

# Underpricing, explained by ex-ante uncertainty

By,

Thijs van Rijn

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Supervisor: Drs. Siraj Zubair



Radboud Universiteit Nijmegen

Nijmegen

## Abstract

This paper examines the influence of ex-ante uncertainty about the intrinsic value of the stock on the underpricing of the IPO's of US companies. The model of K. Rock extended by R. Beatty and J. Ritter (1986) and the model of D. Baron (1982) argue that ex-ante uncertainty about the intrinsic value of the stock causes underpricing of an IPO. These models are tested by developing different proxies of ex-ante uncertainty among the intrinsic value of the stock, i.e. the market capitalization of the company, the reputation of the underwriter, the age of the company, the R&D expenditures of the company and the issue size of the IPO. The research consists of 435 US IPO's from January 2014 until April 2016. The results suggest that all the proxies do have a significant effect on the level of underpricing although they do not all have the expected effect. Therefore, it is possible to conclude that the model of K. Rock (1986) extended by R. Beatty and J. Ritter (1986) and the model of D. Baron (1982) do not hold for this time period in the United States.

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## 1. Introduction

Underpricing is a common-known phenomenon and it has been of great interest for the researchers in the area of financial economics. Underpricing is a stock market anomaly. The anomaly occurs during an IPO (Initial Public Offering), when the first offered price is below its intrinsic value (Beatty, R. & Ritter, J. 1986). An IPO is a first sale of stock by a private company to the public (Bradley, D. et al. 2001). Every year, a lot of firms approach the capital market for the first time. These are often small firms who are growing fast. To fuel their growth, traditional fund raising options, such as owners' own equity and bank loans are not sufficient to finance their expansions, thus they need to find financial capital from the public market. By going public, these companies try to raise equity finance to enlarge their growth opportunities (Saunders, A. 1990). To raise the maximum possible amount of equity, it is important that the initial offer price of the shares reflect the intrinsic value of the assets (i.e. the true value based on the underlying perception of its actual value including, all aspects of the asset) of the company (Jenkinson, T. & Ljungqvist, A. 2001). If the initial offer price is set too low, lower than the intrinsic value of the assets, the company has raised less money than was possible. In other words, their shares were *underpriced* (Saunders, A. 1990).

According to C. Barry and R. Jennings (1993) underpricing refers to the price increase of the IPO on the first day of trading. The first-day closing price represents the investors' willingness to pay for the offered shares. The law of demand and supply will move the price of the stock towards its intrinsic value. This is because of that the demand for underpriced stock increases. The price of the underpriced stock will increase until the price of the stock is equal to its intrinsic value. If the stock is initially overpriced, the supply of the stock will be higher than the demand of the stock. The price of the stock will decrease until the price is equal to its intrinsic value. Traders respond really fast to the mispricing of a stock so the price of the stock usually moves to its intrinsic value on the first day of trading (Tian, L. & Megginson, W. 2007). The amount of underpricing is calculated by calculating the difference between the initial offer price and the price at the end of the first day of trading. If there is a significant increase in the share price on the first day of trading, the stock is underpriced. (Tian, L. & Megginson, W. 2007). According to P. Clarkson and J. Merkley (1994) there is a growing evidence that proves that US IPO's are on average underpriced. According to findings of T. Loughran and J. Ritter (2002), the average first-day return on US IPO's were 7% in the 1980's, almost 15% from 1990 to 1998 and during the years of the internet bubble, 1999-2000 around 65%. After the internet bubble, the underpricing was on average 12,1% (Ritter, J. 2014). It is clear that these

percentages of underpricing exceed the reasonable market risk premium. The market risk premium is the extra required return on top of the risk free rate on an investment by an investor for taking a particular risk (Domowitz, I. & Hakkio, C. 1985). If the first day return on a stock exceeds the market risk premium, the stock is underpriced (Clarkson, P. & Merkley, J. 1994).

A famous example of underpricing is the initial public offering of LinkedIn in 2011 (Blodget, H. 2011). The first day return on the stock of LinkedIn was about 90 percent. The initial offer price was 45 dollar, after 1 day of trading the share price was 85 dollars. This means that the underwriters of the IPO, in this case Morgan Stanley and the Bank of America, offered the stock of LinkedIn for a too low price to its clients. An underwriter is a bank or a company who takes care of the IPO of a company (Ellis, K. et al. 2000). The underwriter determines the initial offer price of the stock by closely working together with the issuing company. After determining the initial offer price the underwriter buys the stock from the issuing company and tries to sell them to its network of clients (Ellis, K. et al. 2000). The heavy underpricing of the IPO of LinkedIn, ensured that the clients of the underwriters, mostly institutional investors, made a gain of 90% on the first day of trading of the stock (Blodget, H. 2011). The board of LinkedIn was probably very satisfied about the “successful” first day of trading. But in fact, it implies that LinkedIn left around 40 dollar per share on the table. If the initial offer price of the stock was set on its intrinsic value, LinkedIn would have raised 3 billion dollars more (Baldwin, C. 2011). The board of LinkedIn may find the IPO successful because they raised the targeted amount of money but in fact, the IPO could have been more successful if the shares were priced appropriately.

Given the fact that underpricing is an interesting and widely studied stock market anomaly, it is important to know the factors which may influence underpricing. The most prominent models which try to explain underpricing are the winner’s curse model of K. Rock (1986) which is extended by the ex-ante uncertainty hypothesis by R. Beatty and J. Ritter (1986) and D. Baron’s (1982) model. The model of K. Rock (1986) and R. Beatty and J. Ritter (1986) argues that ex-ante uncertainty between uninformed and informed investors causes companies to underprice their IPO’s. D. Baron’s (1982) model argues that ex-ante uncertainty between the underwriter of the IPO and the issuing company causes underpricing. Ex-ante uncertainty is here defined as uncertainty about the intrinsic value of the stock when a company goes public (Clarkson, M. & Merkley J. 1994). This will also be the definition of ex-ante uncertainty in this paper.

The most important implication following from these models is that ex-ante uncertainty about the intrinsic value of the stock increases the degree of underpricing (ex-ante uncertainty

between informed and uninformed investors or between underwriter and the issuing company). Thus, the interest is emerged to investigate whether ex-ante uncertainty among the intrinsic value of the stock has an actual influence on IPO underpricing. Hence, the following research question is being formulated:

*Does ex-ante uncertainty about the intrinsic value of the stock lead to underpricing of the IPO of US companies between January 2014 and April 2016?*

The reason for the choice of US companies is because of the broad availability of data over the last decades on US IPO's and because the US is one of the largest and one of the leading economies in the world. The reason for the choice of the time period is because the purpose of the research is to make conclusions about the current IPO-market. The more recent the dataset is, the more applicable are the conclusions to the current IPO-market

Why would answering the mentioned research question be interesting and what is the added value of this research? At first, this thesis will investigate whether US companies experience underpricing of their IPO's and if underpricing is evident, then by how much they were underpriced. As already mentioned earlier, there are researchers who found evidence that US companies on averaged underpriced their stock in the eighties, nineties and from 2000 onwards (Ritter, J. 2014). However, we have a lack of recent evidence in this realm. Due to change in behavior of issuing companies, investors or underwriters, it is possible that the level of underpricing has been changed during the last years. After the global financial crisis, companies, investors and underwriters became more risk-averse (Schuknecht, L. et al. 2010). Possibly this has an effect on the IPO-market. If there is evidence that US companies on average experience underpricing on their assets, this fact will be a contradiction to the efficient-market hypothesis (Malkiel, B. 1992). According to Fama (1965) is an efficient market a "market where prices at every point in time represent best estimates of their intrinsic value. This implies in turn that, when an intrinsic value changes, the actual price will adjust "instantaneously", where instantaneously means, among other things, that the actual price will initially overshoot the new intrinsic values as often as it will undershoot it" (Fama, 1965, p. 94). So in an efficient security market, stock prices fully reflect all available information. If there is evidence that IPO's of US companies are on average underpriced, it will be possible for investors to make a gain by buying stock when it is initially offered and sell the stock at the end of the first day of trading (Malkiel, B. 1992). By knowing this, it is interesting for investors, and in particular institutional investors, to know what kind of companies on average underprice their assets (Chemmanur, T. & Hu, G. 2006). It is particularly interesting for institutional investors because institutional investors have an important relationship with underwriters and are typically the

most important clients of an underwriter when selling initially offered shares to the public (Chemmanur, T. et al. 2009).

J. Alexander (1993) did research on how much an investor could gain if he would only invest in IPO's. He found that US companies between 1980 and 1987 on average underpriced their asset about 16,09%. He claimed that if an investor would have invested 1000 dollars in each IPO during 1980-1987 and sold them after one day of trading, the investor would have made a gain of 698.840 dollars between 1980 and 1987. So if investors know what kind of companies on average face underpricing of their stock, investors have the ability to make even more gains on investing in IPO's. Thus, it is very interesting for investors to know what kind of companies underprice their assets the most. For example, if the results of the regression analyses suggest that the IPO's of small companies are more underpriced than the IPO's of large companies, an investor would make more gains while buying only stock issued by small companies. Thus, this study aims to draw advice for investors so that they can increase their profits when investing in IPO's. If this research succeeds in finding significant results, it is possible to ultimately write an advice for investors on whether they have to invest in old or young companies, IPO's governed by an underwriter with a high reputation or a low reputation, a company with R&D expenditures or not, a large or a small company and a large or a small issue to increase the probability of high returns.

Another reason why it is interesting to answer this question is because of the missed capital gains for the issuing company when the IPO is underpriced. The missed capital gains of an underpriced stock is the difference between the intrinsic value of the stock (i.e. the maximum amount the company could ask for the stock to have a succesful IPO) and the initial offer price. Because of underpricing of IPO's in the last 50 years, US companies missed in total more than 150 billion capital gains (Solomon, S. 2011). In the previously mentioned LinkedIn example, the IPO was valued at about \$3 billion dollars but LinkedIn could have raised almost an extra \$3 billion of new capital if the initial offer price was set on its intrinsic value of 85 dollars (Baldwin, C. 2011). This is an extreme case, but it explains the missed gains when US companies underprice their IPOs. So what are the reasons for companies or the underwriter to underprice the IPO? The theoretical framework of this research may give better insights on why companies or underwriters on average underprice their assets and the answer on the research question may give better insights on what kind of companies have an underpriced IPO. Ultimately, at the end of the research it may be possible to give advice to issuing companies on important aspects when pricing an IPO.

The dataset of this thesis consists of 435 US IPO's from January 2014 until April 2016. Looking at research on underpricing in the eighties nineties and from 2000 until 2010 (Ritter, J. 2014), there is a big chance that US companies also on average underprice their assets from January 2014 until April 2016. Different proxies of IPO ex-ante uncertainty will be formulated according to existing theory on ex-ante uncertainty. The selected proxies are the age of the company, the market capitalization of the company, the issue size of the IPO, the R&D expenditures of the company and the reputation of the underwriter. The influence of these proxies on the level of underpricing will be tested by running regression analyses.

The structure of this paper will be as follows: the following section gives an overview of the existing literature. In the literature overview, existing research on the different kind of causes of underpricing will be discussed. From this discussion it will be clear why the relationship between ex-ante uncertainty among the intrinsic value of the issued stock and the level of underpricing will be elaborated further. The relationship between ex-ante uncertainty and the level of underpricing will be elaborated further by explaining the model of K. Rock (1986) and R. Beatty and J. Ritter (1986) and the model of D. Baron (1982). After discussing existing models and the empirical evidence on the relationship between ex-ante uncertainty and underpricing, the addition of this research to existing research can be made clear. In short, the addition of this research is that this time period has not been examined yet. It is possible that a lot has been changed during the last decades. The IPO-market is very dynamic a lot of different conclusions were made regarding the relationship between ex-ante uncertainty and underpricing. By investigating this relationship it is possible to reject or to confirm earlier findings. After the literature overview, proxies of ex-ante uncertainty will be discussed and the corresponding hypotheses will be formulated. After that, the data and the methodology of the research will be described. This will be followed by a number of regression analyses. The results of the regression analyses will be discussed and the hypotheses will be confirmed or rejected. The paper will end with a discussion and a conclusion.

## 2. Literature overview.

The pricing of IPO's has been subjected to much academic debate the last couple of decades. Especially the anomaly of underpricing has been discussed a lot. The debate is especially about what factors cause underpricing. There are a lot of different theories that try to explain underpricing. In this section, first, the definition of underpricing will be elaborated further. Thereafter, an overview of the literature on the factors that have an influence on underpricing will be given. Consequently will be explained why it is interesting to give deeper insights on the relationship between ex-ante uncertainty and underpricing. Existing research on the relationship between ex-ante uncertainty and underpricing will be discussed. The literature overview will end with an explanation of what this research is going to add to existing research.

### 2.1. Underpricing.

To have a good understanding of this research it is important to explain the exact definition of underpricing. It is very common for companies to go public. Small companies who want to grow further and want to expand their business may go public to raise capital to fund their growth. The raised capital can be used to fund capital expenditures, to fund research and development or to pay off existing debt (Beatty, R. & Ritter, J. 1986). There has been an academic debate about the pricing of an IPO in the last couple of decades. Especially about the factors that cause underpricing. This debate is interesting because a lot of researchers have different explanations for the existence of underpricing. The results of this academic debate and the corresponding models will be discussed after this section. Before starting to discuss the most important models and literature on factors causing underpricing it is important to briefly explain what underpricing is.

As already mentioned in the introduction is underpricing defined as the difference between the offering price and the closing bid price on the first day of public trading (i.e. the first day return on the stock) (Beatty, R and Ritter, J. 1986). This is calculated in the following way:

$$\text{Underpricing} = \frac{(\text{First day closing price} - \text{Offer price})}{\text{Offer price}} * 100\%$$

The following graph shows the number of initial public offerings and the average first day returns of US companies from 1980 until 2015.

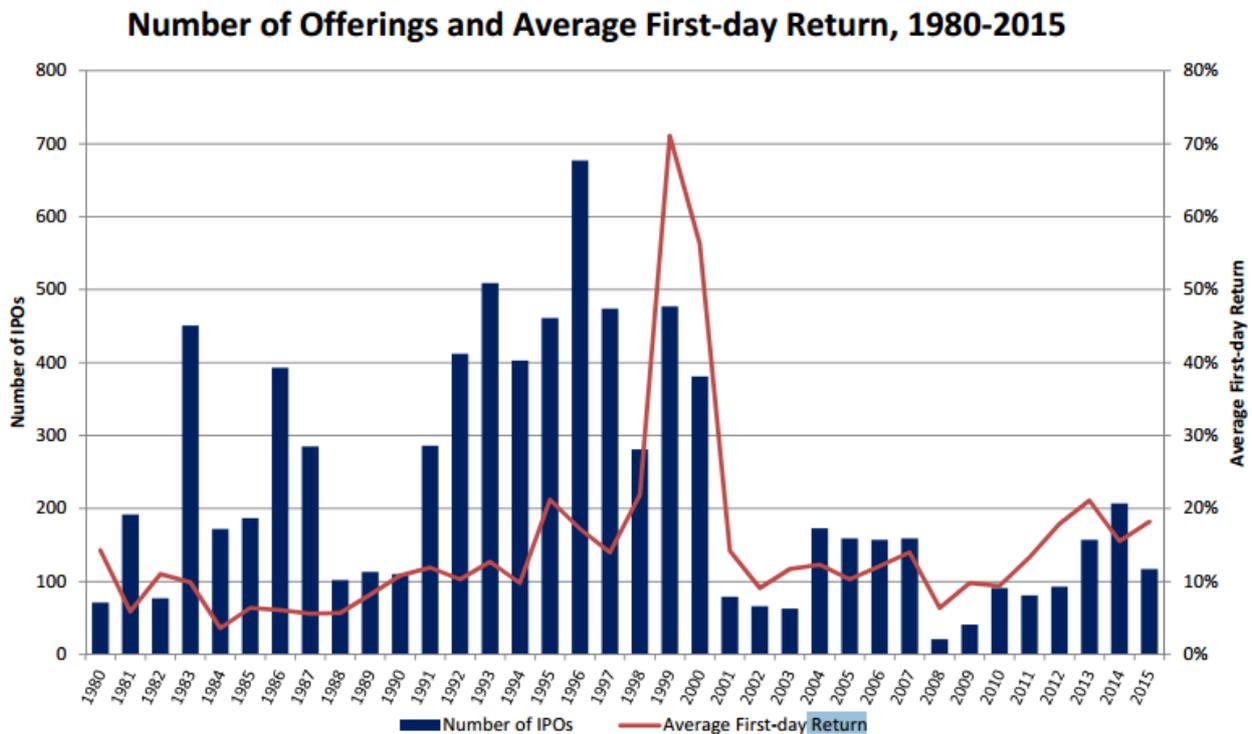


Figure 1. (Ritter, 2016). Retrieved from <https://site.warrington.ufl.edu/ritter/>

## 2.2. Causes of underpricing.

There are academics, for example, J. Ritter, R. Beatty, T. Loughran and K. Rock who devoted almost their entire career on studying the stock market anomaly underpricing. There are multiple researchers who did research on why companies repeatedly go public at a price below the intrinsic value of the stock. So existing literature already provides several explanations for the underpricing of IPO's. In the following section the different explanations of causes of underpricing of IPO's will be discussed.

### 2.2.1. Ex-ante uncertainty.

The first cause of underpricing that will be explained is ex-ante uncertainty. According to J. Ritter (2014) is ex-ante uncertainty the most prominent cause of underpricing. The most prominent models which try to explain the relationship between ex-ante uncertainty and underpricing are the model of K. Rock (1986), and its extension by R. Beatty and J. Ritter (1986) and the model of D. Baron (1982). The model of K. Rock (1986) with its extension by

R. Beatty and J. Ritter (1986) will be discussed first. After that, D. Baron's (1982) model will be discussed.

The model of K. Rock (1986) starts by arguing that information asymmetry causes underpricing. This theory put forth by K. Rock (1986) is known as the Adverse Selection Theory of Underpricing. This model states that information asymmetries among investors are the reason for IPO's to be underpriced. This theory explains underpricing as a competitive outcome in which some investors are considered as the informed investors and a larger group is viewed as the uninformed investors (Saunders, A. 1990). K. Rock (1986) argues that uninformed investors bid without regard to the quality of the IPO because they are uninformed and do not have enough information about the intrinsic value of the stock. In contrast, informed investors bid only on offerings which will give them returns because they do have information on the intrinsic value of the stock. So if there occurs an IPO that is initially overpriced, only uninformed investors will invest and only uninformed investors will lose money (you can see this as the winner's curse<sup>1</sup>). If these losses occur too often, uninformed investors will eventually leave the IPO market. This is a problem for the underwriters because there are not enough informed investors in the market to have a successful IPO when most of the uninformed investors leave the IPO-market. The underwriter solves this problem by starting with a lower opening price to ensure that also uninformed investors stay in the market and buy the stock. This causes underpricing (K. Rock, 1986). So K. Rock (1986) explains underpricing as a kind of reward to uninformed investors for the winner's curse problem. This reward will attract uninformed investors to invest in the IPO market (Folconieri et al. 2007).

R. Beatty and J. Ritter (1986) extend the model of K. Rock (1986) by arguing that the model of K. Rock (1986) implies that ex-ante uncertainty about the intrinsic value of the issue increases the level of underpricing. Following from this, R. Beatty and J. Ritter (1986) argue that if ex-ante uncertainty increases, the winner's curse problem will intensify. So if ex-ante uncertainty among the intrinsic value of the stock increases, the possible share buyer wants to pay a smaller amount of cash for the shares. The issuer of the shares or the underwriter decreases the initial offer price to meet the demands of the buyers because otherwise there is a possibility that too many uninformed investors leave the market and that they are not able to sell all their issued shares. This causes additional underpricing (Clarkson, P. & Merkle, J.).

S. Folconieri et al. (2007) summarize the model of K. Rock (1986) and the extension of R. Beatty and J. Ritter (1986) in the following way: "Rock (1986) interprets underpricing as a

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<sup>1</sup> The winner's curse says that winners of an auction, or in this case the buyers of the stock, often tend to overpay (Kagel, J. & Levin, D. 1986).

premium to uninformed investors for the winner's curse problem they face *vis-à-vis* informed investors, who observe the true firm value. Beatty and Ritter (1986) further develop this idea by claiming that more ex-ante uncertainty aggravates the winner's curse problem and, consequently, requires additional underpricing" (Folconieri et al. 2007. p. 5).

Another prominent model which explains underpricing, is a model developed by D. Baron (1982). In this model the issuer delegates the pricing decision of the stock to an underwriter. Almost every issuing firm delegates the pricing decision and the pricing process of the stock to an underwriter. Very few companies will process the IPO by themselves (Fabrizio, S. 2000). In this model, the underwriter has more information on the pricing conditions in capital markets than the issuing firm (Baron, D. 1982). Because the issuer of the stock cannot perfectly observe the effort of the underwriter, the model predicts that underwriters have the tendency to underprice the IPO so that they can sell the stock more easily to the market. In this way the underwriter minimizes his selling effort and maximizes the probability of successful offering (Huang, Q. & Levich, R. 1998). Due to the enhanced value of the expertise of the underwriter, will greater uncertainty on the value of the stock lead to greater underpricing. So D. Baron's (1982) model shows us that asymmetrical information between the underwriter and the issuer leads to underpricing of the stock (Soana, M. & Regalli, M. 2010). This asymmetric information refers to uncertainty about the intrinsic value of the stock. So this model also predicts that an IPO will be more underpriced if there is more ex-ante uncertainty about the intrinsic value of the stock. This is because ex-ante uncertainty about the intrinsic value of the stock gives the underwriter the ability to underprice the IPO. (Loughran, T. & Ritter, J. 2001).

### 2.2.2. Litigation-risk hypothesis.

The Securities Acts of 1933 and 1934 give investors the right to start a lawsuit against an issuing firm if the price of the offered stock is set according to wrong information. Investors who end up with highly overpriced stock may have the incentive and have the possibility to sue the company and the underwriter for providing incomplete or misleading information (Saunders, A. 1990). For a firm who is planning to go public, the potential costs of litigation is an important cost factor to take into consideration. The settlement payment is the highest cost of litigation, which is on average 11% of the total proceeds raised with the IPO (Lowry, M. & Shu, S. 2002). This, of course varies among companies. Other examples of litigation costs are reputation costs of both the issuing firm and its managers, legal fees and the opportunity cost of the time dedicated to the lawsuit (Lowry, M. & Shu, S. 2002).

Because of costly litigation, companies want to insure themselves against these costs. The best way for companies to insure themselves against these costs is to lower the probability of being sued i.e. lawsuit avoidance (Alexander, J. 1993). This is the reason why all companies conduct due diligence before the IPO. However, it is not possible to perfectly predict what in the future will happen. Another way to lower the probability of being sued is to lower the probability that investors suffer losses on their investment. According to J. Alexander (1993), the probability of being sued has a strong correlation with the first-day returns on the IPO. If the first day return is negative, the probability of being sued is of course higher than if the first day returns are positive. For this reason, underpricing is a tempting way to lower the probability of being sued by investors. An issuing company that underprices its stock by a greater amount has a lower probability of getting sued and has lower potential damages. So an underwriter may underprice the IPO just to keep the investors happy and to reduce the probability of being sued after the IPO (Saunders, A. 1990). For companies, underpricing is a particularly attractive form of insurance against litigation costs (Lowry, M. & Shu, S. 2002).

Tinic (1988) provides evidence for the relationship between litigation costs and underpricing. He took a sample of 70 IPO's between 1923 and 1930, before the formation of Securities Act of 1933, and compares the findings to a sample of 134 IPO's between 1966 and 1971. He finds that IPO's were less underpriced in the period before the implementation of the Securities Act of 1933. K. Hanley and G. Hoberg (2011) investigated this further and also found evidence that issuing companies underprice their stock as potential hedges against litigation risk.

### 2.2.3. Signalling.

F. Allen and G. Faulhaber (1989) designed a model which explains the underpricing of IPO's by means of signalling of the issuing company. This signalling model contains two different types of firms: low quality firms and high quality firms. They assume that the prospects of the company are best known by the company itself. They explain that good firms, with good prospects, want to signal investors about their good prospects. They may signal this to their investors by setting a low IPO price. According to I. Welch (1979), bad companies do not have the ability to underprice their stock because they cannot take a loss that results from underpricing. Also, Ibbotson (1975) argues that underpriced IPO's 'leave a good taste in investors' mouth'. This good taste gives an issuing company the possibility to sell future IPO's at attractive prices because investors' uncertainties about future IPO's of the company are decreased. According to Fabrizio (2000), this does not mean that uncertainty about the state of

the firm is completely excluded, but it does increase the probability that a firm gets evaluated as a good firm by investors. So companies underprice their IPO's to increase the probability that investors will think positive about the future of the company and to increase the probability that a seasoned equity offerings (SEO) can be issued at better terms. A SEO is a new equity issue of a company which is already publicly traded (Cornanic, A. & Novak, J. 2013).

#### 2.2.4. Behavioral explanations.

There exist several different behavioral explanations on the existence of underpricing. A behavioral explanation of I. Welch (1992) is that when IPO shares are sold sequentially, potential investors can get influenced by the purchasing decisions of earlier investors. I. Welch (1992) argues that this can create a 'cascade' in which later investors totally ignore their own information and just imitate the buying decisions of earlier investors. According to this situation, demand of the stock gets very elastic. Due to the increase of demand elasticity does the probability of failure of selling all the IPO shares increase. Even risk-neutral underwriters will underprice the stock to make sure that there will be enough buyers for the IPO stock (Welch, I. 1992).

Loughran and Ritter (2002) have another behavioral explanation for the underpricing of IPO's. They provide a theory where they stress out a behavioral bias among the decision-makers of the issuing firm. They argue that the issuers of the stock tend to sum the loss of wealth due to underpricing with the gain of wealth on retained shares as prices jump after the IPO. This gain is often almost equal to the loss, so the issuing company does not have a problem with an underpriced IPO.

Ljungqvist et al. (2004) were the first who introduced the importance of investor sentiment in the underpricing phenomenon. They show that underpricing can be explained by the presence of sentiment investors. Also, Campbell et al. (2008) find that underpricing is positively correlated to investor sentiment. Investor sentiment is the theory of how investors form their beliefs and trade on the basis of noise (Ljungqvist, A. et al. 2004). Investors who trade on the basis of noise (i.e. investors who make decisions regarding buying or selling stock without using fundamental data) will trade even if rationality suggests that he would be better off by not trading. Baker and Wurgler (2007) define investor sentiment as a belief about future cash flows and investment risks which are not supported by solid facts. In some cases it happens that investor sentiment drives the price of the stock far below its fundamental value. This leads to higher underpricing (Purnanandam, A. & Swaminathan, B. 2004). C. Campbell et al. (2008) found empirical evidence for the relationship between investor sentiment and IPO underpricing.

They found that underpricing is significantly higher for overvalued IPO's than for undervalued IPO's. According to the research of S. Wang and Y. Yao (2013), the price of the new stocks on the first day of trading is more likely to be overestimated with higher investor sentiment. This generates a higher IPO underpricing rate.

#### 2.2.5. The investment bank conflict theory.

According to M. Goldstein (2012), previous research has shown that investment banks e.g. the underwriters have a conflict of interest while pricing the IPO. The investment bank conflict theory argues that investment banks benefit themselves and their clients by arranging for underpricing. An investment bank has certain regular clients who often buy stock when the investment bank is processing an IPO. The investment bank can have such a good relationship with his clients that certain incentives arise to underprice the stock. By underpricing the stock, the investors will have a higher first day return. In this way, the investment bank keeps his clients satisfied (Goldstein, M. 2012).

#### 2.2.6. The managerial conflict theory.

This theory suggests that the management of the issuing company is kind of bribed by the underwriter to underprice the IPO. This occurs by means of that the management receives some of the underpriced stock. The underwriter and the management of the issuing company underprice the IPO to create excessive demand for the stock. This excessive demand causes a price increase of the stock after the issue. This is called the managerial conflict theory because of that the management always should try to maximize shareholders' value and in this situation management wants a lower price of the shares when the stock is being issued. So in this situation, management acts against the economic interest of the shareholders (Arthurs, J. et al. 2008).

From the above-mentioned discussion, it is clear that existing research provides several interesting explanations for the underpricing of IPO's. Considering the different explanations, ex-ante uncertainty seems the most interesting explanation because it is a broadly discussed explanation of underpricing. Guo et al. (2006) argue in their paper that the extensive IPO underpricing literature underpricing primarily relates to ex-ante uncertainty. Ex-ante uncertainty is an interesting cause of underpricing because it is a cause which is easy to test. By formulating proxies for ex-ante uncertainty, this relationship is really testable. Thereby, it is interesting because it is based on two well-known models. The model of K. Rock (1986) and

the extension by R. Beatty and J. Ritter (1986) and the model of D. Baron (1982) both argue that ex-ante uncertainty about the intrinsic value of the stock increases underpricing of the IPO. By testing the relationship between the proxies of ex-ante uncertainty and the level of underpricing, it is possible to ultimately discuss whether my results are in line with the models or not.

According to this, ex-ante uncertainty about the intrinsic value of issued stock seems an interesting and testable cause of underpricing. It can be very useful for investors and issuing companies to get to know more about this relationship. Investors can get more insights on what kind of companies have on average a more underpriced IPO. This can be useful for their investment decisions. Companies can get better insights on what the main causes of underpricing are. By anticipating on this, they may have the ability to price their IPO more accurate.

These are the main reasons why the focus of the remaining of the paper will be on the relationship between ex-ante uncertainty and underpricing. In the next section existing research on the relationship between ex-ante uncertainty and underpricing will be discussed. This will be followed by an explanation of the added value of this paper to existing research.

### 2.3. The relationship between ex-ante uncertainty and underpricing.

P. Clarkson and J. Merkley (1994) examined the effect of ex-ante uncertainty on the underpricing of initial public offerings in Canada during the 80's. They found a significant positive effect of ex-ante uncertainty on the level of underpricing. They argue that if ex-ante uncertainty increases, the investor will demand more returns on the IPO, so underpricing of the IPO increases. They use the size of the issuing company, the reputation of the underwriter and the market climate as proxies for ex-ante uncertainty.

P. Clarkson (1994) also examined this effect in the US in the time period from 1976-1985. The results suggest that there is a positive relationship between ex-ante uncertainty and the degree of underpricing and that if the effectiveness of a selected proxy increases, the strength of the relation between ex ante uncertainty and the degree of underpricing increases. According to P. Clarkson (1994), especially the last finding is a strong support for the existence of a relationship between ex-ante uncertainty and underpricing.

D. Kennedy et al. (2006) tested the relative importance of different explanations of underpricing. They examined a sample of US IPO's for the years 1991-1998 because of the relative high underpriced IPO's in those years. They find that the high-tech sector faces greater ex-ante uncertainty and, as a result, their IPO's will be more underpriced.

Y. Ting and Y. Tse (2006) use three proxies to test the ex ante uncertainty hypothesis of R. Beatty and J. Ritter (1986) and the winner's curse hypothesis of K. Rock (1986) in the Chinese market from 1995 until 1998. They used the offer size, the age of the firm and the standard deviation of the after-market returns to test the ex-ante uncertainty hypothesis. They found that the main reason for the high IPO underpricing in China is caused by the winner's curse hypothesis of K. Rock (1986).

C. Muscarella and M. Vetsuypens (1989) tested D. Baron's (1982) model by examining the IPO's of 38 investment banks that went public and distributed their own securities (so no information asymmetry because investment banks issue their own stock) between 1970 and 1987. According to D. Baron's (1982) model, the securities of these investment banks should be less underpriced than the securities of other companies. This because there is no information asymmetry between the underwriter and the issuing company. C. Muscarella and M. Vetsuypens (1989) found the contrary. The self-marketed offerings of the investment banks are significantly more underpriced than IPO's of other companies.

C. Cheung and I. Krinsky (1994) also tested D. Baron's (1982) model. They did this exactly in the same way as C. Mucarella and M. Vetsuypens (1989). The only difference is that they examined the underpricing of Canadian investment banks. They also found the opposite of what D. Baron's (1982) hypothesis predicts. So they found that ex-ante uncertainty about the intrinsic value of the issued stock does not increase underpricing.

Looking at previous research on the relationship between ex-ante uncertainty it can be concluded that there are already several researchers who found evidence on the existence of a relationship between ex-ante uncertainty and underpricing, but there are also researchers who found evidence that suggests that there is no relationship between ex-ante uncertainty and underpricing.

#### 2.4. Addition of this research.

In the previous section, existing research on the relationship between ex-ante uncertainty and underpricing is discussed. Some researchers found evidence that supports the assertion that ex-ante uncertainty causes underpricing of IPO's. But there are also some researchers who found evidence that contradict the assertion that ex-ante uncertainty causes underpricing of IPO's. The purpose of this paper is to find evidence that will support or contradict the assertion that ex-ante uncertainty causes underpricing.

All the existing research on the influence of ex-ante uncertainty on the underpricing of IPO's are conducted in the eighties and the nineties. It is possible that a lot has been changed

in the IPO-market since these studies were conducted. The behavior of investors or issuing companies may have changed. The studies which were conducted in the eighties and nineties do not give a proper representation of the current IPO-market. For example, according to H. Leow and W. Lau (2015), the Global Financial Crisis had an impact on the IPO-market. They did research in the Malaysian stock market and they found evidence that underpricing was generally lower due to the Global Financial Crisis. S. Henry and N. Gregoriou (2013) argued that the US IPO market was in a cold period during the Global Financial Crisis. A cold IPO market period is associated with stock market dips, and offerings made during cold periods are more underpriced and more frequent oversubscribed (Henry, S. & Gegoriou, N. 2013). Also, looking at the database used in this research it is possible to argue that the Global Financial Crisis had an influence on the underpricing of US IPO's. Before the Global Financial Crisis (from 2000 until 2007) the average underpricing of US IPO's was 14,69%, during the Global Financial Crisis (from 2008 until 2012) the average underpricing of US IPO's was 8,93% and after the Global Financial Crisis, the average underpricing of US IPO's was 13,57%. Looking at these numbers it is very likely that the Global Financial Crisis had a strong influence on the IPO market. So the behavior in the IPO-market before and during the Global Financial Crisis may not give a good representation of the current IPO-market.

Not only the behavior of the issuing companies may have been changed. The Financial Crisis also changed the behavior of investors. According to R. Hall (2010) investors became more risk-averse and suddenly preferred investing in high-quality debt such as debt of the US government to lower quality investments. E. King and L. Banderet (2014) state that the Global Financial Crisis caused widespread investor pessimism.

According to E. King and L. Banderet (2014), it is widely acknowledged that IPO activity can vary significantly across time-periods. They argue that the main reason for this is the existence of 'hot' and 'cold' IPO markets. Hot IPO markets are periods of high volume of offerings, high levels of underpricing and often periods of oversubscription of offerings. Cold IPO markets are, in contrast, periods of low IPO volume, reduced underpricing and a reduced tendency for oversubscription of offerings (Helwege, J. & Liang, N. 2004).

Hence it is clear that the behavior of investors and issuing companies may have changed during the last decade. To give a valid and reliable representation of the current IPO market, a very recent dataset is used. The time period of the dataset runs from January 2014 until April 2016. This time period has not been studied yet and therefore hopefully gives new insights about the current IPO-market.

### 3. Hypotheses.

Because ex-ante uncertainty is unobservable and not measurable, different proxies of ex-ante uncertainty will be formulated and discussed in this section. These different proxies will lead to the formulation of several hypotheses. These hypotheses will be formulated in line with the expectations of the model of K. Rock (1986) extended by R. Beatty and J. Ritter (1986) and the model of D. Baron (1982). By testing these hypotheses it is ultimately possible to argue whether these models hold and whether ex-ante uncertainty among the intrinsic value of the stock increases the level of underpricing.

#### 3.1. The average underpricing of US companies.

From the discussion presented in the literature study it can be argued that companies on average underprice their assets. According to P. Clarkson and J. Merkley (1994) there is a growing evidence that proves that US IPO's are on average underpriced. According to the findings of T. Loughran and J. Ritter (2002), the average first-day returns on US IPO's were 7% in the 1980's, almost 15% from 1990 to 1998 and during the years of the internet bubble in 1999-2000 around 65%. After the internet bubble, the underpricing was on average 12,1%. On average, these percentages of underpricing exceed the reasonable market risk premium. (Clarkson, P. & Merkley, J. 1994). Looking at past decades, the expectation is that US companies also on average underprice their assets for the time period January 2014 until April 2016. This will lead to the formulation of the following hypothesis:

- *Hypothesis 1: The average first-day return on US companies from January 2014 until April 2016 is significantly larger than the market return.*

#### 3.2. Market capitalization.

According to M. Kooli and J. Suret (2001) the market capitalization of a firm is a proxy for ex-ante uncertainty about the intrinsic value of the stock of a company when going public. The market capitalization is an indication of the size of a firm or in other words; the value of a firm (Victor, J. 2010). M. Kooli and J. Suret (2001) state that a substantial body of literature examines the effect of the market capitalization on the level of underpricing of IPO's. Therefore, companies with a large market capitalization are big companies and companies with a small market capitalization are small companies. This literature argues that small IPO's are more risky than large IPO's (Ritter, J. 1987 ; Chalk, A. & Peavy, J. 1990). On average there is

more uncertainty about the intrinsic value of the stock of a small firm when going public. So on average, the smaller the market capitalization of the firm, the bigger the ex-ante uncertainty about the intrinsic value of the stock.

But why is there more uncertainty about the intrinsic value of the stock of small firms? According to X. Zhang (2006), it seems logical that there is more uncertainty about the issue of small firms because large firms are more diversified than small firms. Thereby, small companies have less information available to the market than large firms. Due to this reason, people might be more interested in large companies, and thus, large companies are more in the news. Furthermore, larger companies are more monitored by the government, the shareholders, the media, investors and other stakeholders (Brennan, M. & Franks, J. 1996). Because of this monitoring, less uncertainty exists about the intrinsic value of the stock when going public. X. Zhang (2006) argues that investors might have fixed costs in gaining information about the intrinsic value of a stock. It is less attractive to gain information about small companies because small companies have smaller issues so the possibility to make large gains on issues of small companies is smaller. Therefore, gaining information on large companies is often more profitable. This makes gaining information about small companies less attractive. Consequently, more information is gained and available on large companies. Because more information is gained about large companies, the ex-ante uncertainty among the IPO of large companies is smaller. In line with these arguments, it can be postulated that there is more ex-ante uncertainty about the intrinsic value of the issuing stock of small firms. And as already mentioned earlier, according to the model of K. Rock (1986) and the model of D. Baron (1986), ex-ante uncertainty causes underpricing.

R. Ibbotson et al. (1994) found a negative relationship between market capitalization of a firm and IPO underpricing by investigating 10626 US IPO's from 1960 until 1992. In the Australian context, X. How et al. (1995) studied 340 Australian IPO's from 1980 to 1990 and similarly found that larger firms were less underpriced. J. Mercado-Mendez (2011) also found a negative relationship between the market capitalization of a firm and the level of underpricing by studying 282 US IPO's from 1998 until 2000.

There are also studies which found evidence that the level of underpricing increases with the market capitalization of a firm. P. Clarkson and J. Merkley (1994) studied 180 Canadian IPO's from 1984 until 1987 and report that large companies on average underprice their assets more than small companies. Islam, A. et al. (2010) investigated 173 IPO's from 1995 to 2005 in Bangladesh and also found that large companies have significantly more underpriced IPO's than small companies. F. Allen and G. Faulhaber (1989) have an explanation

for the occurrence that firms with a large market capitalization are more underpriced. They explained this from the perspective of the signalling hypothesis. Large companies are often financially more stable than small companies. So a large company is often more certain about having positive prospects. The company itself knows his own prospects the best. To increase the probability of a successful IPO, firms with the best prospects want to signal their good prospects to investors by underpricing their initial issue. Investors know that only the companies with the best prospects can recoup the cost of the underpriced initial offering (Allen, F. & Faulhaber, G. 1989). In short, companies may signal their good prospects to investors by underpricing their IPO.

From the above mentioned discussion, it can be concluded that there are conflicting views regarding the company size in relation to market capitalization and underpriced IPO. It is clear that this relationship differs for different countries and different time periods. M. Brennan and J. Franks (1996) and X. Zhang (2006) argue that IPO's of companies with a large market capitalization are seen as less uncertain IPO's. According to the model D. Baron (1982) and the model of Rock (1986) extended by R. Beatty and J. Ritter (1986) does ex-ante uncertainty lead to underpricing of an IPO. Therefore is the hypothesis formulated as follows:

- *Hypothesis 2: The market capitalization of a company has a significant negative effect on the level of underpricing.*

### 3.3. Reputation of the underwriter.

The reputation of the underwriter that is involved in the process of the IPO is a good proxy for ex-ante uncertainty about the intrinsic value of the stock. An underwriter is a bank or a company who takes care of the IPO of a company. The underwriter determines the initial offer price of the stock by closely working together with the issuing company. After determining the initial offer price the underwriter buys the stock from the issuing company and tries to sell them to its network of clients (Ellis, K. et al. 2000). S. Fabrizio (2000) investigated the role of the underwriter in processing an IPO. A part of his research is about the role of the reputation of the underwriter on the underpricing of IPO's. He argued that the more prestigious underwriters are mostly associated with less uncertain issues of stock. So according to S. Fabrizio (2000) is an IPO processed by an underwriter with a good reputation a less uncertain IPO. Investors might expect from prestigious underwriters that they are better able to price the assets close to its intrinsic value. The investors are more certain about that the underwriter prices the assets correctly (Sharma, S. & Seraphim, A. 2010).

But there are also scientists who argue that IPO's governed by an underwriter with a high reputation are more underpriced. W. Dimovski and S. Philavanh (2010) argue that underwriters with a high reputation are associated with a higher level of underpricing because prestigious underwriters have more power to price an IPO in their favour (i.e. low prices). Because the issuer of the stock cannot perfectly observe the effort of the underwriter, underwriters have the tendency to underprice the IPO so that they can sell the stock more easily to the market. In this way the underwriter minimizes his selling effort and maximizes the probability of successful offering (Huang, Q. & Levich, R. 1998).

Carter and Manaster (1990) examine the role of the reputation of the underwriter. They examined 501 US IPO's from January 1979 until August 1983. They argue that prestigious underwriters especially process IPO's of low risk firms. Low risk firms are most of the time less underpriced because there is no need for low risk firms to attract investors by underpricing of the assets. Low risk firms do not have to compensate investors for the risk they are taking. The empirical results of Carter and Manaster (1990) confirm the negative relationship between the reputation of the underwriter and the level of underpricing. Also S. Titman and B. Trueman (1986), Maksimovic and Unal (1993) and Carter et al. (1998) found that underwriters with a high reputation underprice less than underwriters with a bad reputation.

W. Dimovski and S. Philavanh (2010) also did research on the relationship between the reputation of the underwriter and underpricing of IPO's. They examined 380 Australian IPO's from 1994 to 2004. Their results suggest the opposite, namely that underwriters with a high reputation are associated with a higher level of underpricing. This positive relationship can be explained by arguing that prestigious underwriters have more power to price an IPO in their favour (i.e. low price) because of their prestige (Dimovski, W. & Philavanh, S. 2010). This pattern of greater underpricing for IPO's which are associated with underwriters with a high reputation is in line with the agency argument that investment bankers seek to underprice IPO's to their own advantage of T. Loughran and J. Ritter (2002). They also found evidence in favor of this agency argument. They found evidence that US IPO's issued by an underwriter with a good reputation were on average more underpriced than US IPO's issued by an underwriter with a bad reputation.

Comparing the discussed studies on the relationship between underwriter reputation and the level of underpricing it is possible to conclude that there are different findings regarding the relationship between the reputation of the underwriter and the level of underpricing. But the argumentation that IPO's guided by underwriters with a good reputation are less underpriced seems to be more logic and is in line with the ex-ante uncertainty hypothesis by R. Beatty and

J. Ritter (1986) and D. Baron's (1982) model. This because IPO's guided by underwriters with a bad reputation are seen as more uncertain IPO's (Fabrizio, S. 2000) and R. Beatty and J. Ritter (1986) and D. Baron (1982) argue that ex-ante uncertainty among an IPO leads to underpricing. This leads to the formulation of the following hypothesis:

- *Hypothesis 3: The reputation of the underwriter has a significant negative effect on the level of underpricing.*

#### 3.4. The age of a company.

The age of a company is also considered as a suitable proxy of ex-ante uncertainty about the real intrinsic value of the stock. Older companies have proved that they can survive and operate in the market for a long time and therefore they often have a higher reputation. Therefore investments in older companies are seen as less risky or less uncertain. Also, the older the company is, the more financial information is available about the company (i.e. enough track records). The availability of financial information makes the pricing of the assets of older companies less uncertain (Muscarella, C. & Vetsuypens, M. 1989). J. Ritter (1984) argued that the age of a company measures how established a company is. An old company is more established than a young company, and therefore there exists on average less uncertainty among the IPO of an old company. According to the mentioned arguments it is possible to say that there is more ex-ante uncertainty about the intrinsic value of the stock of young companies. Therefore, it is harder to measure the right price per share of young companies. This is the reason why J. Ritter (1984) argues that older companies have to leave less money on the table to compensate investors for the amount of information that is available about the company. Younger companies have to attract investors by compensating them by underpricing the IPO.

Researchers such as J. Ritter (1984), who did research on 1075 US IPO's from January 1977 until December 1982 and A. Ljungqvist and W. Wilhelm (2003), who did research on 2178 US IPO's from January 1996 until December 2000 found that old companies experience less underpricing than young companies. Also C. Muscarella and M. Vetsuypens (1989) document a significant negative relationship between the age of the company and the level of underpricing. They attribute their empirical findings to the greater amount of information that is publicly available for older companies. In other words, there is more ex-ante uncertainty among an IPO of a small company. T. Loughran and J. Ritter (2002) found that young US companies (0-7 years) on average underpriced their stock by 9.0% during 1980-1989, by 17.1% during 1990-1998 and by 74.8% during 1999-2000. They found that old US companies (8 years

and older) on average underprice their assets by 5.8% during 1980-1989, by 12.7% during 1990-1998 and by 45.4% during 1999-2000. According to these numbers, T. Loughran and J. Ritter (2002) concluded that IPO's of older companies are on average less underpriced.

In line with the theoretical underpinning and based on previous empirical findings, the age of a company looks like a suitable proxy of ex-ante uncertainty. This leads to the formulation of the following hypothesis:

- *Hypothesis 4: The age of the company has a significant negative effect on the level of underpricing.*

### 3.5. R&D expenditures.

The R&D expenditures of a company is considered as an adequate proxy of ex-ante uncertainty about the intrinsic value of the stock. Guo, R. et al. (2006) identify R&D expenditures of a company as the major and the most important contributor to IPO uncertainty. D. Aboudy and B. Lev (2000) and C. Lu et al. (2011) support the reasoning that R&D expenditures is an important proxy of ex-ante uncertainty of the IPO. Why are the R&D expenditures of a certain company a good proxy for ex-ante uncertainty about the intrinsic value of the issuing stock?

R. Guo et al. (2006) explained that the current US GAAP (i.e. Generally Accepted Accounting Principles) only mandates the disclosure of the amount of R&D expenditures to the investors. No systematic information on the R&D activities or on the progress of R&D activities is disclosed to investors. It is harder to estimate the intrinsic value of the stock because of the absence of information about the progress and the nature of R&D activities. This means that there is more ex-ante uncertainty among the investors about the intrinsic value of the issuing stock of a company with high R&D expenditures (Guo, R et al. 2006). J. Cho and J. Lee (2013) provide several explanations for the contribution of R&D expenditures to ex-ante uncertainty in the IPO process. The first explanation is that company insiders often hold superior information about R&D projects. The second explanation is that investors often have limited information about the R&D projects that can help them accurately assess the feasibility of R&D projects. Thirdly, companies often compose and expense R&D investments with intangible assets. These intangible assets are often difficult to value and have high significant sunk cost.

R. Guo et al. (2006) provide empirical evidence for the positive relationship between R&D expenditures and the level of underpricing. They studied 2696 US IPO's issued from 1980

until 1995 and reported that the pre-IPO intensity of the issuer's R&D is strong and positive related to the first-day underpricing. They found that the returns to R&D intensive issuers is almost double as high than the returns on issuers without R&D expenditures. Also M. Heeley et al. (2007), who did research on 1413 IPO's of manufacturing companies from 1981 until 1998 found that firms investing in increased R&D experience greater underpricing. T. Efrata (2008) did research on the relationship between R&D expenditures and the level of underpricing in the pharmaceutical and the biotechnological market. He did research on 82 IPO's of pharmaceutical and biotechnological companies from the United States from 1998 until 2005. He identified R&D expenditures as the main source of information asymmetry, which in turn leads to underpricing of the IPO's of pharmaceutical and biotech firms. According to the theoretical explanations and empirical findings, R&D expenditures seems a suitable proxy for ex-ante uncertainty. This leads to the formulation of the following hypothesis:

- *Hypothesis 5: The R&D expenditures of a company have a significant positive effect on the level of underpricing.*

### 3.6. Issue size

R. Beatty and J. Ritter (1986) argued in their research that the gross proceeds of an issue is a good proxy for ex-ante uncertainty. They argued that investors consider initial public offerings with a low value as more uncertain because initial public offerings with a low value are often more speculative. Dorsman et al. (2013) explained this by arguing that information about the real intrinsic value of a large issue is much more valuable than information about a small issue. A result is that investors especially try to obtain information about the intrinsic value of large offerings. Ultimately, there will be much more information available about large offerings. This implies that there is often more ex-ante uncertainty among the intrinsic value of a small offer (Beatty, R. & Ritter, J. 1986).

R. Beatty and J. Ritter (1986) empirically tested this relationship. Using data from 1028 US IPO's from 1977 to 1982, they confirmed that small offerings are more underpriced than large offerings. Evidence for this relationship is not only found in the US. X. How et al. (1995) studied 340 Australian IPO's from 1980 to 1990. They also found that small offerings are more underpriced than large offerings. R. Michaely and W. Shaw (1994) have contrary findings. They studied 947 IPO's in the US between 1984 and 1988 and found that larger issues experience greater underpricing. Despite the findings of R. Michaely and W. Shaw (1994) is the expectation that larger issues are less underpriced. This because according to R. Beatty and

J. Ritter (1986) there exists less ex-ante uncertainty among large issues and the expectation is that ex-ante uncertainty leads to underpricing of the issue. This leads to the formulation of the following hypothesis:

- *Hypothesis 6: The issue size of an IPO has a significant negative effect on the level of underpricing.*

## 4. Research Methodology

In this section, the main methodology and the data of the research will be described. First, the measurement of IPO underpricing will be determined. After that the data and the sources of the data will be described. At last, the econometric model will be discussed and will be used to test the hypotheses.

### 4.1. Measurement of IPO underpricing.

There are various ways to define IPO underpricing. The most used and one of the most extent definitions of IPO underpricing could be measured as the first-day return of the issued stock. Also in this research, IPO underpricing is defined as the difference between the offer price of the issued stock and the closing price at the end of the first day of trading:

$$\text{Underpricing} = \frac{(\text{First day closing price} - \text{Offer price})}{\text{Offer price}} * 100\%$$

The above calculation only provides information on whether the stock is overpriced or underpriced. It does not provide any standard of comparison. The initial return on the stock does not take the overall market return into account. To give a good representation of the level of underpricing or overpricing, the initial return on the stock has to be adjusted by the return of the market. Therefore, in this research, the level of underpricing is adjusted by the market return, which is a more accurate valuation of underpricing. The level of underpricing is adjusted by the return on the S&P 500 index on the same day as the day of the IPO:

$$\text{Underpricing} = \frac{(\text{First day closing price} - \text{Offer price})}{\text{Offer price}} * 100\% - \text{Return on S\&P 500}$$

### 4.2. Data

The data used in this research comprises of 435<sup>2</sup> US IPO's issued from January 2014 until April 2016. The data is obtained from different sources. This study includes IPO issues in all types of industries. The starting point of collecting data is to obtain insight in which companies went public from January 2014 until April 2016. This IPO data is gathered from a database: "SCOOP Track Record from 2000 to present" from Jay R. Ritter's website. In this

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<sup>2</sup> 412 US IPO's left after removing 23 companies due to influential cases.

database the following information on an IPO is given: the date of the IPO, the underwriter(s), the offer price, the opening price and the first day closing price. To make the database complete, more information about the companies is needed. The daily return on the S&P 500 is derived from investing.com. The founding years of the companies were found on crunchbase.com, bloomberg.com and marketwatch.com. The age of the companies is calculated by subtracting the founding year from the date of the companies' IPO. The reputation of the underwriters was found on the personal IPO-website of J. Ritter: <https://site.warrington.ufl.edu/ritter/ipo-data/>. The underwriters are ranked on a scale from 1 to 9. If the stock of the issuing company is issued by more than one underwriter, the average of the reputation of the underwriters is calculated. These rankings were first published by X. Carter and X. Manaster (1990) and were complemented by X. Carter et al. (1990). Thereafter, J. Ritter kept this reputation rankings of underwriters up to date. The amount of shares offered is derived from nasdaq.com. The issue size of the IPO is calculated by multiplying the amount of shares offered with the offer price. The market capitalization of the company is calculated by multiplying the amount of shares offered with the first day closing price of the stock. The R&D expenditures of the issuing company are derived from Yahoo Finance and Google Finance. There were 21 missing values for R&D expenditures. Especially companies who went public recently, do not have any information available about their R&D expenditures. However, for most companies it is possible to argue whether or not they spend money on research and development. For example, acquisition companies, holdings, funds generally do not spend any money on research and development. For example, biotech companies, technology companies and pharmaceutical companies all spend money on research and development. Because a dummy variable is created for whether or not the company spends money on research and development, the height of the R&D expenditures is not important. It is only important to note whether the company spends money on R&D. So by logically reasoning, the average R&D expenditures as percentage of the market capitalization are filled in for companies who probably spend money on R&D, such as technology companies, pharmaceutical companies etcetera. A zero is filled in for companies who probably do not spend any money on research and development.

#### 4.3. Research method.

The purpose of this research is to find out if proxies based on ex-ante uncertainty about the offer price significantly affect underpricing of the stock of US companies. An OLS regression is used to test all the formulated hypotheses. The following hypotheses were formulated:

H<sub>1</sub>: The average first-day return on US companies who went public from January 2014 until April 2016 is significantly larger than the market return.

H<sub>2</sub>: The market capitalization of a company has a significant negative effect on the level of underpricing.

H<sub>3</sub>: The reputation of the underwriter has a significant negative effect on the level of underpricing.

H<sub>4</sub>: The age of the company has a significant negative effect on the level of underpricing.

H<sub>5</sub>: The R&D expenditures of a company have a significant positive effect on the level of underpricing.

H<sub>6</sub>: The issue size of an IPO has a significant negative effect on the level of underpricing.

For regression purposes the logarithm of the market capitalization of the companies and the issue size of the IPO is used. Taking the logarithm of a variable is a very common way to handle situations where a non-linear relationship exists between the dependent variable and the independent variables or it is a way to transform a highly skewed variable into a more normal variable (Carter, H. et al. 2012).

To estimate the relationship between the dependent variable: level of underpricing and the different independent variables: market capitalization of the company, age of the company, reputation of the underwriter, the R&D expenditures of the company and the issue size of the IPO, an OLS regression is used. The OLS regression is formulated as follows:

$$\begin{aligned} \text{Underpricing} = & \alpha + \beta_1 \text{market cap} + \beta_2 \text{age} + \beta_3 \text{reputation underwriter} \\ & + \beta_4 \text{R\&D expenditures} + \beta_5 \text{issue size} + e \end{aligned}$$

The point where the regression line crosses the dependent variable is represented by the constant:  $\alpha$ .  $\beta_1 + \dots + \beta_5$  represent the different coefficients of the determinants of the dependent variable. Variable “e” represents the error term of the model, also called the residual.

*Table 1. Variable definition*

Variable	Definition
Level of underpricing	The level of underpricing is measured by calculation the first-day return on the issued stock. The level of underpricing is adjusted by the return on the S&P 500 index on the same day as the day of the IPO
Market capitalization	The number of shares offered multiplied by the closing price at the end of the first day of trading. The logarithm of the market capitalization is used.
Age	The age of the company when going public, stated in whole years.
Reputation underwriter	Dummy variable of the reputation of the underwriter. Ranking from underwriters with the lowest possible reputation (=1) to underwriters with the highest possible reputation (=9). When the underwriters' ranking is below 8, value 0 is given. When the underwriters' ranking is 8 or higher, value 1 is given.
R&D expenditures	Dummy variable of the R&D expenditures of a company: Here, the distinction is made between companies who spend money on research and development and companies who do not spend money on research and development. The value 0 is given to companies who do not spend money on research and development and the value 1 is given to companies who spend money on research and development.
Issue size	The issue size is defined as the size of the initial public offering: the amount of shares offered multiplied by the offer price. The logarithm of the issue size is used.

## 5. Empirical findings.

This chapter will start with some descriptive statistics about underpricing of US companies from January 2014 until April 2016. After that, the road to the final regression analysis will be discussed, i.e. how the assumptions of a multiple linear regression are tested. Thereafter, the results of the OLS regression will be displayed and discussed. This chapter will end with an analysis of the hypotheses.

### 5.1. Descriptive statistics

*Table 2. Descriptive statistics of the sample.*

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
First-day return on stock	435	12,523%	14,943	-34,880%	206,667%
Market adjusted first day return	435	12,536%	14,930	-32,81%	205,537%
Age	435	14,129	22,992	0	186
Reputation of the underwriter	435	7,708	1,694	1	9
Market capitalization of the company	435	310	370,727	7	30055
Issue size	435	265,276	344,483	7	21767
R&D expenditures of the company	435	17943,229	29513,41	0	1719000

Table 2 gives an overview of the descriptive statistics of the sample.

*Table 3. Descriptive statistics of the independent variables.*

Data segmented by:	Number of IPO's	Initial Return	Market adjusted initial return
Age			
Young (0-10 years)	252	12,917%	12,873%
Old (>10 years)	183	11,964%	12,071%
Market capitalization			
Low (0-100 mln)	194	3,389%	3,269%
High (> 100 mln)	241	19,959%	19,994%
Underwriter reputation			
Low (1-7,99)	164	8,615%	8,536%
High (>7,99)	271	14,944%	14,975%
R&D expenditures			
No	206	8,466%	8,680%
Yes	229	16,095%	16,004%
Issue size			
Small (0-100 mln)	215	8,785%	8,992%
Large (>100mln)	220	16,116%	15,998%

Table 3 shows some more descriptive statistics of the independent variables. The statistics for the market capitalization of a company, the issue size and the reputation of the underwriter are remarkably. The statistics suggest another relationship than was expected.

The statistics show that companies with a low market capitalization are on average underpriced by 3,389% and the companies with a high market capitalization are on average underpriced by 19,994%. This contradicts the expectation that companies with a high market capitalization would be less underpriced on average because IPO's of companies with a high market capitalization are seen as less uncertain IPO's. These statistics also contradict the findings of R. Ibbotson et al. (1994), X. How et al. (1995) and J. Mercado-Mendez (2011) who all found a negative relationship between the market capitalization of a company and the level of underpricing.

The descriptive statistics of the reputation of the underwriter are also remarkably. The statistics suggest that there is a positive relationship between the reputation of the underwriter

and the level of underpricing. This contradicts the argument of S. Fabrizio (2000) who argues that the more prestigious underwriters are mostly associated with less uncertain issues of stock and therefore are less underpriced. He finds evidence for the negative relationship between the reputation of the underwriter and the level of underpricing. The statistics also contradict the findings of Carter and Manaster (1990), S. Titman and B. Trueman (1986), Maksimovic and Unal (1993) and Carter et al. (1998) who all found a negative relationship between the reputation of the underwriter and the level of underpricing. The statistics are in line with the results of W. Dimovski and S. Philavanh (2010) who found a positive relationship between the reputation of the underwriter and the level of underpricing. They explain this relationship by arguing that prestigious underwriters have more power to price an IPO in their favour (i.e. low price) because of their prestige.

As well, the descriptive statistics of the issue size contradict the expectations. The statistics contradict the findings of R. Beatty and J. Ritter (1986). They found that small offerings are more underpriced than large offerings. They argued that investors consider initial public offerings with a low value as more uncertain because initial public offerings with a low value are often more speculative. The descriptive statistics are in line with the results of R. Michaely and W. Shaw (1994) who also found a positive relationship between the issue size and the level of underpricing.

The statistics show that the age of the company is not really associated with a higher or a lower level of underpricing.

The statistics of the R&D expenditures are in line with the expectations that the IPO of a R&D company is more underpriced. This is in line with the results of R. Guo et al. (2006), M. Heeley et al. (2007) and T. Efrata (2008).

*Table 4. Descriptive statistics of the dependent variable: market adjusted initial return.*

	No. of IPOs	Average Initial Return	Market adjusted initial return	SD of Market Adjusted Initial Return	Money Left on the Table in mln	Proceeds in mln.
Jan 2016 – April 2016	16	2,600%	2,612%	10,166%	144	3352
July 2015 – Dec 2015	63	14,752%	14,731%	24,611%	1328	13061
Jan 2015 – June 2015	86	13,229%	13,192%	31,242%	2789	15825
June 2014 – Dec 2014	129	10,677%	10,878%	25,002%	11667	51944
Jan 2014 – June 2014	141	13,800 %	13,797%	28,875%	3416	31212
Total	435	12,487%	12,536%	28,431%	19344	115395

Table 4 shows how the statistics of the dependent variable, market adjusted initial return, changed over time. The column money left on the table shows the total missed capital gains all the companies that went public in that particular time period. The money left on the table is calculated by multiplying the initial return of the stock with the issue size. The proceeds in millions are all the issue sizes of the companies that went public in that period added.

## 5.2. Testing of assumptions.

To run the OLS regression correctly, a couple assumptions have to be tested. The data has to be checked on heteroscedasticity. The conditional errors have to be tested on their dependence on the predictors. The data has to be tested on autocorrelation. The values of an independent variable have to be tested on if they are an exact linear function of other independent variables and the conditional errors of the model have to be distributed normally. These assumptions will be tested with residual analysis.

First, outliers will be identified and removed from the dataset. Using Cook's D, outliers were identified. Cook's D is often used to estimate the influence of one data point on the results

of the regression analysis. Data points with large residuals may distort the outcome of the regression. The regression gets more accurate when deleting data points with a large Cook's D (Carter, H. et al. 2012). All data points with a Cook's D higher than  $4/n$  will be deleted. Following these criteria 23 observations are deleted to omit the influence of outliers.

After that, the data set is tested for multicollinearity. The expectation is that multicollinearity exists in the dataset, namely between the issue size of the offer and the market capitalization of the company. This because of that the issue size of the offer is calculated by multiplying the number of shares offered by the offer price and the market capitalization of the company is calculated by multiplying the number of shares offered by the first day closing price. Multicollinearity is the event that an independent variable is an exact or an almost exact linear function of another independent variable. The results of the test for correlation are as follows:

*Table 5. Correlation matrix*

	First day return	Age	Reputation of the underwriter	Market capitalization	Issue size	R&D expenditures
First day return	1,000					
Age	-0,044	1,000				
Reputation of underwriter	0,155	0,147	1,000			
Market capitalization	0,244	0,222	0,545	1,000		
Issue size	0,097	0,235	0,537	0,989	1,000	
R&D expenditures	-0,031	-0,117	-0,0410	-0,342	-0,344	1,000

As expected on beforehand are issue size and market capitalization highly correlated. High correlation between variables might indicate multicollinearity. The VIF (Variance Inflation Factor) -test will be conducted. VIF can be calculated as follows:  $VIF = \frac{1}{(1-R^2)}$ . The  $R^2$  in this equation can be derived by regressing an explanatory variable on all other explanatory variables. A high  $R^2$  indicates problems. A VIF higher than 10 indicates multicollinearity (Carter, H. et al. 2012). The VIF of the market capitalization is 23,40 and the VIF of the issue size is 23,62. This implicates that multicollinearity exists in the model.

In this case, one variable has to be removed from the analysis. Another solution is to conduct two separate analyses, one analysis where market capitalization is included and one

analysis where issue size is included. Because of multicollinearity, two separated regression analyses will be conducted and discussed.

Heteroskedasticity is the event that the error terms of the model do not have constant variance. Heteroskedasticity means literally “differing variance”. For example, errors may increase as the value of an independent variable increases (Carter, H. et al. 2012). So the variance of the error term has to be homoskedastic, the variance has to be constant. Heteroskedasticity can be tested with the Breusch-Pagan test (Carter, H. et al. 2012). The P-value of the test is zero so we can reject the 0-hypothesis of homoscedasticity. At least one of the x-variables variance of the residuals increases as a function of at least one of these x-variables and probably more than one. So the data is heteroscedastic. One solution for this is to run a Weighted Least Squares Regression. A more popular and more common method of dealing with issues of heteroskedasticity is robust standard errors. The robust option relaxes the assumption that the error terms are independent of each other (Carter, H. et al. 2012). Therefore, to deal with the heteroskedasticity, a robust regression analysis is conducted.

Autocorrelation is a data characteristic in which the correlation between the values of a variable is based on related objects. Autocorrelation violates the assumption of independence. Testing for autocorrelation can be done with a Durbin-Watson test. The outcome of the Durbin-Watson test for this dataset is 1.815. A Durbin-Watson statistic close to zero means that there exists positive autocorrelation in the data. A Durbin-Watson statistic close to four means that there exists negative autocorrelation in the data. A Durbin-Watson statistic close to 2 means that autocorrelation does not exist in the data. Regarding the Durbin-Watson statistic of 1.815, it is possible to conclude that there is no autocorrelation in the data.

### 5.3. Results Ordinary Least Squares Regression.

Table 6 describes the results of the OLS-regressions.

*Table 6. Results OLS-regressions*

Independent variable	Model including market capitalization	Model including issue size
Logarithm of market capitalization	0,052 (6,35)***	
Age of the company	-0,001 (-4,14)***	-0,001 (-3,32)***
Dummy of reputation of underwriter	0,024 (1,48)	0,052 (3,04)***
Dummy of R&D expenditures	0,061 (3,99)***	0,049 (3,10)***
Logarithm of issue size		0,026 (3,12)***
Constant factor	-0,212 (-5,57)***	-0,098**
R-squared	0,148	0,086
Adjusted R-squared	0,139	0,084
Number of observations	412	412

Table 6 summarizes the results of the OLS regressions. The model where market capitalization is included has a higher R-squared than the model where issue size is included. Both the regression analyses have significant results. Looking at the results it can be noticed that there are four significant results in the model where market capitalization is included and five significant results where issue size is included. So in fact, there is found a significant relationship between all the independent variables and the level of underpricing. The idea is to discuss all the results from the model where market capitalization is included because the R-squared of that model is higher. Because of the significant effects of issue size and the reputation of the underwriter in the model where issue size is included, also that particular significant results will be discussed.

It can be noticed that the market capitalization of a company has a significant positive effect on the level of underpricing. This model is a linear-log model because one of the independent variables (market capitalization) is log-transformed. The literal interpretation of the estimated coefficient  $\beta$  is that a one-unit increase in the logarithm of the market capitalization will produce an expected increase in Y of 0,0518.  $\beta$  is the expected change in Y when X is multiplied by e. So if the market capitalization of a company increases with 1 million, the level of underpricing will increase with 0,0224%<sup>3</sup>. This implies that there is a positive relationship between the market capitalization of a company and the level of underpricing.

The significant negative age coefficient implies that the older a company is, the less underpriced the asset will be. For every year increase in age of the company, the level of underpricing will be 0,0706% lower.

The reputation of the underwriter does have a significant positive effect on the level of underpricing in the model where issue size is included. The coefficient of the dummy of the reputation of the underwriter indicates that the level of underpricing of an IPO managed by an underwriter with a high reputation level (>7,99) is 5,18% higher than the level of underpricing of an IPO managed by an underwriter with a low reputation level (<8,00).

The significant positive coefficient of the R&D variable indicates that the level of underpricing is 6,14% higher for a company who spends money on research and development

The issue size of an IPO has a positive significant effect on the level of underpricing according to the results of the model where issue size is included. This model is a linear-log model because one of the independent variables (issue size) is log-transformed. The literal interpretation of the estimated coefficient  $\beta$  is that a one-unit increase in the logarithm of the issue size will produce an expected increase in Y of 0,0261.  $\beta$  is the expected change in Y when X is multiplied by e. So if the issue size of an IPO increases with 1 million, the level of underpricing will increase with 0,01128%<sup>4</sup>. This implies that there is a positive relationship between the issue size of an IPO and the level of underpricing.

The constant factor is the intercept of the model. It is the expected mean value of the market adjusted first day change when all de independent variables are zero (Carter, H. et al. 2012). The significant negative constant coefficient in the model where market capitalization is included indicates that if all the independent variables are zero, the level of overpricing would

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<sup>3</sup> A 1% increase in X gives an expected change in Y of:  $0,0518 \cdot \log([100 + 1]/100) = 0,000223847$  (Benoit, K. 2011).

<sup>4</sup> A 1% increase in X gives an expected change in Y of:  $0,0261 \cdot \log([100 + 1]/100) = 0,0001127879$  (Benoit, K. 2011).

be 21,2%. The significant negative constant coefficient in the model where issue size is included indicates that if all the independent variables are zero, the level of overpricing would be 9,81%.

The R-squared of the model is a statistical measure of how close the data are to the regression line (Frost, J. 2013). The R-squared is the percentage of the variation of the dependent variable that is explained by the model. The R-squared of the model where market capitalization is included is 14,78%. This means that we can explain 14,78% of the variation in the data with our model and the rest is due to air (Carter, H. et al. 2012). The R-squared of the model where issue size is included is 8,60%. The R-squared of both models are pretty low. The model would give better predictions if the R-squared would be higher. The R-squared is probably low because there are a huge amount of different things that can influence underpricing. Low R-squared values are not inherently bad (Frost, J. 2014). Because of a couple of significant results, it is still possible to draw important conclusions about how changes in the independent variables are associated with changes in the dependent variable. The significant results represent the mean change in the response for one unit of change in the independent variable while holding other independent variables constant. Clearly, these results can be very valuable.

#### 5.4. Hypotheses analysis.

In this section, the formulated hypothesis will be analyzed and discussed.

H<sub>1</sub>: The average first-day return on US companies who went public from January 2014 until April 2016 is significantly larger than the market return.

Looking at the tables in the previous section it is possible to conclude that the average first day returns on US companies who went public from January 2014 until April 2016 are significantly larger than the market return. Namely, the market adjusted first day return on issued stock was 12,356%. This is in line with the expectation that US companies on average underprice their assets.

H<sub>2</sub>: The market capitalization of a company has a significant negative effect on the level of underpricing.

There is found a significant positive effect of the market capitalization of a company on the level of underpricing. This leads to a rejection of the second hypothesis. This is contrary to the findings of R. Ibbotson et al. (1994), X. How et al. (1995) and J. Mercado-Mendez (2011)<sup>5</sup>. The results of the OLS regression are in line with the findings of P. Clarkson and J. Merkley (1994) and A. Islam et al. (2010)<sup>6</sup>. It is possible to conclude that the effect of the height of the market capitalization is different for different countries and time periods.

According to previous theories the expectation was that the market capitalization of a company would have a significant negative effect on the level of underpricing. According to X. Zhang (2006), it seemed logical that small firms have a more uncertain initial public offering because there is more uncertainty about the issue of small firms because large firms are more diversified than small firms. Because of this higher uncertainty among an IPO of a small company the expectation was that small firms would have a more underpriced IPO.

Is there a possible explanation that the results of the OLS regression are the opposite from what was expected? F. Allen and G. Faulhaber (1989) have an explanation for this contrary relationship. They explain this with the formulation of the signalling hypothesis. Large companies are often financially more stable than small companies. So a large company is often more certain about that its prospects are good. The company itself knows his own prospects the best. In certain circumstances, firms with the best prospects want to signal their good prospects to investors by underpricing their initial issue because a company can benefit from a good reputation. Investors know that only the companies with the best prospects can recoup the cost of the underpriced initial offering (Allen, F. & Faulhaber, G. 1989). An underpriced initial public offering is a sign to the investors that the prospects of the company are favorable. In fact, they shift own capital gains to gains for the investors because investors make gains on an underpriced IPO. According to this signalling hypothesis, the market capitalization should be positively related to the level of underpricing (Vong, A. & Trigueiros, D. 2010).

H<sub>3</sub>: The reputation of the underwriter has a significant negative effect on the level of underpricing.

Looking at the results of the OLS regression it is possible to conclude that the reputation of the underwriter has a significant positive effect on the level of underpricing. An IPO managed

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<sup>5</sup> Research on 10626 US IPO's from 1960 until 1992, 340 Australian IPO's from 1980 until 1990 and 282 US IPO's from 1998 until 2000, respectively.

<sup>6</sup> Research on 180 Canadian IPO's from 1984 until 1987 and 173 Bangladeshi IPO's from 1995 until 2005.

by an underwriter with a high reputation is more underpriced than an IPO managed by an underwriter with a low reputation. The third hypothesis is rejected.

This contradicts the results of the studies of R. Carter and S. Manaster (1990) and D. Logue (1973)<sup>7</sup>. They both argue that underwriters with a high reputation process less risky IPO's. They argue that IPO's governed by an underwriter with a high reputation are seen as less uncertain and less risky. People expect a more accurate and reliable offer price when the IPO is governed by a prestigious underwriter. So they argue that investors have to be compensated for the ex-ante uncertainty among the IPO if the IPO is governed by an underwriter with a bad reputation. Is there a possible explanation for that the opposite of what was expected is found?

Yes, there are researchers who found the same relationship. W. Dimovsky and S. Philavanh (2010) also found evidence that suggests that underwriters with a high reputation are associated with a higher level of underpricing<sup>8</sup>. Q. Huang and R. Levich (1998) explain this relationship by arguing that prestigious underwriters have more power to price an IPO in their favour (i.e. low price) because of their prestige. Because the issuer of the stock cannot perfectly observe the effort of the underwriter, underwriters have the tendency to underprice the IPO so that they can sell the stock more easily to the market. In this way the underwriter minimizes his selling effort and maximizes the probability of successful offering (Huang, Q. & Levich, R. 1998). So the results of this research are in line with the argument that underwriters seek to underprice IPO's to their own advantage.

H<sub>4</sub>: The age of the company has a significant negative effect on the level of underpricing.

The OLS regression provides evidence to accept the fourth hypothesis. The results of the OLS regression suggest that the older the company gets, the less underpriced its IPO will be. These results are in line with the findings of J. Ritter (1984) and A. Ljungqvist and W. Wilhelm (2003) that older companies have a less underpriced IPO<sup>9</sup>.

C. Muscarella and M. Vetsuypens (1989) argue that older companies have proved that they can survive and operate in the market for a long time and therefore often have a better reputation. Therefore investments in older companies are seen as less risky or less uncertain. Also, J. Ritter (1984) and C. Muscarella and M. Vetsuypens (1989) argue that there is less ex-

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<sup>7</sup> Research on 501 US IPO's from January 1979 until August 1983 and 250 US IPO from March 1965 until February 1969, respectively.

<sup>8</sup> Research on 3980 Australian IPO's from 1994 until 2004.

<sup>9</sup> Research on 1075 US IPO's from 1977 until 1982 and 2178 US IPO's from 1996 until 2000, respectively.

ante uncertainty among an IPO of an older company because the older the company is, the more financial information is available about the company. Because of the less availability of information on young companies, there is more ex-ante uncertainty about the intrinsic value of the stock. J. Ritter (1984) argues that older companies have to leave less money on the table to compensate investors for the amount of information that is available about the company. Younger companies must attract investors by compensating them by underpricing the IPO.

H<sub>5</sub>: The R&D expenditures of a company have a significant positive effect on the level of underpricing.

There is found a significant positive effect of the R&D expenditures on the level of underpricing so the fifth hypothesis can be accepted. Because a dummy variable was created on whether or not a company spends money on R&D, it is possible to conclude that companies who spend money on R&D have a more underpriced IPO than companies who do not spend any money on R&D. This result confirms the earlier findings of R. Guo et al. (2006), M. Heeley et al. (2007) and T. Efrata (2008)<sup>10</sup>.

Guo, R. et al. (2006) explained that the current US GAAP (i.e. Generally Accepted Accounting Principles) only mandates the disclosure of the amount of R&D expenditures. No systematic information on the R&D activities or on the progress of R&D activities is disclosed to investors. It is harder to estimate the intrinsic value of the stock because of the absence of information about the progress and the nature of R&D activities. This means that there is more ex-ante uncertainty among the investors about the intrinsic value of the issuing stock of a company with high R&D expenditures (Guo, R et al. 2006).

J. Cho and J. Lee (2013) provide several explanations for the contribution of R&D expenditures to ex-ante uncertainty in the IPO process. The first explanation is that company insiders often hold superior information about R&D projects. The second explanation is that investors often have limited information about the R&D projects that can help them accurately assess the feasibility of R&D projects. Thirdly, companies often compose and expense R&D investments with intangible assets. These intangible assets are often difficult to value and have high significant sunk cost. According to D. Baron's (1982) model and K. Rock's model with the extension of R. Beatty (1986) and J. Ritter (1986) does ex-ante uncertainty among the intrinsic value of the stock lead to underpricing of the stock.

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<sup>10</sup> Research on 2696 US IPO's from 1980 until 1995, 1413 US IPO's from 1981 until 1998 and 82 US IPO's of pharmaceutical and biotechnological companies from 1998 until 2005, respectively.

H<sub>6</sub>: The issue size of an IPO has a significant negative effect on the level of underpricing.

According to the results of the OLS-regression the sixth hypothesis has to be rejected. The result of the OLS-regression shows that the issue size of an IPO has a significant positive effect on the level of underpricing. This contradicts the findings of R. Beatty and J. Ritter (1986) and X. How et al (1995)<sup>11</sup>. R. Beatty and J. Ritter (1986) argue that investors consider initial public offerings with a low value as more uncertain because initial public offerings with a low value are often more speculative. He argues that because of this uncertainty, small issues are often more underpriced. Also, Dorsman et al. (2013) argue that there is more information available about large issues and because of the information availability are large issues less underpriced. Because of this contradictory finding it is possible to conclude that the behavior in the IPO-market is different for different time periods and different countries.

The results are in line with the results of R. Michaely and W. Shaw (1994). They also found a positive relationship between the issue size and the level of underpricing. R. Michaely and W. Shaw (1994) explain this relationship as follows: they observed that successful subscription of a large issue is dependent on attracting enough investors. They argue that this increases the variance of information asymmetry to be addressed by the issuers while determining the price of the issue. They observed that this leads to more underpricing of larger issues to significantly increase the probability of a successful issue.

#### 5.5. Are the results in line with the models?

The hypotheses which were formulated according to the models of K. Rock (1986) extended by R. Beatty and J. Ritter (1986) and D. Baron (1982) are tested with a multiple OLS regression. Now that the hypotheses are tested, it is possible to discuss whether the results of this research are in line with both models or not.

In order to refresh the memory: the model of K. Rock (1986) and the extension by R. Beatty and J. Ritter (1986) argues that ex-ante uncertainty between uninformed and informed investors causes companies to underprice their IPO's. D. Baron's (1982) model argues that ex-ante uncertainty between the underwriter of the IPO and the issuing company causes underpricing. Ex-ante uncertainty is defined as uncertainty among the intrinsic value of the

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<sup>11</sup> Research on 1028 US IPO's from 1977 until 1982 and 340 Australian IPO's from 1980 to 1990, respectively.

issued stock. In table 6, the expectations of the models and the results of this research will be summarized and compared.

The effect on the level of underpricing	Expectation of the models	Results of the OLS-regression
Market capitalization of the company	-	+
Reputation of the underwriter	-	+
Age of the company	-	-
R&D expenditures of the company	+	+
Issue size of the IPO	-	+

(Table 6)

The results of the OLS-regression are not totally in line with the model of K. Rock (1986) and the extension of R. Beatty and J. Ritter (1986) and the model of D. Baron (1982). The mentioned independent variables are all proxies for ex-ante uncertainty and according to the models, these proxies should have an influence on the level of underpricing of an IPO. The results suggest that all the proxies do have a significant effect on the level of underpricing, but they do not all have the expected effect. The market capitalization of the company, the reputation of the underwriter and the issue size of the IPO have the opposite effect from what was expected according to the models. The effect of the age of the company and the R&D expenditures on the level of underpricing are in line with the expectations of the models. In the previous section is already discussed what the possible causes of the different findings could be.

With the findings of this research it is possible to conclude either that the market capitalization of the company, the reputation of the underwriter and the issue size of the IPO are not good proxies for ex-ante uncertainty or that ex-ante uncertainty among the intrinsic value of issuing stock does not lead to IPO-underpricing. Because the formulation of the proxies for ex-ante uncertainty are theoretically grounded and are used as proxies for ex-ante uncertainty by many well-known researchers, it seems that ex-ante uncertainty among the intrinsic value of the issuing stock does not necessarily lead to IPO-underpricing. So the model of K. Rock (1986) extended by R. Beatty and J. Ritter (1986) and the model of D. Baron (1982) do not hold for the time period between January 2014 and April 2016 in the United States.

According to Loughran and Ritter (2004), it is very reasonable that the causes of underpricing vary across time and environment.

#### 5.6. Advice for investors

In the introduction was said that answering the research question could be useful for investors. And so it does, the results of this research are useful for investors. With the results of this research it is possible to give advice to investors about in which companies they have to invest to increase the probability of high profits. Observing the results, it is possible to argue that the characteristics of companies which are most underpriced are as follows: large market capitalization, young, underwriter has a high reputation, the company does spend money on R&D and the issue size is large. Therefore, if an investor only invests his money in IPO's with those characteristics, he would make more gains than he would if he would invest in all IPO's, assuming that the relationship between the proxies and the level of underpricing stays the same.

To prove that investing in companies with that particular characteristics will give investors more gains, the whole database is filtered on those characteristics. After filtering the database, only companies with the following characteristics are left: large market capitalization, young, underwriter has a high reputation, the company does spend money on R&D and the issue size is large<sup>12</sup>. After filtering, 39 companies are left. The average market adjusted first day return for these companies is 38,80%. This is a huge difference from the market adjusted first day return for all the companies who went public between January 2014 and April 2016. That is namely 12,36%. Therefore, if investors only would invest their money in IPO's with those particular characteristics, they would definitely make a higher profit. So the advice for the investors is to keep investing in companies who go public who have a large market capitalization, are young, are governed by an underwriter with a high reputation, spend money on R&D and the issue size of their IPO is large.

#### 5.7. Advice for issuing companies

Another reason why it would be interesting to conduct this research is because of the missed capital gains for the issuing company when the IPO is underpriced. The missed capital gains of an underpriced stock is the difference between the intrinsic value of the stock (i.e. the maximum amount the company could ask for the stock to have a successful IPO) and the initial

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<sup>12</sup> Large market capitalization: > 100 mln, young company: 0-10 years, underwriter with a high reputation: > 7,99, company does spend money on R&D: > 0, issue size is large > 100 mln.

offer price (McLean, C. 2013). Because of underpricing of IPO's in the last 50 years, US companies missed in total more than 150 billion capital gains (Solomon, S. 2011).

The reason why big companies are more underpriced was explained by the signalling hypothesis (Allen, F. & Faulhaber, G. 1989). Large companies are often financially more stable than small companies. So a large company is often more certain about that its prospects are good. In certain circumstances, firms with the best prospects want to signal their good prospects to investors by underpricing their initial issue. It is good for a companies' reputation if the first day returns are positive. The advice for the companies who have an underpriced IPO because of this reason would be to try to signal their good prospects in another way to the investors. For example, by making more financial information available to the public.

The reason why IPO's governed by an underwriter with a high reputation are more underpriced is because of that prestigious underwriters have more power to price an IPO in their favour (i.e. low price). Because the issuer of the stock cannot perfectly observe the effort of the underwriter, underwriters have the tendency to underprice the IPO so that they can sell the stock more easily to the market. In this way the underwriter minimizes his selling effort and maximizes the probability of successful offering (Huang, Q. & Levich, R. 1998). Therefore, the advice is for issuing companies to work more closely together with the underwriter when determining the price of the stock. By working more closely together with the underwriter, the effort of the underwriter can be better monitored. The underwriter has less ability to underprice the assets in their favor.

It is often the case that there is more financial information available about older companies. Therefore, young companies are often more underpriced because older companies have to leave less money on the table to compensate investors for the amount of information that is available about the company (Ritter, J. 1984). The advice is here for young companies to give more financial information to the public. If there is more information available about the company, the ex-ante uncertainty among the intrinsic value of the issued stock decreases. Subsequently, the company does not have to leave less money on the table to compensate investors for the amount of information that is available.

The reason that IPO's of companies who spend money on R&D are often more underpriced is because of the uncertainty that R&D expenditures creates. J. Cho and J. Lee (2013) argue that company insiders often hold superior information about R&D projects, that investors often have limited information about the R&D projects that can help them accurately assess the feasibility of R&D projects and that companies often compose and expense R&D investments with intangible assets. The advice is to publish as much information on R&D

projects as possible. If investors are more informed about the expenditures on R&D and about the feasibility of the R&D projects, they will have less uncertainties among the intrinsic value of the IPO. If there are less uncertainties among the R&D expenditures, the stock has to be less underpriced to successfully issue the stock.

R. Michaely and W. Shaw (1994) observed that successful subscription of a large issue is dependent on attracting enough investors. They argue that this increases the variance of information asymmetry to be addressed by the issuers while determining the price of the issue. They observed that this leads to more underpricing of larger issues to significantly increase the probability of a successful issue. The advice for companies is to make a more accurate prediction of the intrinsic value of the stock. An issue does not have to be underpriced by 30% to be successful. If a company has a more accurate valuation of its IPO, the issue does not have to be underpriced by a hugh amount to be successful.

## 6. Discussion.

The research question of this research is: Does ex-ante uncertainty about the intrinsic value of the stock lead to underpricing of the IPO of US companies between January 2014 and April 2016? The answer to this question is: not necessarily. The effect of certain proxies on the level of underpricing indicates that ex-ante uncertainty among the intrinsic value of the stock does not necessarily lead to IPO-underpricing. These results conflict with the model of K. Rock (1986) and the extension of R. Beatty and J. Ritter (1986).

In the literature overview, previous studies on the relationship between ex-ante uncertainty and underpricing were discussed. P. Clarkson and J. Merkley (1994), Y. Ting and Y. Tse (2006), Clarkson (1994) and D. Kennedy et al. (2006)<sup>13</sup> all found evidence for ex-ante uncertainty to cause IPO underpricing. The results of this research suggest that ex-ante uncertainty among the intrinsic value of the issued stock does not necessarily cause IPO underpricing. Therefore, it is possible to say that the behavior in the IPO-market has changed over time. As mentioned earlier, it is possible that the financial crisis from 2008-2012 had an impact on the behavior in the IPO market. According to S. Henry and N. Gregoriou (2013) did the Global Financial Crisis change the behavior of issuing companies. They argue that offerings are now often more underpriced and oversubscribed. R. Hall (2010) argues that investors became more risk-averse after the Global Financial Crisis and therefore suddenly prefer investing in high-quality debt such as debt of the US government to lower quality investments. E. King and L. Banderet (2014) say that the Global Financial Crisis caused widespread investor pessimism.

Another explanation would be that in the current IPO-market less ex-ante uncertainty exists among IPO's. Throughout the years, it became easier and it takes less time to get informed about a company. This is mainly because of the emergence of the internet and because of the increased influence of the media. Because of the internet, for example, an investor in Europe is informed about an US company in less than one second. It became easier to get informed about a company. Also because of the increased influence of the media, information gets spread widely more easily. This decreases the ex-ante uncertainty among the pricing of an IPO. Hence it is possible that because there is less ex-ante uncertainty among the pricing of an IPO nowadays compared with an IPO in the eighties or nineties, there is no clear relationship between ex-ante uncertainty and underpricing anymore. So perhaps, the influence of ex-ante

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<sup>13</sup> Examined Canadian IPO's in during the 80's, Chinese IPO's from 1995 until 1998, US IPO's from 1976 until 1985 and US IPO's from 1991 until 1998, respectively.

uncertainty on underpricing of an IPO decreased, while the influence of other causes of underpricing, such as litigation, signalling or behavioral causes increased.

The results of this research have also some things in common with the results of previous conducted studies. D. Kennedy et al. (2006) found that the high-tech sector faces greater ex-ante uncertainty and, as a result, their IPO's will be more underpriced. This is in line with the finding of this research, that companies who spend money on R&D are more underpriced. This because the R&D expenditures are high in the high-tech sector. Also, C. Muscarella and M. Vetsuypens (1989) and C. Cheung and I. Krinsky (1994) both tested D. Baron's (1982) model and both found the opposite of what Baron's model predicts. The results of this research also partially contradict the model of D. Baron (1982).

Looking at the findings of previous studies and the findings of this research, what does this research add? The purpose of this paper was to find evidence that will support or contradict the assertion that ex-ante uncertainty causes underpricing. Therefore, the most important finding is the finding that ex-ante uncertainty about the intrinsic value of an issuing stock does not necessarily cause underpricing. Furthermore, the data of the research is as recent as possible so the results of the research are applicable to the current IPO-market in the US. Also, the results of the research are innovative because the results really differ from previous conducted studies. Because of the recency and the innovativeness of the data and the results, it was possible to give a renewing advice to IPO-investors and issuing companies.

## 7. Conclusion.

Looking at studies conducted in the last couple of decades it is possible to conclude that initial public offerings of companies who went public always have been underpriced on average. Also for the time period January 2014 until April 2016 initial public offerings have been underpriced on average with 12,536%.

Among the underpricing literature, there are several models which try to explain underpricing of IPO's. Two of the most important models are the winner's curse model of K. Rock (1986) which is extended by the ex-ante uncertainty hypothesis by R. Beatty and J. Ritter (1986) and D. Baron's (1982) model. The model of K. Rock (1986) and R. Beatty and J. Ritter (1986) argues that ex-ante uncertainty between uninformed and informed investors causes companies to underprice their IPO's. D. Baron's (1982) model argues that ex-ante uncertainty between the underwriter of the IPO and the issuing company causes underpricing. Ex-ante uncertainty is here defined as uncertainty about the intrinsic value of the stock when going public. To test whether these models hold, the following research question was formulated:

*Does ex-ante uncertainty about the intrinsic value of the stock lead to underpricing of the IPO of US companies between January 2014 and April 2016?*

To test this relationship, different proxies for ex-ante uncertainty were formulated: the market capitalization of the company, the reputation of the underwriter, the age of the company, the R&D expenditures of the company and the issue size of the IPO. By testing the relationship between these proxies of ex-ante uncertainty and underpricing, it is possible to ultimately discuss whether ex-ante uncertainty has a significant effect on the level of underpricing and whether the model of K. Rock (1986) extended by R. Beatty and J. Ritter (1986) and the model of D. Baron (1982) hold.

The results of the OLS-regression are not totally in line with the model of K. Rock (1986) and the extension of R. Beatty and J. Ritter (1986) and the model of D. Baron (1982). The results suggest that all the proxies do have a significant effect on the level of underpricing although they do not all have the expected effect. The market capitalization of the company, the reputation of the underwriter and the issue size of the IPO have the opposite effect from what was expected according to the models. The effect of the age of the company and the R&D expenditures on the level of underpricing are in line with the expectations of the models. Therefore, it is possible to conclude that the model of K. Rock (1986) extended by R. Beatty and J. Ritter (1986) and the model of D. Baron (1982) do not hold for this time period in the United States. Subsequently, the answer to the research question whether ex-ante uncertainty

about the intrinsic value of the stock leads to underpricing of the IPO of US companies from January 2014 until April 2016 can be answered with: no, not necessarily. Ex-ante uncertainty does not have a significant effect on the level of underpricing of an IPO.

The results of the research give really good insights for investors. The results give insights for investors about in which issuing companies they have to invest to possibly increase their profits. Observing the results, it is possible to argue that the characteristics of companies which are most underpriced are as follows: large market capitalization, young, underwriter has a high reputation, the company does spend money on R&D and the issue size is large. If an investor would have invested only in companies with those characteristics from January 2014 until April 2016, he would have made an average first-day gain of 38,80%. This is a major difference from the 12,536% average first day return on all IPO's.

The results of the research also gave some good insights for issuing companies. The advice for issuing companies is to make more financial information and information about R&D expenditures available to the public, work more closely together with the underwriter and make a more accurate prediction of the intrinsic value of the stock. If issuing companies follow this advice, they can decrease the underpricing of their IPO (i.e. the compensation for investors). Issuing companies will leave less money on the table.

Now that there is found that there is no significant relationship between ex-ante uncertainty and the level of underpricing of an IPO and therefore the models of R. Beatty and J. Ritter (1986) and Baron (1982) do not hold, it may be interesting for future research to test whether the signalling hypothesis, the litigation hypothesis or the discussed behavioral causes of underpricing hold. By testing these causes of underpricing, it may become even more clear for what reasons, underwriters, or the issuing company underprice their IPO and what kind of companies underprice their IPO.

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