, underwriters who have relatively high amounts of information could reduce underpricing because the information is used in favor of issuers. As underwriters allocate the shares to regular investors, information will be reproduced by these investors. The uncertainty about the issued shares will hereby decrease, as at the end of the chain all investors become more informed. Next to this, the excess demand in combination with the allocation of shares to regular investors makes the firm more confident about selling the capital for higher prices. So when regular investors reproduce information received from underwriters, there will be lower levels of underpricing. Issuers and investors are both perceiving less market risk due to the underwriters. (Benveniste & Wilhelm, 1997 ; Loughran & Ritter, 2004 ; Sherman & Titman, 2002).

Chemannur & Krishnan (2012) established that high-ranked underwriters have relatively few incentives to not handle in favor of the issuer and leave money on the table, so they are expected to offer higher initial share prices compared to low-ranked underwriters. The rank of underwriters (from high to low) in this theory is measured by the number of underwriting processes (issues) an underwriter is part of, and which proportion of the issuance exactly is handled by the underwriter (Dimovski et al, 2010). Beatty & Ritter (1986) already found that underwriters with a high reputation will issue shares less underpriced than other underwriters, as the presence of reputable underwriters leads to investors perceiving less uncertainty about the profitability of the shares. Accordingly, investors are willing to pay higher prices and underpricing will be reduced. Baron (1982) examined that underwriters have an information advantage[6] with respect to issuing firms, and can use this advantage for

[6] Baron (1982) stated that underwriters have more information and better knowledge about the capital market than issuers, as they are more experienced. This is named an information advantage. Especially underwriters with high reputations are using this advantage to allocate shares, set prices and give advices to issuing companies. On the other hand, this advantage leads to potential principal-agent problems.

own interests. Opposite from this, Benveniste & Wilhelm (1997) stated that underwriters could also act in line with interests of the issuer. Looking at this difference, underwriters are also hired by issuers to gain more information about the market. This will decrease the information asymmetry between investors and issuers. Issuers will know better if investors are long-term investors and if they will be a source of profits in later rounds of capitalization. Firms will incur so called information production costs (for example fees to underwriters) to obtain the information. But next to these costs, there are relative wealth gains because of the better allocation of shares. This causes underpricing to decrease, because of the excess demand for the shares (leading to higher prices) and the absence of incentives to set a low price to compensate for uninformed investor's risk (Ljungqvist & Habib, 2001).[7] Also underwriters are not able to use their information advantage to underprice the shares, as they gave up this advantage in exchange for the ingestion of information production costs (paid by issuers).[8] This theory is built on the trade-off between information production costs and the secondary wealth gains on the long-run.

Looking at the above explicated research findings, historical literature on underwriters and information asymmetries is inconsistent. As most of the research is based on US-data, it is interesting to see which theory is the dominant for on the European IPO market. Our expectation is that the information asymmetry between underwriters and issuing firms is causing underpriced initial price offers because of the changing objective issuer model and the analyst lust hypothesis (Loughran & Ritter, 2004). Underwriters are using their information advantage to fully sell the capital. Second, firms base their choice on underwriting investment banks more frequently on analyst coverage, where high ranked underwriters demand higher fees. Underpricing could be used as indirect underwriter fee. These theories are supported by empirical evidence from Cliff & Denis (2004) and others. Hereby we formulate the next hypothesis:

H5: There is a positive relationship between underwriter ranking and IPO underpricing.

If this hypothesis is not supported, the results could indicate evidence for the entrepreneurial losses model and the information production theory. It is interesting to investigate which of the contradicting theories will be the dominant theory in the European IPO market.

2.3 IPO cycles

Prominent studies mentioned IPO underpricing as something we cannot deny or avoid. It is described as an empirical regularity and historical phenomenon before (Loughran & Ritter, 2004 ; Ibbotson, 1975). Ibbotson & Jaffe (1975) hereby exploited the cyclical nature of IPOs. IPOs are split into 'hot' and 'cold' market periods where a hot market period is a period of IPO-booming with many offers and at the same time high initial returns. Researchers refer

[7] The theory of Habib & Ljungqvist (2001) is called *The entrepreneurial losses model.* Reputable underwriters are decreasing information asymmetry because of their information production, which will lead to lower uncertainty and less underpricing. Also, the occurrence of reputable underwriters causes high (excess) demand for the share. Wealth losses are minimized, because there is optimal allocation of shares by reputable underwriters and relative high share prices.

[8] Issuers can reduce the information asymmetry between them and underwriters by paying information production costs as fees to underwriters. Underwriters in return produce the information to the issuers (and other investors). This will lead to lower levels of underpricing, as underwriters do not have an information advantage and cannot use this to underprice the shares for own interests (which could be fully selling the shares offered). Hereby undesired low-price offerings are avoided by issuers, but in return they have to pay underwriters for not using the low-price strategy and obtain true market information (Habib & Ljungqvist, 2001).

unanimous to the presence of hot and cold market periods, but are indifferent in underlying explanations on this topic. Ritter (1984) linked the high risk of certain industries with relative low offer prices to the presence of a hot issue market. Positive productivity or technological shocks in an industry could be a reason why many firms in the same industry go public at the same time. A large number of firms coming to the market at the same time is a convincing signal of profitability for investors. Ghosh (2004) argued that a large number of firms going public is used by investors as a signal of high initial return series. Ghosh suggests a connection with the signaling theory of Allen & Faulhaber (1989), as high-quality firms will go public after a positive market shock. Issuing firms will try to adapt investor confidence by signaling their high-quality with underpriced shares, while coming to the market in clusters. Bunching of IPOs and underpricing are results from unexpected positive market surprises, Hoffmann-Buchardi (2001) estimated. This is resulting in hot market periods, with firms coming from the same industry in most of the cases.

The earlier mentioned ‘Internet-bubble’ saw a lot of IPO offers with high first-day gross spreads. Ljungqvist & Wilhelm (2003) found average first-day returns on IPOs of 69% in 1999 and 56% in 2000, which is astronomically high. They noted that during these times, information frictions were higher than in other periods. Firms going public had less or not so reliable information available, which make them risky. The result was that investors wanted a compensation when getting involved in these firms. The shares were underpriced relatively more than in other periods of share issues, making first-day returns sky-high. When the internet was introduced, firms wanted to stand out to gain attention from the market. Firms with relatively high initial returns got a lot of press coverage on the new digital web, so in this context underpricing was used as a marketing tool (Demers & Lewellen, 2003). This theory is related to the signaling theory (Allen & Faulhaber, 1989) and the theory that only high-quality firms can bear the risk of underpricing (Welch, 1989). Taking into account all these theories on IPO-booms, the last hypothesis is formulated:

H6: There is a positive relationship between the number of firms going public in a certain period and IPO underpricing.

This means that during IPO boom periods the underpricing effect is significantly more relevant than in other times.

2.4 Overview of hypotheses

The aim of this study is to provide evidence on the relationship between information asymmetry theories and the underpricing effect in the European IPO market. The most relevant theories outlined in chapter 2 are tested by regression models on cross-sectional data. The results of the models are then used to test the formulated hypotheses. An overview of these hypotheses and the corresponding underlying theories is shown on the next page.

It is interesting to investigate if the underlying theories are supported in the European IPO market. If this is not the case, the results could support other, contradicting, theories. For example, H2 is contradicting to what the signaling theory of Allen & Faulhaber (1989) would expect. The same holds for H1, where we should mention that the signaling theory could be two-folded and working in opposite ways. If the results are not supporting H1, we must take into account that the explanation could be opposite. As stated, low firm age (younger firms) could be a signal of underpricing because of higher uncertainties (Engelen & Van Essen, 2010). On the other hand, underpricing could be a used as a signal of high-quality which is often related to older firms (Allen & Faulhaber, 1989).

Moreover, H5 is in contrast with the theory of information production and the entrepreneurial losses theory (Habib & Ljungqvist, 2001). So if the research results are not supporting H5, the results could eventually support these contradicting theories. Some implications are linked to more than one theory. We assume that if the hypothesis is supported, all mentioned theories that belong to the statement are supported. If the hypothesis is not supported, suggestions are made to which relevant theories could come around the corner in that case.

TABLE 1. OVERVIEW OF HYPOTHESES AND SUPPORTING THEORIES

Hypothesis	Implication to be tested	Supporting underlying theories
H1	There is a negative relationship between the age of the firm going public and IPO-underpricing.	- Uncertainty theory (Beatty & Ritter, 1986). - Signaling theory (Engelen & van Essen, 2010).
H2	There is a negative relationship between market capitalization and IPO-underpricing.	- Uncertainty theory (Beatty & Ritter, 1986 and Habib & Ljungqvist, 2001).
H3	Historical profits of the firm going public are positively related to IPO-underpricing in the European stock market.	- Litigation risk hypothesis
H4	IPO-underpricing is significantly more present in high-tech industries than in low-tech industries.	- Information production model
H5	There is a positive relationship between underwriter ranking and IPO underpricing.	- Changing issuer objective function model - Analyst lust hypothesis
H6	There is a positive relationship between the number of firms going public in a certain period and IPO underpricing.	- Theory of 'hot & cold' markets - Signaling theory (Allen & Faulhaber, 1989). - Historical empirical findings (f.e. Internet bubble)

3. Methodology

3.1 Data sample

All data is retrieved from Thomson One, Eikon Datastream and Zephyr. The original sample is selected and retrieved from Thomson One. This initial data sample includes all IPO issues listed on the European stock market from 1994 to 2019.[9] The broad time frame is chosen to account for various hot and cold issue periods. For example, the 'Dot-com bubble' (late 90's) and the financial crisis (2008-2009) could be addressed. The financial crisis had significant effects on investor's risk perception and therefore the number of IPO´s and initial returns were expected to fall during that period (Henry & Gregoriou, 2013). The information contains offer prices and first-day closing prices of the shares, most closing prices are retrieved from Eikon Datastream and Zephyr. Initial first-day return or level of underpricing will be calculated and used as dependent variable. Information on founding dates, number of shares outstanding at issue date, lead underwriters, nation of headquarters (country-specifics) and industry-specific SIC codes[10] are retrieved from Thomson One. These numbers are used to define a number of dependent variables.

As said, the initial data sample will contain all European initial public offerings between 1994 and 2019. However, some issues are taken out of the sample. Closed-end funds and unit-issues[11] are taken out as the research by Liu & Ritter (2011) recommend. These issues differ in their characteristics from the other share offers in the sample such that they influence the results disproportionally. Offers with a share price below $5.00 are also excluded from the sample, as these stocks are relatively irrelevant and could influence the result undesirably because the initial returns are highly volatile (Liu & Ritter, 2011). At last, financials (SIC-codes 6000-6999) and utilities (4000-4999) are canceled out, as regulations could influence the issuance of equity significantly different compared to other industries (Spies & Pettway, 1997). When a firm misses crucial, or has incomplete, data on prices, underwriters or other variables the firm is also excluded from the sample. In some cases of missing data, mean values or estimated values are filled in if this is assessed as appropriate, suitable and desirable for the research. The exclusion of certain firms and industries is done based on the SIC-codes provided by Thomson One. Most information on corresponding financials had to be found on Eikon Datastream and Zephyr. Information on closing prices, historical profits, revenues, assets, interest rates and the MSCIeurope index returns are retrieved from these data sources. The final data set will include a large base of initial public offering firms over many years, a lot of countries and a lot of industries. A broad data sample should insure the explanatory power of the model. The data sample contains of 2359 European initial public offering firms between 1994 and 2019.

The next page shows country by country statistics in Table 2. The sample consists of IPOs in 35 different European countries. The country classification is distributed over 16 specific countries with the highest number of IPOs, while the other countries are brought together in the category 'other'. The table provides a summary of the mean and median initial returns,

[9] This sample period is chosen due to data availability.
[10] Standard Industrial Classification (SIC) is a system that classifies industries with specific four-digit industry codes.
[11] Closed-end funds and unit issues are both offerings that contain of a combination or pool of shares, assets and/or securities.

and the number of IPOs per country. This table provides an overview of the distribution of the initial public offerings and levels of underpricing across the European countries.

TABLE 2. COUNTRY BY COUNTRY SUMMARY STATISTICS

Country	Mean	Median	N
Austria	.025	.022	42
Belgium	.057	.028	76
Denmark	.198	.082	52
Finland	.056	.035	62
France	.054	.021	706
Germany	.133	.049	477
Greece	-.002	.067	78
Italy	.038	.031	125
Netherlands	.138	.023	106
Norway	.204	.041	54
Poland	.206	.102	99
Russia	.177	.053	42
Spain	.113	.037	51
Sweden	.166	.102	123
Switzerland	.113	.089	97
United Kingdom	.129	.058	75
other	.16	.047	94

Table 2 presents the mean and median levels of underpricing per country. Also the number of IPOs per country between 1994 and 2019 on the European stock market are outlined. Countries with a small number of IPOs are taken together in the category 'other'. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Level of underpricing or initial first-day return is calculated by the natural logarithm of first-day closing price divided by initial offer price. Data from Thompson One, Eikon Datastream and Zephyr.

France is the country with the highest number of IPOs, namely 706 during the sample period. France and Germany are the outstanding countries in terms of number of IPOs, followed by Italy, Netherlands and Sweden who also represent more than 100 initial public offers between 1994 and 2019. Noteworthy is the negative mean initial return of Greece with -0.002 (-0.2%). Poland has the highest mean and median initial return with 20.6% and 10.2% respectively. Austria and Italy are, next to Greece, countries with relative low means. Greece and Italy have both been hit hard by the financial crisis, which could be the period downgrading the mean initial return. France, the biggest country in terms of IPOs, has the lowest median initial return (2.1%) followed by Austria. Scandinavian countries Norway, Sweden and Denmark are having relatively high mean and median initial returns relatively to other regions. This region is known for their stable economic growth over the years. Overall, the differences in initial returns between countries are marginal. At first sight, no specified relationship between number of IPOs in a country and initial return is shown. But this needs further investigation. The overall mean of the sample is 10.35%, while the overall median is around 3.9%. All countries show figures that are not extremely far away from the overall mean and median.

The distribution of IPOs and corresponding initial returns over the years is provided in figure 1 on the next page. The IPO-boom years are 1997 to 2000 and 2006-2007. We see that in 1999 and 2000 the IPO-market was booming with more than 300 IPOs per year at the European market, while these years also show high levels of IPO underpricing (15%+). This is already supporting our sixth hypothesis. The figure shows that from 1997 to 2000 (during the 'Internet-bubble') the number of IPOs keeps rising and at the same time the initial returns are also rising. In 2001 the number of IPOs drops fundamentally, while the level of underpricing remains higher as in 2000, namely around 16%. Another rare period is the period 2010-2013, where the levels of underpricing were rising but only few initial share offers took place. The extreme initial return in 2013 of around 18% is not expected as it is a cold market period. It could be the case that this year has some outliers who effect the distribution in extreme ways, as periods with a low number of IPOs are influenced relatively easy by outliers compared to IPO-boom years. The lowest levels of initial returns are in the early stages of the sample (1994-1996) and after the last financial crisis (2008-2010). This could be due to investors and issuers having little to no confidence in the stock market during these times. Overall, there are extreme differences in number of IPOs and initial first-day returns over the years. The trend of hot and cold market periods with differences in initial returns will be further elaborated in the results section, as hypothesis 6 is analyzed with regression results.

FIGURE 1. NUMBER OF IPOS AND AVERAGE LEVEL OF UNDERPRICING PER YEAR

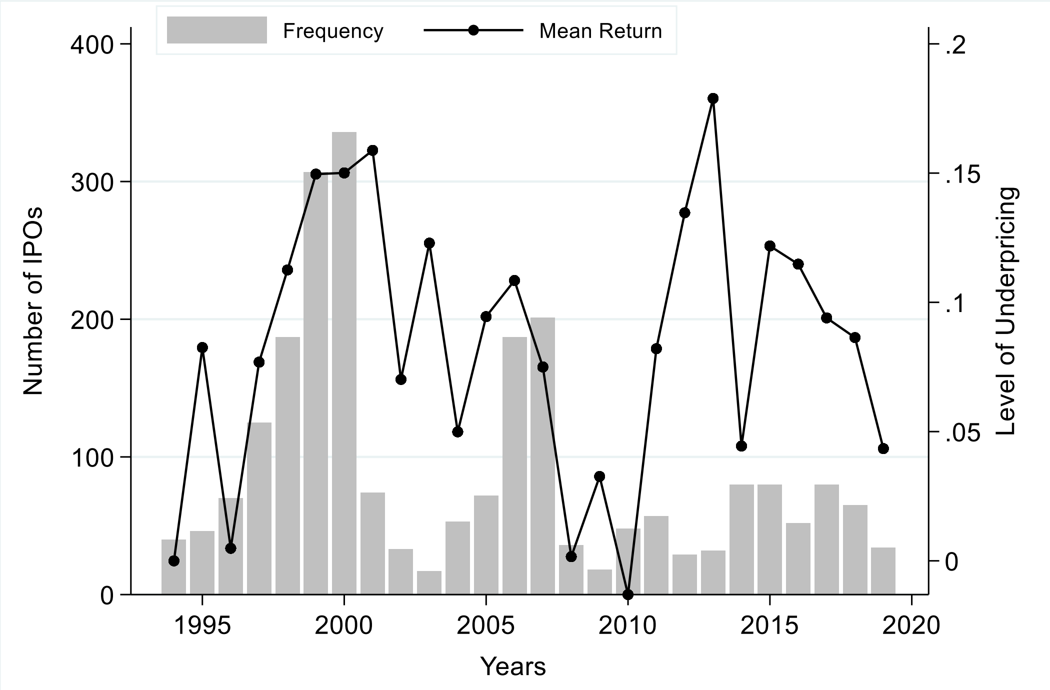

Figure 1 presents the number of IPOs per year issued between 1994 and 2019 on the European stock market, with corresponding average first-day returns per year. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Level of underpricing or initial first-day return is calculated by the natural logarithm of first-day closing price divided by initial offer price. Data from Thompson One, Eikon Datastream and Zephyr.

3.2 Research method

In this study, a quantitative research method will be used to provide an answer on the research question. This method will be an ordinary least squares (OLS) regression, including controls for country, market return at the moment of issuance and the interest rate as macro-economic factor. As the study on IPOs is seen as an event study, cross-sectional data will be adopted.[12] The results part will discuss to what extent the stated hypotheses have value, and how the regression results relate to the existing literature. An argumentation could thereafter be made on which relevant theories are the most dominant in the field of European IPO-underpricing. All information on data is retrieved from Thomson One, Eikon Datastream and Zephyr. This data sources are specialized in the collection of financial data (of event studies) and use financial data analysis tools. Moreover, the data sources offer a large base of initial public offering firms, which is positive for the explanatory power of this research.

However, only performing an OLS-regression is not considered to be sufficient here. An endogeneity test will be adopted for underwriter reputation, as Habib & Ljungqvist (2001) suggest that this variable is endogenous in regressions with initial first-day return (IFR) being the dependent variable. The underwriter choice could be biased, as it is not a one-sided procedure. Issuing firms are reliant on the enthusiasm of the underwriter they would like to involve in the process. On the other side, underwriters also make a selection on which issuing firms they want to work with. In this process, an endogeneity bias could be present in the linkage of underwriters and issuers (Akkus et. al, 2013). Normally, the Hausman test is an appropriated measurement method to test for endogeneity. But since underwriter reputation is binary (as it is based on a ranking), the Hausman test is not allowed in this research. Instead, a 2SLS-regression[13] will be adopted, in line with Habib & Ljungqvist (2001) and Liu & Ritter (2011). An instrumental variable will be implemented in the first regression part. If the instrumental variable shows significance in the first part of the regression, endogeneity seems to be present. The significance of the residuals in the first stage is also tested. Next, the fitted values for underwriter reputation are included in the original regression. Logged assets are included in the first part as instrumental variable for underwriter reputation. Logged assets is chosen based on earlier research by Habib & Ljungqvist (2001) and Akkus et. al (2013). This method is selected based on the argumentation that the coupling of issuers and underwriters is two-sided. Not only firms choose underwriters based on reputation and experience, but underwriters also select share issues they absolutely want to be involved in. High-quality underwriters choose firms based on for example the quality of a firm, industry, issue size and also the size of a firm (relative to the market). Therefore, the characteristics of a firm are important to be able to bind reputable underwriters. The amount of assets a firm holds could be such a characteristic that measures how big a firm is. Therefore, logged assets is an appropriate instrumental variable to test for the endogeneity of underwriter reputation, which is as explained possibly strongly dependent on the size of the firm (Akkus et. al, 2013, Beatty & Welch, 1996). After all, the results of the 2SLS-regression will be compared to the original OLS-regression and striking differences are exploited.

[12] Cross-sectional data is a type of data that measures many subjects at one moment in time. Cross-sectional data analysis is appropriate in this study, because the dependent variable (initial return) is measured at one specific moment in time, namely the time of the IPO.
[13] A two-stage least squares regression. This is used when a variable is endogenous in the regression. First, underwriter ranking should be regressed to the independent variables including an instrumental variable (logged assets). The second part is implementing the resulting coefficients of the first part in the original OLS-regression.

3.3 Operationalization of variables and method

The amount by which the share is underpriced is the dependent variable. The level of underpricing is measured by initial first-day return (IFR). Initial first-day return is measured as the natural logarithm of the percentage change from beginning offer price to first day closing price (Loughran & Ritter, 2004). These returns are calculated with the following formula:

(1) $$\boldsymbol{IFR} = ln \ \left(\frac{1st\ day\ closing\ price}{initial\ offer\ price}\right)$$

The explanatory variables of interest are firm age, market capitalization, historical profits, technological level of a firm, underwriter ranking, and the year the IPO took place in (hot / cold period). These variables are used as proxies for uncertainty and/or information asymmetry. Firm age is measured as the natural logarithm of the difference between founding date and issue date in years. Older firms are expected to have more information available and are therefore related to low uncertainty levels. Accordingly, firm age is a good proxy for information asymmetry (Boubaker & Mezhoud, 2011 ; Ljungqvist & Wilhelm, 2003 ; Ritter, 1991). Market capitalization is measured as offer price times the number of shares outstanding after the IPO, the natural logarithm will be used in the regressions. Market capitalization is also a good proxy for uncertainty as firms with higher market capitalization tend to be more stable and of high-quality (Boubaker & Mezhoud, 2011). The next independent variable is historical profits.[14] The profit (as in operating income) of the year before the IPO is taken to measure this variable. The values need to be adjusted a little bit to be able to use the natural logarithm in the regressions, as profits can also equal a negative value. The minimum value of the distribution of the year-before-IPO-profits is obtained (which is logically a big loss value) and the absolute value of this number is added up to the profit values. After doing this the distribution looks the same, with the same gaps between the values, but all values are above zero and the natural logarithm can be used. A dummy variable is created for high-technology firms, which are expected to be more underpriced as they conduct more uncertain, high-tech projects. This dummy variable is equaling 1 if the industry the firm belongs to is classified as high-technological, and zero otherwise. This categorization is based on the primary SIC-codes obtained from Eikon Datastream. Firms with SIC-codes that begin with 357, 367, 382, 384 and 737 are classified as high-technological (Field & Hanka, 2001). The sample consists of high-tech firms for 30.5% and of low-tech firms for 69.5%. The next explanatory variable underwriter reputation is based on the IPO underwriter rankings provided by Migliorati & Vismara (2014), Griffin et. al (2014) and Carter et. al (1990). Migliorati & Vismara (2014) rank European underwriters, Carter et. al (1990) rank American underwriters and Griffin et. al (2014) rank both European and American underwriters and is the most recent ranking, but less complete than the other two. The dummy variable equals 1 if one of the lead underwriters of an IPO-process is mentioned as 'reputable', 'high-ranked' or 'prestigious'. If the variable equals zero, the lead underwriters

[14] Lowry et. al (2002) argued that high-profit companies offer lower prices, because they can bear the risk of setting low prices. They want to avoid lawsuits by underpricing the shares. Contrasting, firms with high profits are associated with certainty, stability and a low 'litigation risk' (see chapter 2). Historical profits is therefore a proxy for (un)certainty, related to information asymmetry.

are referred to as ‘non-reputable’ or ‘low-ranked’.[15] The last independent (dummy) variable is measured a bit subjective, as we assign the value of 1 to issues during a ‘hot issue period’ and 0 to issues in a ‘cold issue period’. This dummy variable is created to test the tendency that underpricing is higher during IPO booming periods. The years 1997-2000 and 2006-2007 are classified as hot market periods, the rest of the years are classified as cold market periods.

In order to control for differences between country, a country dummy variable will be included in the regressions. The issuers will be categorized by country in a dummy variable. Each issuing firm will be assigned to the nation in which the headquarters of the company are located. Like in table 2, the country-by-country summary statistics, 16 specific countries are separated while the rest of the countries are taken together in the category ‘other’. In periods of high average market return, high first-day returns of IPOs are also more likely. Accordingly, a control for European (daily) market return will be included. The MSCIeurope index will be used to control for average first-day return in the market. This index measures the performance of large and mid-cap firms across Europe. This variable will be calculated by percentage change between the closing index price on the day before the IPO took place and the closing index price after the first trading day. So the level of underpricing will be compared to the MSCIeurope index return on the first trading day (Banerjee, 2011). Another control variable will be the interest rate in the market, to control for macro-economic characteristics. The interest rate is used as proxy for macro-economic market characteristics, as it is often used as instrument by central banks to stimulate economic growth. Lower interest rates are stimulating investors and firms to engage in financial investments such as initial public offerings. For higher interest rates, future IPOs are discouraged because expected income is extremely discounted. Consequently, periods of high interest rates are expected to be causally related with periods of low economic activity and contraction. In the IPO-market this is referred to as ‘cold’ market periods as mentioned before. So the macro-economic circumstances, reflected by interest rate, could be a side effect on IPO-booms (Ameer, 2012 ; Angelini & Foglia, 2018 ; Jovanovic & Rousseau, 2004).

All explanatory and control variables are assumed to be exogenous, except underwriter reputation (Liu & Ritter, 2011).

The endogeneity test outlined in paragraph 3.2 that will be adopted for underwriter reputation will be one of the robustness checks. A 2SLS-regression with logged assets as instrumental variable will be examined. Two interaction terms will be added to the original regressions as robustness check. An interaction term of the market cap times the underwriter reputation is included in the regressions, as Habib & Ljungqvist (2001) suggest that bigger firms are more able to gain attention among high-quality underwriters. Furthermore, an interaction term of profits and market capitalization will be included, as bigger firm tend to have higher profits on average. The last robustness check will be the replacement of the profit variable by revenues. The variable profit is chosen to account for economic performance. However, profits are highly volatile and could defer from one year to the other. A year of low operating income does not automatically mean that the company is in bad economic state. Therefore, a robustness check is performed with revenues involved in the regressions, instead of profits.

[15] The equally weighed reputation ranking of Migliorati & Vismara (2014) is used to rank underwriters from 0 to 1. All underwriters with a ranking of above 0.75 are classified as reputable and equal 1 in the dummy variable measurement. For the Carter et. al (1990) and Griffin et. al (2014) rankings a threshold of at least 8 out of 10 is chosen to be classified as reputable and equal 1 in the dummy variable measurement.

Revenues are more stable figures as sales or turnover are not likely to change as much from year to year as profits do. Moreover, all values for revenue are above zero so the variable does not need the adjustment that profit needs to use logged values in regressions. Revenue is measured by the natural logarithm of the operating revenue of the company in the year before the IPO took place. Data on operating revenue is retrieved from Eikon Datastream and Zephyr.

A Breusch-Pagan test for heteroscedasticity will be applied to check if the errors terms have constant variance. Since heteroscedasticity could be a problem in cross-sectional data analyses, this test is relevant to include in the research (Williams, 2010). If heteroscedasticity is found, the errors term might be clustered into a robust regression to cancel this bias out. Next to the Breusch-Pagan test, a White General test will be applied on the OLS-regressions to test for heteroscedasticity.

An OLS-regression will be performed to examine to what extent the explanatory variables are related to the level of underpricing or initial first-day return (IFR). The explanatory variables are defined as AGE, MARKETCAP, PROFIT, TECH, UNDRW and BOOM. The control variables are defined as COUNTRY, MSCI and INTEREST. An overview of all variables and their description is provided in table 3 on the next page. The following regression formula is composed:

(2) $$IFR = \alpha + \beta 1AGE + \beta 2MARKETCAP + \beta 3PROFIT + \beta 4TECH + \beta 5UNDRW + \beta 6BOOM + \beta 7COUNTRY + \beta 8MSCI + \beta 9INTEREST + \varepsilon$$

As explained above, a 2SLS-regression with an instrumental variable approach will be adopted and analyzed to control for a possible endogeneity problem of UNDRW.

TABLE 3. OVERVIEW AND DEFINITION OF ALL VARIABLES

Variable	Abbreviation	Definition
Initial first-day return	IFR	Natural logarithm of the change between the offer price and the first-day closing price.
Firm age	AGE	Natural logarithm of the difference between the year the IPO took place and the founding year of the company.
Market capitalization	MARKETCAP	Natural logarithm of the offer price times the number of shares outstanding after the IPO.
Profits	PROFIT	Natural logarithm of the operating income of the company the year before the IPO took place after adding up the absolute value of the minimum value of the distribution to make sure all values are positive.
Technological level of the industry	TECH	Dummy variable equaling 1 for firms with SIC-codes 357, 367, 382, 384 or 737, and 0 otherwise.
Underwriter reputation	UNDRW	Dummy variable equaling 1 if the underwriter is ranked as ‘reputable’ in one of the relevant underwriter rankings, and 0 otherwise.
Year of IPO	BOOM	Dummy variable equaling 1 if the IPO took place in a ‘hot market period’ (1997-2000 ; 2006-2007), and 0 if the IPO took place in a ‘cold market period’ (all other years).
Country dummies	COUNTRY	Dummy variable which assigns the firm to a specific country where the company’s headquarters are located.
MSCIeurope returns (control variable)	MSCI	Return of the MSCIeurope index on the first-trading day.
Interest rate (control variable)	INTEREST	3-months EURIBOR daily interest rates. For the years 1994-1998 monthly rates are used because of data availability.
Revenues (robustness check)	REVENUE	Natural logarithm of the operating revenue of the company the year before the IPO took place.
Logged assets (robustness check)	LOGASS	Natural logarithm of the assets the company had the year before the IPO took place.

The hypotheses formulated in chapter 2 will be tested using the research method explained in this chapter. The results of this research are outlined in the next chapter. After analyzing the results in chapter 4 the hypotheses and research question can be judged.

4. Results

4.1 Descriptive statistics

Table 4 shows the descriptive statistics of all variables used in the regressions. All variable descriptions and abbreviations can be found in Table 3. All variables have 2359 observations, which is equal to the number of IPOs in the data sample.

TABLE 4. DESCRIPTIVE STATISTICS

VARIABLES	Mean	Median	SD	Min.	Max.	N
IFR	0.102	0.0386	0.405	-2.386	3.203	2359
Age	21.49	11	29.37	0	327	2359
MARKETCAP*	3.413	3.536	2.186	-8.998	9.650	2359
PROFIT*	12.93	12.83	0.366	8.973	15.77	2359
TECH	0.305	0	0.460	0	1	2359
UNDRW	0.387	0	0.487	0	1	2359
BOOM	0.569	1	0.495	0	1	2359
MSCI	0.000151	-3.76e-05	0.0103	-0.0552	0.113	2359
INTEREST	0.0299	0.0349	0.0185	-0.00425	0.0758	2359
REVENUE*	10.82	10.97	2.847	-5.246	21.62	2359

Table 4 represents statistics on IPOs between 1994 and 2019 issued on the European stock market. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Level of underpricing or initial first-day return (IFR) is calculated by the natural logarithm of first-day closing price divided by initial offer price. Data from Thompson One, Eikon Datastream and Zephyr. Variable descriptions can be found in Table 3.
* Variable adjusted by taking the natural logarithm

There is a striking difference between the mean IFR of 10.2% and the median IFR of 3.86%, which means that 50% of the IPOs had a first-day return of above 3.86%. The minimum value of IFR shows that a company had -238.6% underpricing (or 238.6% overpricing), while the maximum shows that one company had a level of underpricing of 320.3%. These values that lie far away from the mean are making the standard deviation of the dependent variable IFR relatively high. The variable Age is not logged yet, so it shows how old the firms in the sample are on average (21.49 years). The oldest firm in the sample is 327 years old and of course some firms have an age of 0 years, as the IPO took place in the same year the company was founded. For the variables MARKETCAP, PROFIT and REVENUE the natural logarithms were already taken before the descriptive statistics were outlined. So the values shown in table 4 are relevant to analyze before running regressions. The variable REVENUE is used in a robustness check to replace PROFIT and analyze which variable is more appropriate to use to account for company performance. The variables TECH, UNDRW and BOOM are dummy variables. The descriptive statistics show that 38.7% of the firms hired a reputable underwriter for their first public share offer. Furthermore, 56.9% of the issues took place in hot market periods (1997-2000 & 2006-2007), which is a remarkably high amount. Only five years of the sample period count for more than half of the IPOs. 30.5% of the companies are part of a high-tech industry. The control variable MSCI has a mean of 0.0151% average market return during the first-trading day with a maximum return of 11.3% and a minimum of -5.52%. The minimum interest rate was negative, which was the case in 2019. The highest interest rates were measured during the early years of the sample period.

TABLE 5. PEARSON'S CORRELATION MATRIX

Variables	IFR	AGE	MARKET CAP	PROFIT	TECH	UNDRW	BOOM	MSCI	INTEREST
IFR	1.000								
AGE*	-0.034	1.000							
MARKETCAP*	0.047	0.175	1.000						
PROFIT*	-0.004	0.119	0.316	1.000					
TECH	0.056	-0.130	-0.102	-0.128	1.000				
UNDRW	0.024	0.057	0.281	0.186	-0.027	1.000			
BOOM	0.054	-0.045	-0.068	-0.139	0.111	-0.044	1.000		
MSCI	0.011	0.003	-0.041	-0.009	-0.026	0.021	0.017	1.000	
INTEREST	0.007	-0.030	-0.152	-0.062	0.056	-0.026	0.509	-0.003	1.000

Table 5 represents a correlation matrix. Data on IPOs between 1994 and 2019 issued on the European stock market. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Data from Thompson One, Eikon Datastream and Zephyr. Variable descriptions can be found in Table 3.
* Variable adjusted by taking the natural logarithm

Table 5 shows the correlations between all variables used in the original OLS-regressions. Predictive relationships are provided by the correlations in the table. The correlations for IFR and the independent variables are all rather low indices, but since these are only predictive relationships it says nothing about the outcome of the regressions. What is most important here are the correlations between the independent and control variables. A high correlation between MARKETCAP and UNDRW could be expected because bigger firms are expected to be more able to hire prestigious underwriters (Megginson & Weiss, 2001). The correlation of 0.281 is not extremely high, but we will include an interaction term as part of a robustness check in this research to check if it is improving the model. The highest correlation of two explanatory variables is between MARKETCAP and PROFIT. Although the correlation of 0.316 is also not extremely high, and an interaction term will again be included in the robustness checks. The correlation follows logically, as bigger firms are often more able to make profits. The high correlation of BOOM and INTEREST (0.509) can be explained by the fact that the hot issue period 1997-2000 fell together with a period of high interest rates in the 90's. In more recent periods Europe had to deal with very low and even negative interest rates, while these years are also cold issue periods in the IPO market.

High correlations between independent variables could indicate signs of multicollinearity. The variance inflation factor (VIF) is therefore calculated. The outcome can be found in Appendix A. All values in the VIF test statistics are lower than 2, which disclaim indications of multicollinearity as the rule of thumb is that multicollinearity could only play a role when the VIF is higher than 10 (O'Brien, 2007). Following this, all variables are retained in the model.

4.2 OLS-regression results

To indicate if there are potential influential cases that have a disproportionate influence on the outcome of the model a residual analysis is examined. The Cooks distance (COOKSD) and DFITS are used to identify possible outliers and influential cases. Not every outlier has such a large influence on the outcomes of the regression model that it has to be an influential case.

First, all values of COOKSD and DFITS that are higher than the threshold the rule-of-thumb[16] provides were taken out to see if this caused an improvement of the model. However, too many values were taken out and the model did not improve. Visual inspection led to a higher threshold where only 13 influential cases were identified and taken out of the final sample, as this was observed as the best improvement for the model. The initial sample (used in the descriptive statistical analysis) consisted of 2359 IPOs, while the final sample used in the regression models consists of 2346 IPOs. The average initial first-day return for the sample period, excluding the 13 outliers, is 9.8%. This is slightly lower than the mean of the initial sample before excluding the influential cases (see Table 4). The t-test of IFR in Appendix B shows that the level of underpricing is significantly different from 0, as the p-value equals 0.000. Looking at these statistics, the level of underpricing of European IPOs between 1994 and 2019 shows statistical significance on the 1% level.

Several tests and analysis are used to check for heteroskedasticity. Heteroskedasticity means that the error terms do not have constant variance. Constant variance is one of the assumptions of the OLS-regression model. If there is heteroskedasticity, this assumption is rejected and in case independent variables increase at the same time error terms could increase. As this data uses cross-sectional data, heteroskedasticity could be a major problem. Squared residual analysis, the Breusch-Pagan test and the White-General test all indicate signs of heteroskedasticity, which means standard errors could be biased. Explanatory variables have an effect on the variance of the error term, so the null hypothesis of constant variance is thrown away. See Appendix C for the results of the tests and statistics. Following this, the estimation of the variables must be altered to make sure the best possible estimator with the lowest variance is used. Robust standard errors are included in the model to deal with the possible problem of biased standard errors. The estimators are indeed of lower variance and the significance of the coefficients is improving when the model including robust standard errors is used. This means that the control for heteroskedasticity is causing an improvement of the model and that this model with robust standard errors is used as the best possible estimator, as it the most appropriate and useful model when analyzing the regressions results. The regression results of these models are outlined in Table 6. The regression results without robust standard errors are shown in Appendix D, Table 14. The results in Table 6 are most relevant to analyze in this research.

Regression results of the models including robust standard errors, regressing all explanatory variables on initial first-day return (IFR), are shown in Table 6. Models 1 to 6 show that all independent variables except from PROFIT and UNDRW have significant effects on IFR on the 5% level, or even the 1% level for BOOM, when the variables are analyzed separately. When all explanatory variables are modeled in one regression no major changes are shown (model 7). The same holds for model 8 and model 9, as control variables MSCI and INTEREST are added one by another. Eventually, in model 11, control variable MSCIeurope index return shows no significant effect and control variable interest has a significant effect on the regression results, which means the results are robust to interest rate changes.

[16] For COOKSD the rule-of-thumb sets the threshold at 4 / (N-k-1) where N is the number of observations and k the number of independent variables. The threshold using this formula equals 0.00172. For DFITS the rule-of-thumb sets the threshold at 2 x √ (k/N), which equals 0.116469 for this sample. However, excluding all observations that had a COOKSD and/or DFITS higher than the threshold did not improve the model. Eventually, all values having a COOKSD of higher than 0.01 and/or a DFITS higher than 0.3 were canceled out.

TABLE 6. OLS-REGRESSION RESULTS WITH ROBUST STANDARD ERRORS

IFR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
AGE	-.017**						-.017**	-.017**	-.017**	-.017**	-.013*
	(.007)						(.007)	(.007)	(.007)	(.007)	(.007)
MARKETCAP		.006**					.007**	.007**	.006*	.006**	-.002
		(.003)					(.003)	(.003)	(.003)	(.003)	(.004)
PROFIT			.018				.021	.021	.023	.022	.002
			(.019)				(.019)	(.019)	(.019)	(.019)	(.019)
TECH				.043**			.038**	.038**	.038**	.038**	.036**
				(.018)			(.018)	(.018)	(.018)	(.018)	(.018)
UNDRW					.024		.018	.018	.019	.018	.034**
					(.016)		(.016)	(.016)	(.016)	(.016)	(.016)
BOOM						.049***	.048***	.048***	.061***	.06***	.066***
						(.015)	(.015)	(.015)	(.017)	(.017)	(.017)
MSCI								.641		.617	.635
								(.716)		(.714)	(.706)
INTEREST									-.655	-.645	-.679*
									(.408)	(.408)	(.41)
Constant	.139***	.078***	-.135	.085***	.088***	.07***	-.198	-.197	-.205	-.204	
	(.019)	(.012)	(.241)	(.009)	(.011)	(.009)	(.248)	(.248)	(.248)	(.248)	
N	2346	2346	2346	2346	2346	2346	2346	2346	2346	2346	2346
R-squared	.002	.001	0	.003	.001	.004	.011	.012	.012	.012	.09
Country dummies	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES

Table 6 represents regression results on IPOs between 1994 and 2019 issued on the European stock market. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Level of underpricing or initial first-day return (IFR) is calculated by the natural logarithm of first-day closing price divided by initial offer price. Data from Thompson One, Eikon Datastream and Zephyr. All standard errors are robust. Variable descriptions can be found in Table 3.
*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Model 10 shows almost the same results, bringing together all explanatory and control variables but without country dummies included. All variables that were significant initially stay significant on at least the 10% level. The country dummies are included in model 11 to control for differences in country. Adding the 17 country dummies to the regressions causes the R-squared to increase significantly compared to the other models. In the models without country dummies the R-squared values are very low. The R-squared of 0.09 in model 11 is considered as acceptable, although it is still relatively low. The R-squared implies that 9% of the variance in the initial first-day returns is explained by our model. That is to say, information asymmetry theories are explaining 9% of the total level of underpricing. An important assumption here is that the independent variables are representing the information asymmetry theories in an appropriate way. Also important to note is that large parts of the explanations are due to the country control variable. Concluding, information asymmetry theories are explaining a small part of the total underpricing as there are other factors (not included in this research) influencing the initial returns.

Considering the R-squared, model 11 is the most relevant to analyze regression coefficients. Interesting to see is that the effect of underwriter reputation is significant on the 5% level after adding the country dummies, while before there was no significant effect. Noteworthy is that the coefficient of MARKETCAP changes to a negative coefficient after adding country dummies, which is in line with our hypothesis, however the effect is still not significant. The effect of profits on initial first-day return is not significant in any of the models. The other variables are robust to cross-country differences, as they remain significant over all the models. An increase in the age of a firm by one year, causes the level of underpricing to decrease by 1.3%. This effect is significant on the 10% level. The effect of TECH on IFR is significant on the 5% level, as well as the effect of underwriter reputation. When a firm belongs to a high-technological industry sector the level of underpricing is on average 3.6% higher compared to low-tech industries. Furthermore, if firms hire a reputable underwriter, this is increasing the initial first-day return with 3.4% compared to underwriters with low reputation rankings.

A number of robustness checks are used to check if (some parts of) the model can still be improved. The results are lined out in paragraph 4.3. All research results are eventually leading to the hypotheses analyses in paragraph 4.4 and conclusions in chapter 5.

4.3. Robustness checks

The first robustness check in this research is the 2SLS-regression to control for endogeneity of the independent variable underwriter reputation. Endogeneity is present when the explanatory variable is correlated with the error term, which makes the relationship biased. As explained in paragraph 3.2, this endogeneity bias is suggested for underwriter reputation by Habib & Ljungqvist (2001). Logged assets is used as instrumental variable for underwriter reputation in a 2SLS-regression model based on earlier research by Akkus et. al (2013) and Habib & Ljungqvist (2001). Logged assets is chosen as the selection of underwriter seems a two-folded procedure. Reputable underwriters often choose large firms with large share offerings to be involved in. Using this argument, firms are not completely autonomous in selecting a certain underwriter. Reputable underwriters have their own influence on the issuer-underwriter matching principle, as they can select the issues they want to be involved in based on firm-characteristics such as firm size (measured by assets in this case).

First, UNDRW needs to be regressed as dependent variable to all the other independent variables of the original OLS-regression model. Second, the residuals are predicted and substituted in the original OLS-regression. Thereafter, logged assets (LOGASS) is substituted in the second part of the regression as instrument for UNDRW. In this regression, the fitted values for all other independent variables are obtained from the first stage regression. These fitted values are substituted in the original regression model with IFR as dependent variable. The results can be found in Table 7 on the next page. Model 1 is the original OLS-regression model, while models 2 and 3 represent the results of the two stages of the 2SLS-regression model. The residuals of the first-stage regression are not significant, which disclaims the presence of endogeneity. Nevertheless, the coefficient of LOGASS is significant on the 1% level (Model 2), which indicates that UNDRW is influenced by instrumental variable LOGASS. The control for endogeneity is therefore proven as valuable addition to the research model. In model 3 the coefficient of UNDRW has decreased and is not significant anymore compared to the original model. This means that underwriter reputation has no significant effect on initial first-day return when controlled for the endogeneity bias. Consequently, there is a strong suspicion that there are one or more omitted variables, for example LOGASS, in the OLS-regression model. A suggestion is made that logged assets has an influence on the relationship between underwriter reputation and initial first-day returns. Other possible omitted variables could also influence this effect. The R-squared of model 3 is slightly lower compared to model 1 but no noteworthy increase or decrease has been observed. Concluding, when controlled for endogeneity the effect of underwriter reputation on IFR disappears. How this is affecting the analysis of hypothesis 5 will be elaborated in section 4.4.

TABLE 7. 2SLS-REGRESSION RESULTS

Variables	(1) IFR (OLS)	(2) UNDRW (2SLS)	(3) IFR (2SLS)
AGE	-.013*	.002	-.014**
	(.007)	(.009)	(.007)
MARKETCAP	-.002	.055***	-.012
	(.004)	(.006)	(.013)
PROFIT	.002	.119***	-.024
	(.019)	(.029)	(.036)
TECH	.036**	.023	.034*
	(.018)	(.021)	(.018)
UNDRW	.034**		.189
	(.016)		(.193)
BOOM	.066***	-.007	.069***
	(.017)	(.023)	(.018)
MSCI	.635	.959	.489
	(.706)	(.953)	(.736)
INTEREST	-.679*	.213	-.754*
	(.41)	(.579)	(.435)
LOGASS		.023***	
		(.005)	
N	2346	2346	2346
R-squared	.09	.508	.089
Country dummies	YES	YES	YES

Table 7 represents two-stage regression results on IPOs between 1994 and 2019 issued on the European stock market. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Level of underpricing or initial first-day return (IFR) is calculated by the natural logarithm of first-day closing price divided by initial offer price. Data from Thompson One, Eikon Datastream and Zephyr. All standard errors are robust. Variable descriptions can be found in Table 3.
*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Table 8 presents the results of the OLS-regressions including interaction terms. Noticeable is that the effect of the interaction term market capitalization times underwriter is not significant and takes away the significance of explanatory variable UNDRW on its own (models 2 and 3). Including this interaction effect in the regressions is therefore not considered as relevant. The second interaction term, market capitalization times profits, is significant in both model 3 and 4 leading to the statement that it its relevant to include this interaction effect in the research. PROFIT showed no significance at all in the original OLS-model (Table 6), while both the interaction term and the singular coefficient are significant on the 10% level in Table 8. This means that including the interaction term has a positive influence on the significance of the relationship between historical profits and level of underpricing. Besides, the coefficient of the interaction term has a negative sign, meaning that firms with bigger market capitalization are downgrading the effect of historical profits on initial first-day return. Furthermore, the singular coefficient of MARKETCAP is positive and higher compared to the original model. The coefficient is now also robust to cross-country differences, while in the original OLS-regressions significance was only present when no country dummies were included. The inclusion of an interaction term increases the relationship of market capitalization on level of underpricing. Because of the negative sign of the interaction, firms with higher profit levels are downgrading this effect with 1.8%. Concluding, both PROFIT and MARKETCAP show significance on the 10% level and are robust to differences between countries after including the interaction term between both variables. Again, results are presented in Table 8.

TABLE 8. OLS-REGRESSION RESULTS INCLUDING INTERACTION EFFECTS

IFR	(1)	(2)	(3)	(4)
AGE	-.013*	-.013*	-.013*	-.013*
	(.007)	(.007)	(.007)	(.007)
MARKETCAP	-.002	-.003	.231*	.234*
	(.004)	(.005)	(.13)	(.13)
PROFIT	.002	.001	.108*	.109*
	(.019)	(.02)	(.065)	(.065)
TECH	.036**	.036**	.036**	.036**
	(.018)	(.018)	(.018)	(.018)
UNDRW	.034**	.029	.035**	.027
	(.016)	(.023)	(.016)	(.023)
BOOM	.066***	.066***	.066***	.066***
	(.017)	(.017)	(.017)	(.017)
MSCI	.635	.638	.65	.656
	(.706)	(.707)	(.707)	(.708)
INTEREST	-.679*	-.675	-.684*	-.676*
	(.41)	(.411)	(.409)	(.41)
MARKETCAP*UNDRW		.001		.002
		(.006)		(.006)
MARKETCAP*PROFIT			-.018*	-.018*
			(.01)	(.01)
N	2346	2346	2346	2346
R-squared	.09	.09	.091	.091
Country dummies	YES	YES	YES	YES

Table 8 represents regression results on IPOs between 1994 and 2019 issued on the European stock market. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Level of underpricing or initial first-day return (IFR) is calculated by the natural logarithm of first-day closing price divided by initial offer price. Data from Thompson One, Eikon Datastream and Zephyr. All standard errors are robust. Variable descriptions can be found in Table 3. Interaction terms are based on the correlations between the relevant variables (Table 5).
*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Appendix E shows results of the additional robustness check. Table 15 shows results of the regressions including operating revenue as explanatory variable in the place of profits. As said, PROFIT is a highly volatile variable and needed some adjustments before it could be included in the model. Revenues[17] do not have these issues and is therefore used as replacement for profits to be able to compare the results on both variables and indicate which variable is the most relevant to analyze as measurement for company performance. All coefficients for PROFIT (without interaction effects) are not significant (see Table 6). Hence,

[17] The alternative explanatory variable REVENUE is measured by the natural logarithm of the operating revenue of the company in the year before the IPO took place (see Table 3). Regression results are shown in Appendix E, Table 15.

operating profit is not seen as the best explanator of the level of underpricing. Appendix E shows that REVENUE is significant on the 10% level when not controlled for the country dummy variable. When cross-country differences are added the effect is not significant anymore. Operating revenue is a relevant addition to the model, as it explains a part of the IPO underpricing when not controlled for country differences. Although the coefficient is very low (0.005), a significant effect is found. The results are relevant, as PROFIT showed no significant effects on its own. Moreover, company performance can also be measured by operating revenues, which does have a significant influence on the level of underpricing. Operating revenue is a better explanator for IPO underpricing compared to operating profits, although it has a very small effect on the dependent variable and is not robust to cross-country differences and disregarding interaction effects. Through the variable REVENUE, historical company performance has at least a small influence on the level of underpricing.

4.4 Hypotheses analyses

The analyses of the hypotheses are based on all regression results in Tables 6, 7 and 8. All hypotheses are summarized in Table 1. Hypothesis 1 suggested a negative relationship between firm age and the level of underpricing, mainly because older firms face less uncertainty. Hypothesis 1 is supported based on the OLS-regression model presented in Table 6, as firm age is significantly negative on the 10% level in the most relevant model 11. This means that older firms have significant lower levels of IPO underpricing than younger firms. The signaling theory of Engelen & Van Essen (2010) and uncertainty theory (Beatty & Ritter, 1986) are supported by this evidence. Hypothesis 2 suggested a negative relationship between market capitalization (after IPO issue) and initial return. This hypothesis is not supported as the coefficient of market capitalization is positive in the regression results including interaction terms. In the OLS-regression model (Table 6) the coefficient is significant on the 5% level, but not robust to cross-country differences. However, when an interaction effect with operating profits, one of the other independent variables, is included, the effect of market capitalization became positive and showed significance on the 10% level. The negative coefficient of the interaction effect is significant, meaning that the positive effect of market capitalization is negatively affected by the profits of the firm. These effects are also robust to cross-country differences. All things considered; the results are not supporting hypothesis 2. There is no evidence in favor of the uncertainty theory (Beatty & Ritter, 1986 ; Habib & Ljungqvist, 2001). Oppositely, our results support the signaling theory of Allen & Faulhaber (1989). Our results insinuate that market capitalization is positively related to IPO underpricing. In line with this, Allen & Faulhaber argued that big firms with high levels of market capitalization wield underpricing as a signal for good-quality. Hypothesis 3 suggested a positive relationship between historical profits and level of underpricing. The original OLS-regression model (Table 6) showed no significant effects for the explanatory variable PROFIT. However, when an interaction term with market capitalization was included, the effect of historical profits on initial first-day return became significant. Both the interaction term and the singular coefficient of PROFIT are significant on the 10% level in model 4 of Table 8. This means that there is a positive relationship between historical profits and level of underpricing, but that this relationship is negatively influenced by the market capitalization of the firm. The results show evidence with respect to the litigation risk hypothesis, as firms with high profits are assumed to have more liquidity in the company to insure themselves against litigation risks (Lowry et. al, 2002). An annotation must be made about the fact that the effect of historical profits on level of underpricing depends on the effect of market cap on historical profits. Profit is used as measurement for economic performance of the company, but as said, showed no significant effects in the original model. Therefore, a robustness check with another measurement for economic performance was included, namely historical revenues. Revenues showed a small significant positive effect on initial first-day return, but was not robust to the country dummy effect (see Appendix E).

Hypotheses 4 predicted that firms with a high level of technology had significantly higher levels of underpricing than low-tech firms. This implication is based on the information production model of Chemannur (1993). The OLS-regression results in Table 6 reveal that high-tech issuing firms were significantly underpricing their shares with 3.6% more than low-tech issuing firms. Consequently, IPO underpricing was significantly more present in high-tech industries compared to low-tech industries. Hypothesis 4 and the information production model are supported by these research results. Hypothesis 5 implies a positive relationship between underwriter ranking and the level of underpricing. This hypothesis was formulated based on the theory of Loughran & Ritter (2004). They found that issuing firms rely their choice for a certain underwriter on coverage by analysts. High-ranked underwriters demand higher fees, which could lead to lower share prices as indirect underwriter fee. The OLS-regression results in Table 6 present a significant positive effect of underwriter ranking on level of underpricing. However, when controlled for the endogeneity bias in a 2SLS-regression model the significance of the coefficient disappears, see Table 7. As a consequence, the hypothesis can not be supported. There is no undisputed evidence in favor of the changing issuer objective function model and the analyst lust hypothesis (Loughran & Ritter, 2004). Hypothesis 6 suggests that IPO underpricing is higher during periods with many IPO issues (hot market periods or IPO boom periods) than in periods with relatively few IPO issues (cold market periods). This statement is supported by the findings of the OLS-regression model in this study, presented in Table 6. The level of underpricing was on average 6.6% higher during IPO boom periods, with the coefficient being significant on the 1% level. Figure 1 partly supports these implications, because from 1998 to 2000 many initial public offerings took place while at the same time initial first-day returns were high. Accordingly, hypothesis 6 is supported. The results are in line with the theory of hot and cold market periods, historical empirical findings and the signaling theory of Allen & Faulhaber (1989). The latter theory argues that firms signal their high-quality by coming to the market in clusters, which is a signal that a particular industry is doing well. Hereby they try to attract investors to the IPO, while also alluring them with relatively low prices and high initial returns.

Concluding, hypothesis 1, 3, 4 and 6 are supported. Hypothesis 2 and 5 are not supported, but for hypothesis 2 the opposite effect is found to be significant and therefore supported.

5. Conclusion and discussion

5.1 Interpretation of the results

The results of this research are based on the European IPO market during the sample period 1994-2019, and can be compared to the mostly American based findings in historical literature. The results for firm age are supporting earlier findings, as a difference in the age of the firm of one year is causing the older firms to be significantly less underpriced by 1.3% on average. Loughran & Ritter (2004) found similar evidence for American IPOs, based on the theory that older firms are related to lower uncertainty levels. Older firms represent a stable position in the market and have high amounts of information available, such that investors are more certain about the share performance of these older firms. Therefore, investors are on average demanding lower prices for younger (uncertain) firms and initial returns are higher amongst recently founded companies (Engelen & Van Essen, 2010). Our results in Table 8 suggest that market capitalization is positively related to IPO underpricing, which is contradicting to hypothesis 2. The signaling theory of Allen & Faulhaber elaborates that bigger firms are more able to bear the costs of underpricing than smaller firms and use underpricing as a signal for good-quality, which could be an explanation for our findings. This theory is supported by earlier research results (Bundoo, 2007 ; Sohail & Raheman, 2011 ; Welch, 1989). Anyhow, as the signaling theory of Allen & Faulhaber is not supported by the results for firm age, this theory is not seen as a dominant theory in the research field of European IPOs. The litigation risk hypothesis is supported by our results, but only after including an interaction term of profits times market cap. Lowry et. al (2002) suggested already that high-profit firms are, because of their excess liquidity in the company, able to bear the cost of underpricing to ensure against litigation risks. As the risk of being sued is higher for American firms compared to European firms, it is interesting to see that European firms also might use the underpricing-strategy to face less litigation risks (Jenkinson, 1990 ; Welch, 1989). Important to note is that the market capitalization of the companies is lowering the effect of profits. One could expect that bigger firms are expected to have higher profits, but this was not the case in our sample. Overall, the litigation risk hypothesis of Lowry et. al (2002) based on American IPOs is also supported using European data. Hypothesis 4 was established on insider traders bringing insider information to the market, using the information production model. This theory of Chemmanur (1993) is supported by the OLS-regression results in Table 6. Insiders demand a compensation for the ‘information production’, which could be underpriced shares. As high-tech companies have more detailed and comprehensive information, it is often only available for insiders. This leads to the conclusion that firms in high-tech industries are more engaged in underpricing strategies than low-tech firms. Moreover, historical findings based on American data are supported by our research results for European IPOs. The predicted relationship between underwriter reputation and initial first-day return was not found in this research. The effect was not robust to the endogeneity effect, shown in Table 8. In line with what Habib & Ljungqvist (2001) thought, the variable underwriter reputation experienced the endogeneity bias. Consequently, the results are not supporting the changing issuer objective function model, the analyst lust hypothesis (Loughran & Ritter, 2004) and historical US-based research findings of Cliff & Denis (2004). No alternative theories on underwriter reputation related to the level of underpricing are supported, since no significant effect was found at all in the 2SLSregressions. The European IPO market behaves not in line with the American IPO market here. Choosing a reputable underwriter is not leading to higher or lower levels of underpricing in the European IPO market, and the presence of a prestigious underwriter is not a useful signal for investors to build on when deciding whether or not to buy the share. The theory of hot and cold market periods can be seen as the most dominant theory analyzed in this research. The positive coefficient of the BOOM dummy was significant on the 1%-level in the OLS-regression model (Table 6). Although the t-test in Appendix B tells us that the level of underpricing was significant over the whole sample period, when an IPO took place during a hot market period the level of underpricing was on average 6.6% higher. This means that firms came to the market in clusters, setting low prices as a signal for high-quality and to attract investors (Allen & Faulhaber, 1989). The 'Internet-bubble' of 1998-2000 can be seen as a positive market shock, which leads to a hot market period. This is in line with the expectations of Ritter (1984). Historical literature corresponds to our results, which could be managed by investors. When a period of IPO-booming occurs, investors are expected to have high initial profit possibilities. An advice to investors could be to buy European IPO shares during a future IPO-boom. High market-cap, high-profit and younger firms could also be useful indicators for investors to buy an IPO share.

5.2 Limitations and recommendations

Limitations of this research must be considered in the analysis. The first limitation is the measurement of the explanatory variable PROFIT. The variable needed some adjustment, as the mean must be added up to all values to be able to take the natural logarithm. A recommendation for further research could be to include another measurement for company performance. Although we tried this already by replacing historical profits by operating revenue in a robustness check, ratios are maybe also good alternatives. For example, quick ratio or book-to-market ratio combines multiple figures for one company such that it is more a company-specific variable. Profits are often highly volatile and can vary from year to year. Another limitation is that this research only takes into account the short-term stock performance. A proposal for future research is to include SEO's and analyze the stock performance over the (middle-) long term. This could give insights about long-term strategies of firms and underwriters, as underpricing could be part of a strategy of multiple share offers following the IPO. Another recommendation for further research could be to include all separate industries instead of only the separation of high-tech and low-tech to analyze which industries stand out in terms of IPO underpricing. A categorical dummy variable, like the country dummy in this research, could provide this separation of detailed industries easily. A possible improvement of the model is to use an alternative instrumental variable in the 2SLS-regression model. Logged assets is used as instrumental variable to check for the endogeneity of underwriter reputation. Logged assets is the best available estimator, according to Akkus et. al (2013) and Habib & Ljungqvist (2001). It is seen as a relevant addition to the research, as the t-statistic is relatively high (T = 4.27) and the coefficient of logged assets in the 2SLS-regression is significant on the 1% level. However, checking for multiple or alternative instrumental variables could be relevant to check if logged assets is indeed the best available estimator. The R-squared of all relevant models is around 0.09. This means that information asymmetry theories are explaining roughly 9% of the IPO underpricing. This leaves room for other theories to be examined in the light of IPO underpricing. For example, the effect of behavioural theories, managerial conflicts and/or institutional economics on IPO underpricing could be interesting for future research. Asymmetric information theories are explaining a small part of the underpricing, which makes it interesting to investigate if other theories are more dominant in the European IPO market over the last couple of decades. A last recommendation could be to include specific MSCIeurope index returns and interest rates for all different countries. The overall MSCIeurope index return and interest rate in Europe do not take differences between different exchange markets within Europe into account. The improvement of the model could be to include the index return and the interest rate on the IPO date of the particular country or market where the IPO is exchanged on. Altogether, this research provides some relevant research results about underpricing on the European IPO market between 1994 and 2019. On the other hand, enough space is left open for future research to explore things from a different perspective and improve the analysis.

5.3 Overall conclusion

This research investigated the effect of information asymmetry theories on IPO underpricing. The goal of the research was to determine to what extent information asymmetries are the reason behind IPO underpricing and to prove which are the dominant theories within this field. Six hypotheses were formulated based on historical literature to investigate which theories are supported by the results. Overall, 9% of the IPO underpricing is due to information asymmetries, based on the R-squared of our models. This research provides new insights on the European IPO market between 1994 and 2019, while most literature is based on American data. The findings are supporting a couple of theories in line with earlier results on American stock data. The most relevant asymmetric information theory in this research is the theory on hot and cold market periods, as the results on the IPO-boom dummy are significant on the 1% when controlled for cross-country differences. The level of underpricing is significantly higher during IPO-booming periods. Allen & Faulhaber (1989) explained that this could be a useful signal for investors, as they can elaborate profit opportunities when firms are going public in clusters. The high demand for IPO shares is combined with low-price offers and on average high initial returns. The results on firm age and underpricing are not supporting the theory of Allen & Faulhaber, concluding that this theory is not the dominant asymmetric information theory in the field of IPO underpricing. The findings are that older firms on average are less underpriced than recently founded companies, supporting uncertainty theory (Beatty & Ritter, 1986). On the other hand, hypothesis 2 is not supported which is diminishing the power of uncertainty theories. Furthermore, evidence is found on the litigation risk hypothesis (Lowry et. al, 2002) and the information production model (Chemmanur, 1993). Both historical profits and technological level are positively related to the amount of money left on the table. The coefficients are significant on the 10% level and the 5% level respectively, making the theories relevant but not the most dominant. No evidence is found in favor of the changing issuer objective function model and the analyst lust hypothesis, as the results are not robust to the endogeneity of the underwriter reputation. The 2SLS-regressions showed that the endogeneity bias was present in our model, in line with Loughran & Ritter's (2004) research on the American IPO market. Noteworthy is that the research of Welch (1989) is convincing in the light of our results. Welch (1989) suggested that only certain companies can bear the cost of underpriced share offers, such as high-profit companies, young firms or relatively big firms with high market capitalization. All these effects are consistent with our findings, since the named categories all had a positive relationship with initial first-day return. Investors can use this in their favor, as certain company characteristics could be indicators of profit opportunities.

At the end, the theory of hot and cold market periods is the most relevant information asymmetry theory in explaining IPO underpricing. This research also provides evidence on the litigation risk hypothesis and the information production model, but these theories are less dominant. Evidence of Welch (1989) about the American IPO market is again found for the European data sample. The biggest limitation of the research is the fact that only a small part of the underpricing is caused by our explanators in the model. Therefore, asymmetric information theories are not the only relevant explanation of IPO underpricing. Interesting for future research is to elaborate these other theories, next to the long-term price evolution and issuer-strategies. Theories to exploit in future research are behavioural sentiments amongst investors, strategical decision making of investors or issuers and institutional differences affecting long-term stock performance. IPO underpricing could be part of a long-term strategy by issuers and underwriters, which could be influenced by these theories and also affecting investor choices. Interesting to examine is how share prices differ from IPO's to later SEOs and if there are theories behind these differences. Moreover, the research on long-term share price development and the influence of information asymmetries could be fascinating, next to the elaboration of the above-named other theories and their influence on IPO underpricing and SEO-price development. A strength of the research is the broad timeframe with a large data sample of more than 2300 IPO's. The research results are contributing to the American-based literature, because well-known theories, such as the dominant theory on IPO-booms, are also relevant in the modern European IPO market.

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Appendix A. VIF-Test

TABLE 9. VIF TEST STATISTICS

Variables	VIF	1/VIF
BOOM	1.390	0.717
INTEREST	1.390	0.719
MARKETCAP	1.250	0.801
PROFIT	1.170	0.854
UNDRW	1.100	0.906
AGE	1.050	0.954
TECH	1.040	0.959
MSCI	1.010	0.995
Mean VIF	1.180	

Appendix B. T-Test for IFR

TABLE 10. ONE SAMPLE T-TEST FOR IFR

	N	Mean	St. error	t-value	p-value
IFR	2346	.098	.008	12.51	0.000

Appendix C. Tests for heteroskedasticity

TABLE 11. BREUSCH-PAGAN TEST

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance Variables: fitted values of IFR chi2(1) = 67.54 **Prob > chi2 = 0.0000**

TABLE 12. SQUARED RESIDUALS ANALYSIS

resid2	(1)
yhat	0.301
	(0.715)
yhat2	2.668
	(3.584)
Constant	0.0818**
	(0.0343)
Observations	2,346
Prob>F	**0.0003**
R-squared	0.007

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 13. WHITE-GENERAL TEST

White's test for Ho: homoskedasticity against Ha: unrestricted heteroskedasticity chi2(41) = 77.51 **Prob > chi2 = 0.0005**

Conclusion:
All probabilities are very close to zero. This could be evidence for the presence of heteroskedastic data. Robust standard errors must be included to test if this is an improvement of the model and its estimators.

Appendix D. Original OLS-regression results

TABLE 14. ORIGINAL OLS-REGRESSIONS WITHOUT ROBUST STANDARD ERRORS

IFR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
AGE	-.017**						-.017**	-.017**	-.017**	-.017**	-.013*
	(.007)						(.007)	(.007)	(.007)	(.007)	(.007)
MARKETCAP		.006					.007*	.007*	.006	.006	-.002
		(.004)					(.004)	(.004)	(.004)	(.004)	(.005)
PROFIT			.018				.021	.021	.023	.022	.002
			(.022)				(.023)	(.023)	(.023)	(.023)	(.024)
TECH				.043**			.038**	.038**	.038**	.038**	.036**
				(.017)			(.017)	(.017)	(.017)	(.017)	(.017)
UNDRW					.024		.018	.018	.019	.018	.034*
					(.016)		(.017)	(.017)	(.017)	(.017)	(.018)
BOOM						.049***	.048***	.048***	.061***	.06***	.066***
						(.016)	(.016)	(.016)	(.019)	(.019)	(.019)
MSCI								.641		.617	.635
								(.759)		(.76)	(.758)
INTEREST									-.655	-.645	-.679
									(.495)	(.495)	(.496)
Constant	.139***	.078***	-.135	.085***	.088***	.07***	-.198	-.197	-.205	-.204	
	(.019)	(.014)	(.282)	(.009)	(.01)	(.012)	(.3)	(.3)	(.3)	(.3)	
N	2346	2346	2346	2346	2346	2346	2346	2346	2346	2346	2346
R-squared	.002	.001	0	.003	.001	.004	.011	.012	.012	.012	.09
Country dummies	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES

Table 14 represents regression results on IPOs between 1994 and 2019 issued on the European stock market. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Level of underpricing or initial first-day return (IFR) is calculated by the natural logarithm of first-day closing price divided by initial offer price. Data from Thompson One, Eikon Datastream and Zephyr. All standard errors are non-robust. Variable descriptions can be found in Table 3.
*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.

Appendix E. Additional robustness check

TABLE 15. REGRESSION RESULTS WITH REVENUE REPLACING PROFIT

IFR	(1)	(2)	(3)	(4)
REVENUE	.004	.004*	.005*	.002
	(.002)	(.003)	(.003)	(.003)
AGE		-.015**	-.015**	-.011
		(.007)	(.007)	(.007)
MARKETCAP		.005	.004	-.004
		(.003)	(.003)	(.004)
TECH		.04**	.041**	.039**
		(.017)	(.017)	(.017)
UNDRW		.018	.018	.034**
		(.015)	(.015)	(.015)
BOOM		.045***	.059***	.065***
		(.015)	(.017)	(.017)
MSCI			.512	.53
			(.699)	(.693)
INTEREST			-.776*	-.786*
			(.414)	(.417)
Constant	.055**	.025	.037	
	(.027)	(.03)	(.029)	
N	2342	2342	2342	2342
R-squared	.001	.011	.012	.089
Country dummies	NO	NO	NO	YES

Table 15 represents regression results on IPOs between 1994 and 2019 issued on the European stock market. Closed-end funds, unit issues, issues with an offer price below $5.00, financials, utilities, outliers and missing values are excluded. Level of underpricing or initial first-day return (IFR) is calculated by the natural logarithm of first-day closing price divided by initial offer price. Data from Thompson One, Eikon Datastream and Zephyr. All standard errors are robust. Variable descriptions can be found in Table 3.
*** Significant at the 1% level. ** Significant at the 5% level. * Significant at the 10% level.