IPO market of the U.S. and Germany in relation to recessions

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Abstract

Past research by Ritter and Welch (2002) showed that business-cycles might be an important factor in the IPO market. In order to explore this idea further I look how recessions affect the IPO industry and the level of underpricing in the United States and Germany from the period 1990-2018 and 2002-2018, respectively. I analyzed 3841 U.S. IPOs and 124 German IPOs and find that recessions especially alter the IPO distribution per industry and that characteristics affecting the level of underpricing also change drastically.

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1 Introduction

There have been many papers on the different effects of information asymmetry on the level of underpricing of an IPO (Ritter & Welch, 2002) (Clarkson, 1994) (A. Ljungqvist, 2007). However, despite the abundance of literature on the subject matter, research has yet to deliver a satisfactory answer to this phenomena. This paper aims to add to this literature and contribute to this yet mystery with a new perspective. With the recent recession caused by the coronavirus outbreak, it ought to be interesting to see whether recession affects the level of underpricing and whether recession affects variables that influence underpricing, such as the frequency and total issuance.

Halfway December 2019 the first cogs of a global crisis was set in motion when a virus outbreak struck the city of Wuhan, China. This crisis was later known as the Coronacrisis or Covid-19 outbreak after it became a pandemic in just a few months. Besides obvious humanitarian consequences after a third of the world and almost all developed countries went on some form of lock-down, it is also interesting to see how this pandemic affected economics, in specific how it materializes in the initial public offering market.

In the first quarter of 2020, we witnessed a stock price plummet of the S&P500, which is considered as one of the best representations of the U.S. stock market. The stock market exchange dropped over 30 per cent in just a month, evidence for a strong economic recession as found in recent papers by Farmer (2012) and Wolff (2016). These stock market plummets insinuate that Covid-19 does indeed have severe economic consequences that are interesting to look into. Recessions are an extremely common thing and some like Caballero and Hammour (1991) would argue they are necessary to maintain a healthy economic system. Moreover, Eichengreen (1996) would argue that recessions caused by crisis are what stimulates rapid economic growth for a longer period once the crisis is averted. Abramovitz (1986) claimed that this was mostly due to the fact of dormant technology, unused during the crisis. I do believe these assumptions to have some definitive truth to it.

In this paper, I will take a closer look at the New York Stock Exchange for the IPO market of the United States. More specifically this paper looks at IPOs from 1990 up to and till 2018 and investigates the IPO market during previous times of recession through statistical methods for a total of 3841 IPOs. Furthermore, I also compare the United States with Germany as a mean of cross-sectional comparison, this will be a comparison between the two countries between 2002 and 2018. A total of 124 German IPOs were used as data. As mentioned in La Porta, Lopez-De-Silane, Shleifer, and Vishny (1996) La Porta, Lopez-de Silanes, Shleifer, and Vishny (1997) the legislation and the trust in

the execution of a country around the financial market is detrimental for markets such as the IPOs. Therefore it would be interesting to see if recessions affect the IPOs of disparate financial systems differently. Different from Ritter and Welch (2002) this paper will mainly focus on short-term performances of the initial issuance of stock, whereas their paper also looks at long-term performances. Characteristics such as the first day-return, quantity of IPOs and market capitalization are all variables that will be used to analyse the performance of the IPOs during a recession and normal economic circumstances.

This paper aims to contribute to previous literature on business-cycle affecting the IPO market climate. I do this by adding a new and larger time-frame than the one used in Ritter and Welch (2002). Also by adding a European comparison using Germany as a staple for European IPO climate I want to contribute to literature about the difference in IPO market beyond the United States. Ritter and Welch (2002) show evidence that IPO quantity and other measures such as total market capitalization are most likely correlated to business-cycle and market conditions. They review IPOs in the U.S. from 1980 up to and till 2001, this research aims to add a new time-frame and to add socio-economic crisis into consideration.

The remainder of the paper is structured as follows. Section two provides a theoretical framework, where recent and past literature on this subject and its concepts is discussed. After the review and explanation of concepts, I develop hypotheses to answer my research question: What can we expect of the U.S. and German IPO market of the U.S. and Germany in relation to recessions? Section three discusses the data sample and key variables used in the analysis. Then the fourth section, an explanation and reasoning for the empirical analysis and methods. Section five presents the evidence for my hypotheses, describes the results derived from analyzing the data and provides summarized tables of the most important findings of this paper. And finally, I will conclude and attempt to answer my research question also relating to past evidence and provide limitations of the study and propose suggestions for future research.

2 Theoretical Framework

In this theoretical framework, I review research that has been done in this field before and try to develop my hypotheses. This paper tries to contribute to previous works such as Ritter and Welch (2002), Clarkson (1994) and A. Ljungqvist (2007) by providing a greater set of data to explore business-cycle and adding the current social aspect of a new potential recession caused by the Coronacris.

2.1 The Underpricing Anomaly

Ritter and Welch (2002) wrote a seminal paper on the underpricing of IPOs but had yet found a definitive answer in reviewing past literature. Underpricing is such a relevant subject matter due to two reasons. The first reason is that when companies decide to go public, besides the obvious advantage of raising capital there are also disadvantages that come with it; the labour intensive process, the compliance with strict regulatory requirements and the disclosure of financial information. However, for the advantages to outweigh the disadvantages such companies need to leave as little money on the table as they possibly can. For this reason, companies usually seek out assistance from an underwriting firm to determine the right price and timing to go public with. On the other side of the coin, however, it is likewise interesting for private and institutional investors to exploit this anomaly.

The discrepancy between the offering price and the market price is what is commonly know as the level of underpricing. The first-day returns that can be gained from buying a stock at IPO and selling it for the market price that same day for a high initial return is the anomaly we know as short-term underpricing. Ibbotson, Sindelar, and Ritter (1994) showed in their article that the level of underpricing in the U.S. in the period 1960-1992 is approximately 10-15%. This paper also proved that underpricing remained persistent throughout this entire period. Similar results were found in Germany in a paper by A. P. Ljungqvist (1997) who found an average of 9.2% in short-term underpricing during the period 1970-1993. Moreover, Wasserfallen and Wittleder (1994) found an even higher level of underpricing with an average of 17.6% over the period 1970-1987. It will be interesting to see how recessions affect the first-day return of IPOs.

2.2   Ex-Ante Uncertainty

A multitude of research has been done on the underpricing of IPOs by various researchers. They proposed a couple of different explanations; ex-ante uncertainty (Rock, 1986); (Beatty & Ritter, 1986), litigation-risk hypothesis (Tinic, 1988), signaling (Allen, Faulhaber, et al., 1989), behavioral explanation (Welch, 1992), investment bank conflict theory (Goldstein, Irvine, & Puckett, 2011) and managerial conflict theory (Arthurs, Hoskisson, Busenitz, & Johnson, 2008). This thesis will focus on the ex-ante uncertainty aspect of prior research. Rock (1986) explained this in his paper using the 'Winner's Curse' problem. Rock's main argument was that uninformed investors subscribe to every IPO due to lack of information. On the other hand, informed investors only subscribe to IPOs which they have identified to certainly reign in a profit. Hence, if an IPO is initially overpriced, uninformed investors are the sole investors in such IPOs and will lose their money after the market price declines. Eventually, this will drive out any uninformed investor in the market. Therefore, underwriters deliberately underprice the initial public offering to attract the investors staying in the market. This can be considered as a reward for uninformed investors. Beatty and Ritter (1986) extended the model and stated that the greater the ex-ante uncertainty, the more intensified the winner's curse problem, and the more underpricing in the initial public offering.

2.3   Recession

Sohail, Raheman, and Durrani (2010) write a paper about IPOs in Pakistan during three states of the economy; normal, booming and recession and find that recessions almost always show a lower initial return than during normal or booming states. They also analyze per industry sector and find that some sectors outperform even in recessions. Recessions are an extremely common thing, for example in the 20th century the United States has seen more than 15 recessions of different lengths. Often these recessions last approximately a year, and sometimes in the case of the Great Depression of 1929 it last 3 years. The most commonly known definition for a recession is two subsequent quarters with a negative real GDP. The National Bureau of Economic Research (NBER) describes a recession as ''a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales'' (NBER, 2008). For the sake of this research, we are going to assume a recession if the negative real GDP holds for a period longer than 3 months. This leads me to my first hypothesis;

Hypothesis 1: Recessions significantly decrease the first-day return on IPOs

2.4   IPO Characteristics

2.4.1   Quantity

Ritter and Welch (2002) found evidence that business-cycle was part of the reason for issuers of IPOs, but could not fully explain it. This was due to there being no clear identifier or information of the private business that withheld from going public. Their motives were therefore never made public.

2.4.2   Life-cycle

Another indicator for issuers to go public was the age of the business, the life-cycle. Mezhoud and Boubaker (2011) wrote that younger business has a lot less information available, which causes a higher ex-ante uncertainty. Beatty and Ritter (1986) argue in their paper that underpricing is related to ex-ante uncertainty. Furthermore, they demonstrate that there is a relation between the expected underpricing of an IPO and the ex-ante uncertainty of investors regarding its value. According to another paper by Bilson, Heaney, Powell, and Shi (2003) this ex-ante uncertainty will be directly reflected in a higher first-day return. Since younger companies have more uncertainty in general an expectation can be drawn that during a recession this uncertainty is generally higher than normal and older companies, who have survived more economic downturns, have increased reliability, thus less uncertainty.

2.4.3   Issue Size

Beatty and Ritter (1986) did empirical research on 1028 IPOs in the US from 1977 to 1982. In their paper, they show empirical evidence that small issuances are on average more underpriced than large issuance. Beatty and Ritter used gross proceeds as a proxy for ex-ante uncertainty, arguing that gross proceeds can capture the regularity between small and large issued size, which was initially proposed in another paper by (Ritter, 1985), one year earlier. Similar results were also observed in the studies of How, Izan, and Monroe (1995) and (Megginson & Weiss, 1991), who find that larger IPOs have less underpricing on average. Dorsman, Simpson, and Westerman (2013) suggests one possible explanation is that larger IPOs often attract more attention from investors because they intrinsically estimate the value to be higher. Therefore, there is much more available information on large offerings. Finally, similarly to company age, during recessions, people are more likely to research the companies with larger issue sizes, since investors often naturally risk avers.

2.4.4 Market Capitalization

According to Zhang (2006) large firms are often more diversified than small companies, therefore investors are exposed to financial data and structural data more frequently of those large firms. Large firms also tend to be closely monitored by other mediums such as the government and television, so there is a lot less ex-ante uncertainty about the value of its stock. This would naturally mean that large-cap firms should see less underpricing. Nevertheless, various papers provide evidence that there's a positive relationship between market capitalization and IPO underpricing. Clarkson (1994) Sohail and Raheman (2009) found evidence of this in their papers. Allen et al. (1989) suggests this happens due to large companies underpricing their stocks to reflect their positive prospects to individual and institutional investors. He explains this at the hand of the signalling hypothesis. Thus, the effect of Market Capitalization on the ex-ante uncertainty is controversial at best, however, for this paper we assume that the latter of the two holds.

However, there is various evidence of the positive relationship between market capitalization and IPO underpricing, which was found in previous studies of Clarkson and Merkley (1994), Sohail and Raheman (2009), and Islam, Ali, and Ahmad (2010). Allen et al. (1989) explained this occurrence using the signalling hypothesis, in which, large companies underprice their stocks to reflect their positive prospects to the investors. It is clearly shown that there are still controversial opinions regarding the effect of market capitalization on the level of IPO underpricing, therefore, with these IPO characteristics in mind, our second hypothesis is formulated below:

Hypothesis 2: Recessions significantly alter the effects and significance of IPO characteristics affecting initial return.

2.5   Disparate financial systems

Furthermore, unlike Ritter and Welch, this paper also broadens the view towards Europe including Germany in the research. According to La Porta et al. (1997) these two countries should see different effects of recessions due to different financial systems and a different level of supervision on illegalities such as inside trading. Ritter (2003) found several other differences between European and American IPO market. A major difference is the 'quiet period' all issuers have to adhere to in the U.S. Whereby analysts that are associated with underwriters are forbidden to report recommendations for 40 days after the issuer went public. This quiet period, however, does not exist in Europe according to this paper. I have not found any evidence this has changed since then. To go further into the specifics

of these legal differences would be beyond the scope of this paper but for this paper, we are assuming that it is likely to find significant differences in reactions to business-cycle in the IPO market. Another paper by Wasserfallen and Wittleder (1994) is about the German IPO market, they research 92 german IPOs between 1961 and 1987 and find over 90% of those to be underpriced. Furthermore, they find evidence for this underpricing in the ex-ante uncertainty about the values of the shares. To compare the United States IPO market with the German IPO market the following hypothesis was formulated.

Hypothesis 3: The United States sees a significantly greater alteration during a recession, in the effects of IPO characteristics on initial return and the returns per industry, compared to Germany

2.6   Coronacrisis

The United States has been hit by the coronavirus only recently so the consequences of the virus in relation to the IPO market are not researched yet it is however interesting to see the different reactions of country leaders. Donald J. Trump the President of the United States claims that, even though output has substantially declined, there is no reason to worry for a recession. (Eichengreen, 2020) however, disagrees and thinks the economic consequences of this pandemic will be seen for years to come. He attributes this mostly to higher savings by people that have now realized that they do not necessarily have the capital to sustain themselves during another crisis. Logically when people start saving output would have to decline, following basic macro-economic concept and less output often means higher unemployment rates, thus a recession. Kaas (2020) writes that in Germany several measures were taken to limit the loss of income by people that were laid off as a result of the coronavirus. Furthermore, tax leniency and emergency loans are issued by the government, so large business can sustain their capital costs such as rent during these times of lower output. The coronavirus will not be investigated for the remainder of this paper, however, the results found in this paper will be used to draw expectations of how it might affect the IPO market.

3 Data and Methodology

This section will provide the empirical foundation on which my research is based on. I use the data discussed in this section to answer my hypothesis and find explanations on the effects of recessions on IPOs. The remainder of this section is divided into four subsections. In subsection 1 I discuss the different data sources and which data I retracted from which source. In subsection 2 I will discuss the manners in which data transformation has taken place. In subsection 3 I will define the dependent and independent variables used in this research and translate this to understandable measures.

3.1 Data sources

Data for this paper was gathered from a multitude of different sources. The main source of data was the Datastream database. This data was extracted using the ThomsonOne tool-app. In Datastream I gathered all information regarding a company's offer prices, closing prices, closing price after 1 week, date of issue, a nation of IPO and the industry the IPO takes place in (i.e. Consumer Products and Services, Consumer Staples, Energy and Power, Government and Agencies, Healthcare, Industrials, Materials, Media and Entertainment, Retail and Telecommunications services). Secondly, the Center of Research in Security Prices (CRSP) was used for all security-related items such as the shares issued, total issue size, the market capitalization. Moreover, CRSP was also used to extract the daily return on the S&P500 which will be used as a control variable in the regressions.

The data regarding the company age of U.S. based companies was gathered from the Field-Ritter dataset of company founding dates. This data was first used in papers by Field and Karpoff (2002) and Loughran and Ritter (2004). This data set contains all the company names of firms that have decided to go public with an IPO in the U.S. between the period of 1975 and 2018. This data set also contains these firm founding dates, CRSP permanent IDs and the first day of trading on CRSP. Companies for which Ritter and Field did not find a trustworthy founding date were left out from the list. The company age of German-based companies was gathered from the Bloomberg database. This dataset included the CRSP permanent ID's, and the founding year and the first day of trading.

3.2   Data transformation

The IPO market is infamous for having extreme positive outliers especially when the only thing observed is the initial return of the offering. In some industries, we see initial public offerings with initial returns of more than 15000 per cent and therefore it is important to acknowledge the special circumstances of these offerings. This often occurred when a tech company offered issues at 0,01$ and then rose to many times that value in the first day. For this reason, offerings with an offering price less than 5$ were removed from the data set initially. These outliers often fell in the same industry and for this reason, all public offerings in the High Electronics industry have been left out, as there was no substantial dataset left to represent this industry after removing all offerings with an offer price below 5$. Furthermore, given the vastly different financial characteristic of an IPO in Real Estate, Financial and Governmental IPOs, these have been removed from the data set as well.

Moreover, Ritter and Field's database and Bloomberg database did not have a complete list of all founding years in the dataset. For that reason, all companies for which I was unable to find a founding year were removed from the dataset. Secondly, in the dataset retrieved from Datastream, some variables were missing including some closing prices and some offer prices. The purpose of this research is to find out how recession affects these variables and therefore, observations that were missing a variable were removed from the dataset.

Table 1: Dataset Table visualization of observations.

The dataset transformation visualized by identifying observations lost after each transformation indicated by N-observations left after each step used in the transformation

	Raw IPO data retrieved from ThomsonOne Datastream (1990-2018 U.S. and Germany)	Removed all observations that missed either closing price or offer price information	Removed all IPO's with offer prices below 5$	Removed High Electronics, Real Estate, Government Agencies, and Financial Institutions.	Removed all observations with missing variables for one of the mentioned variables in Table 2. Most of these were missing company age.
U.S.	N=10586	N=8840	N=4778	N=3855	N=3841
Germany	N=1121	N=212	N=162	N=125	N=124
Total	**N=11707**	**N=9052**	**N=4940**	**N=3980**	**N=3965**

3.3 Data variables and interpretation

In this paper the main dependent variable is 'Initial Return', however, I will also look at the dependent variable 'Initial One Week Return' because it is interesting to see whether recessions can alter not only the initial return but also the expected return one week after. In this paper 'initial return', 'IR' and 'level of underpricing' are used interchangeably. The remainder of the independent, dummy and control variables used in this paper can be found in Table 2

Table 2: Variable names and descriptions.

Decription and measurement of the dependent variables; Initial Return and Initial One Week Return. Also description of the independent, dummy and control variables used in this paper; Company Age, Issue Size, Market Capitalization, Total Shares Issued, Recession(dummy), Nation(dummy),Industry(dummy) and Return on S&P500 and DAX index (contol).

Dependent	Description and Measurement	Source
Initial Return	This variable measures the first day return of an IPO. The initial return is calculated as the percentage change from the offer price to the closing price on the first day.	DataStream
Independent		
Company Age	The age of the firm at the time the IPO was issued (in years), calculated by subtracting the founding year of the company by the issuing year.	Jay Ritter Database (U.S.) / Bloomberg (Germany)
Offer Price	The initial price of the share at the IPO.	DataStream
Issue Size ($ mln)	Is the total equity gained from the IPO calculated by the number of shares offered multiplied by the offer price, stated in millions of dollars.	CRSP
Market Capitalization ($ mln)	Is the total net worth of the published shares at the closing of the exchange. Calculated by the number of shares offered multiplied by the market price, stated in millions of dollars.	CRSP
Total Shares Issued ($ mln)	This is the total shares issued at the moment of IPO, stated in millions.	CRSP
Dummy Variables		
Recession	The lead dummy variable for this research. This variable is 0 in normal economic times and 1 in times of economic recessions	OECD
Nation	This variable indicates the country in which the IPO takes place. This variable is 0 in case of an IPO in the U.S. and a 1 in case of a German IPO.	DataStream
Industry	This variable is sub-divided into 9 macro industries (i.e. Consumer Products and Services, Consumer Staples, Energy and Power, Government and Agencies, Healthcare, Industrials, Materials, Media and Entertainment, Retail and Telecommunications services). This variable is either 0 or 1 depending on the industry the IPO takes place in.	DataStream
Control Variables		
Return on DAX	The return on DAX Index at the end of the first day. Calculated as the Natural Logarithm of the current closing index price divided by the closing index price of yesterday.	Yahoo Finance
Return on S&P500	The return on S&P Composite Index at the end of the first day. Calculated as the Natural Logarithm of the current closing index price divided by the closing index price of yesterday.	CRSP

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3.4 Methodology

The dependent variable of importance in this paper is the 'Initial Return' the initial return is calculated as the percentage change from the offer price to the closing price on the first day. The formula for this looks as follow:

$$\textbf{Initial Return}_i = \frac{ClosingPrice_i - OfferPrice_i}{OfferPrice_i} \tag{1}$$

For this research I run some simple OLS regressions both univariate and multivariate to discover the relation between the different independent variables and the dependent variables. The basic univariate OLS-regression model will look like the following:

$$\textbf{InitialReturn}_i = \alpha + \beta_1 X_{1_i} + \epsilon_i \tag{2}$$

In this regression, Y_i denotes the initial return of the IPO at company $_i$. Hence Y stands for the level of underpricing for each company $_i$ that went public between 1990 and 2018. Furthermore, the independent variables are represented by the $X_1 + ... + X_n$. The coefficients of the determinants are denoted in $B_1 + ... + B_n$. α is the point where the regression crosses our Y coordinate, the constant. Finally, the ϵ denotes the error term of the model. When I extrapolate our determinants I find the following multivariate model for each country respectfully.

$$\begin{aligned}
\textbf{Initial Return}_i = \alpha &+ \beta_1 CompanyAge_i + \beta_2 OfferPrice_i + \beta_3 IssueSize_i \\
&+ \beta_4 MarketCapitalization_i + \beta_5 TotalSharesIssued_i \\
&+ \beta_6 ReturnOnSP500_i + \beta_7 Recession_i + \epsilon_i
\end{aligned} \tag{3}$$

$$\begin{aligned}
\textbf{Initial Return}_i = \alpha &+ \beta_1 CompanyAge_i + \beta_2 OfferPrice_i + \beta_3 IssueSize_i \\
&+ \beta_4 MarketCapitalization_i + \beta_5 TotalSharesIssued_i \\
&+ \beta_6 ReturnOnDax_i + \beta_7 Recession_i + \epsilon_i
\end{aligned} \tag{4}$$

Where: $X_4 = $ Market Capitalization

                                                $X_5 = $ Total Shares Issued

Constant $= \alpha$ $X_6 = $ Return on Index

Continuous Variables;   **Dummy Variables;**

$X_1 = $ Company Age $D_1 = $ Recession

$X_2 = $ Offer Price

$X_3 = $ Issue Size

3.5 Validity

The validity of the results is one of the most important aspects of research, otherwise, it would be a weak investigation into empirical data. For this reason, a few proofs of validity were exercised to check for the soundness of this empirical research.

3.5.1 Heteroskedacity

Heteroskedasticity is another problem I am most likely facing when running my regression without adding any robust measures to it. I run a simple White-test to reject or not reject the null hypothesis of homoskedacity. We indeed find beyond a reasonable doubt that the null can be rejected and that there is heteroskedasticity, therefore I decided to include robust standard error terms in the regressions. Furthermore, we tested whether the significance and betas of the different industries were significantly different from each other. Ritter and Welch (2002) also note that industries play a huge difference in the level of underpricing of an IPO. For that reason, I transformed my regression into panel data with industries as entities. This panel data will be run in a fixed-effect model to compensate for clustered standard errors and also partly, due to the nature of the model, also helps against omitted variable bias. In the next section, I talk more about OVB and endogeneity in general.

3.5.2 Endogeneity

Endogeneity through reverse and simultaneous causality and Omitted Variable Bias (OVB) is a serious issue in the research in IPOs. There is a multitude of different factors affecting the IR of an IPO. These factors can by anything from the mechanics of the market to the intra-relations of the private business going public. It is therefore up and till this point been impossible for many researchers such as Ritter and Welch and many others to build a model that perfectly incorporates all variables. OVB will therefore always an issue when empirically investigating IPOs. However, to compensate for some OVB a control variable

was added to the regression in the form of an index return. The S&P 500 and the DAX index growth has been added as a control variable to the regression. This way I control for the increase or decrease of underpricing caused by the mechanics of the stock market in the U.S and Germany. Since all U.S. IPOs are listed on an exchange and S&P500 has been regarded as one of the best indicators of the U.S. stock exchange movement (Kenton, 2020), my choice fell on the S&P500 as the control variable for the U.S. In Jasic and Wood (2004) their paper they look into a new method of short-term stock prediction. In this paper, they look at both the S&P500 and the Deutscher Aktienindex (DAX) as similar exchanges. For this reason, I used DAX as the control variable for the German IPOs.

4   Results

In this section the results are derived from the model discussed earlier in the methodology and I collect enough data to sufficiently answer my hypotheses. This section will be divided into several subcategories. First I will go over some of the descriptive statistics, then I will continue into the univariate regressions and panel data regressions. These results will be discussed in the next section, the conclusion where I aim to answer all my hypotheses.

4.1   Descriptives

In this section, I will go over the descriptive statistics of both the U.S. and Germany. In Table 17 and Table 18 a brief look at the distribution of the sample between normal and recession IPOs is taken. These tables can be found in the Appendix. It is clear from these tables that the average German IPO quantity does not alter too much between the two different economic situations. On the contrary, U.S. IPO quantity seems to alter quite heavily. IPO frequency during recessions is about a fifth of the frequency compared to normal economic times in the U.S.

For the U.S. a total of 3841 IPOs from the period of 1990 up to and till 2018 were used in this analysis with a sample average of 132 IPOs yearly. The averages and medians of the IPOs from this period can be found in Table 3 and Table 4, respectfully. In Table 3 you can see that between 2000 and 2001 a change happened in the IPO market when the total amount of IPOs started to diminish. The period from 1990 up to and till 2000 make up for a total of 2610 IPOs, more than two-thirds of the total IPOs investigated in this period. In 1996 alone, more than 10% of the sample size can be found. In 1999 we find the highest average initial return of 58,77% followed by 2000 with an average initial

return of 48,31%.

This period is nowadays widely known as the dotcom bubble and is infamous for its astronomical levels of initial return that would overshadow any level of initial return thereafter (A. Ljungqvist & Wilhelm Jr, 2003). However, this all came crashing down after the bubble was popped in the spring of 2000, these high initial returns were then followed by times of recession and it would never reach those same heights again. Another recession in 2008-2009 caused the total amount of IPOs to plummet to only 19 and 25 that year, respectfully. After that, the IPO market seems to slowly but surely stabilize around the averages for every benchmark in the table, with 2011 and 2016 as an exception, where another recession seems apparent.

In Table 4 the medians of the IPOs can be found. Immediately you notice that the median initial return is much lower than the average initial return. This indicates that the initial return is heavily skewed to the right. This is most likely since you can have initial returns higher than 100% but never lower than negative 100% - because the stock value cannot become negative. Other than that, we see similar patterns in the increase and decrease of the benchmarks as we have seen in Table 3.

Table 3: Average Initial Return, Average Closing Price, Average Offer Price and Total of IPOs sorted by year in the U.S.

Year	Total IPOs	Average Initial Return	Average Closing Price	Average Offer Price
1990	77	9,29%	$11,77	$10,82
1991	191	10,08%	$12,89	$11,70
1992	279	10,33%	$12,41	$11,19
1993	347	12,33%	$13,22	$11,68
1994	280	8,88%	$11,53	$10,58
1995	256	15,94%	$13,47	$11,72
1996	417	15,45%	$14,25	$12,28
1997	284	12,06%	$13,83	$12,21
1998	144	14,90%	$15,20	$13,02
1999	178	58,77%	$26,09	$15,19
2000	157	48,31%	$22,86	$14,27
2001	39	13,24%	$17,18	$15,22
2002	38	9,21%	$18,42	$16,82
2003	34	10,52%	$16,92	$15,13
2004	106	10,88%	$15,29	$13,41
2005	99	9,81%	$16,11	$14,54
2006	106	8,00%	$16,08	$14,63
2007	93	12,37%	$17,22	$15,06
2008	19	7,63%	$16,78	$15,09
2009	25	7,02%	$16,02	$14,78
2010	59	7,56%	$14,82	$13,67
2011	45	9,70%	$17,65	$16,02
2012	58	14,22%	$17,56	$15,06
2013	102	20,60%	$20,00	$16,34
2014	129	15,07%	$16,82	$14,39
2015	78	19,44%	$18,56	$14,97
2016	45	15,36%	$16,58	$14,58
2017	64	8,99%	$16,09	$14,73
2018	92	14,78%	$17,20	$14,79
Total	**3841**	**16,14%**	**$15,43**	**$12,99**

Table 4: Median Initial Return, Median Closing Price, Median Offer Price and Total of IPOs sorted by year in the U.S.

Year	Total IPOs	Median Initial Return	Median Closing Price	Median Offer Price
1990	77	2,92%	$11,00	$10,00
1991	191	6,25%	$12,00	$11,50
1992	279	2,94%	$11,75	$11,00
1993	347	6,25%	$12,13	$12,00
1994	280	4,12%	$10,44	$10,00
1995	256	8,71%	$12,47	$12,00
1996	417	8,17%	$13,13	$12,00
1997	284	6,18%	$12,53	$12,00
1998	144	6,57%	$14,13	$13,00
1999	178	22,83%	$18,22	$14,00
2000	157	22,06%	$17,00	$14,00
2001	39	9,25%	$16,20	$15,00
2002	38	7,15%	$16,10	$15,00
2003	34	9,08%	$16,33	$14,50
2004	106	6,56%	$14,00	$13,00
2005	99	7,27%	$15,55	$14,00
2006	106	4,54%	$15,57	$15,00
2007	93	6,84%	$16,00	$15,00
2008	19	2,92%	$16,50	$16,00
2009	25	1,46%	$14,00	$13,50
2010	59	5,00%	$13,41	$13,00
2011	45	4,07%	$17,75	$16,00
2012	58	13,50%	$16,38	$15,00
2013	102	10,48%	$18,56	$16,00
2014	129	6,32%	$15,15	$15,00
2015	78	10,87%	$17,78	$15,00
2016	45	3,75%	$16,25	$15,00
2017	64	9,62%	$14,55	$15,00
2018	92	5,55%	$16,24	$15,00
Total	**3841**	**6,67%**	**$13,85**	**$13,00**

For Germany, a total of 124 IPOs from the period of 2002 up to and till 2018 were used in this analysis with an average of 7 IPOs yearly. The averages and medians of the IPOs from this period can be found in Table 5 and Table 6, respectfully. Some striking features you immediately notice are the quantity of the IPOs and the average initial return. The quantity of the IPO is much lower for Germany than that of the U.S. indicating that there are much fewer businesses going public in Germany than there are in the U.S. this might partly be geographic and demographic if we compare the sizes of the U.S. and Germany it makes sense that the U.S. has more IPOs. However, this much of a discrepancy cannot be attributed to size alone and indicates that it could be that the financial systems and IPO markets of these countries are fundamentally different from each other. Other than that, the average initial return seems to be a lot more volatile than in the U.S. fluctuating between -45.29% and 99.99% in the level of underpricing between 2002 and 2018. I believe this can partly be attributed to the number of IPOs per year which is less than 10 observations a year, excluding 2006 and 2007.

Table 5: Average Initial Return, Average Closing Price, Average Offer Price and Total of IPOs sorted by year in Germany

Year	Total IPOs	Average Initial Return	Average Closing Price	Average Offer Price
2002	2	-6.47%	$38.35	$41.00
2004	4	21.98%	$14.02	$11.31
2005	7	41.79%	$36.82	$24.79
2006	23	35.62%	$34.11	$24.73
2007	24	45.05%	$27.64	$19.41
2008	3	99.99%	$120.75	$61.50
2009	3	-45.29%	$8.22	$28.25
2010	9	40.04%	$23.16	$16.37
2011	8	35.51%	$21.01	$15.21
2012	6	23.13%	$12.74	$10.48
2013	4	66.87%	$29.69	$19.18
2014	8	36.29%	$20.28	$14.37
2015	8	11.55%	$17.23	$15.28
2016	2	21.39%	$28.04	$24.15
2017	7	26.76%	$36.43	$28.11
2018	6	24.09%	$49.57	$40.08
Total	**124**	**34.19%**	**$29.88**	**$22.06**

In the recession of 2008, the benchmarks seem to differentiate from the average the most. This makes sense in the economic story of a recession that took place that year. However, unlike the U.S. the benchmarks are higher for this year compared to the sample average.

In 2009 we see similar IPO market reactions as we see in the U.S. but stronger. This insinuates that the housing crash of 2008, that started in the U.S. and that caused the recession, probably hit the German economy later with a lag.

Table 6: Median Initial Return, Median Closing Price, Median Offer Price and Total of IPOs sorted by year in Germany

Year	Total IPOs	Median Initial Return	Median Closing Price	Median Offer Price
2002	2	-6.47%	$38.35	$41.00
2004	4	20.04%	$10.96	$9.13
2005	7	44.56%	$26.52	$21.00
2006	23	31.22%	$24.84	$17.25
2007	24	39.75%	$24.58	$17.50
2008	3	99.43%	$86.81	$47.00
2009	3	-86.67%	$4.93	$37.00
2010	9	37.12%	$17.52	$13.00
2011	8	41.90%	$19.93	$13.75
2012	6	28.33%	$12.21	$11.50
2013	4	32.46%	$33.32	$18.50
2014	8	37.58%	$18.38	$12.63
2015	8	8.43%	$16.35	$15.50
2016	2	21.39%	$28.04	$24.15
2017	7	22.69%	$33.13	$24.00
2018	6	21.95%	$41.98	$31.00
Total	**124**	**32.50%**	**$23.73**	**$17.13**

The medians in Table 6 tell a similar story to the average. We identify similar findings of IPO benchmarks as we did in the averages. Moreover, the medians do not deviate from the average substantially. This would usually entail that there are no big outliers, thus we could conclude that German IPOs are less volatile than their United States counterparts. However, in this case, it is also reasonable to assume that this is caused by the lack of observations for Germany in general.

In Figure 1 and Figure 2 we see the distribution of IPOs per industry during normal economic times. For the U.S. it is shown from the period of 1990 up to and till 2018 and for Germany, the distribution is shown for the period of 2002 up to and till 2018.

In Figure 1 we can see that the industries are fairly well divided into similar fractions of the pie. However, in the case of the United States, Healthcare and Consumer Products and Services seem the highest represented industries, with 28% and 14% respectively. IPOs in the Healthcare industry is by far the biggest piece of the pie nearly doubling

the amount of IPOs in this period compared to the second-largest industry Consumer Products and Services and more than 5 times as much as Consumer Staples.

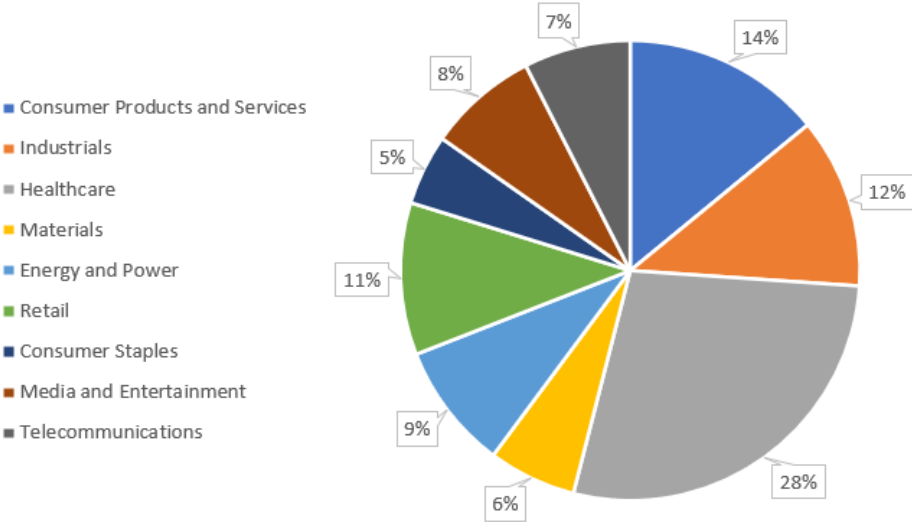**Quantity of IPOs by industry (U.S. 1990-2018)**

Figure 1: IPO quantity in the U.S. by industry from 1990 up and till 2018

In Figure 2 we also find the industries are fairly well distributed into similar-looking fractions. Nevertheless in Germany, there also seem to be one industry the large contributor to the amount of IPOs between the period of 2002 and 2018. Industrials seem to take the cake in the German IPO sector, with a third - 33% - of the total IPOs contributed. The Materials industry is the second largest industry in Germany with less than half of the contribution compared to the Industrials industry.

An important distinction to notice between the two figures representing the quantity of IPOs segregated by industry is the difference between the particular segregation. Whereas in the United States Industrials only make up a meagre 12% of the total, while this industry takes up a third of total IPOs in Germany. Similarly, Healthcare takes up 28% of the total contribution in the U.S. but only 11% in Germany.

Quantity of IPOs by industry (Germany 2002 - 2018)

- Consumer Products and Services
- Industrials
- Healthcare
- Materials
- Energy and Power
- Retail
- Consumer Staples
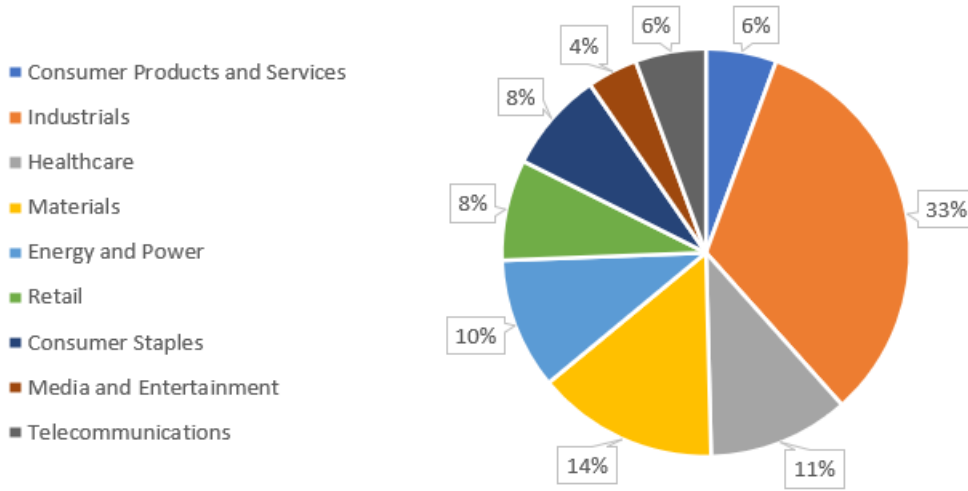- Media and Entertainment
- Telecommunications

Figure 2: IPO quantity in Germany by industry from 2002 up and till 2018

In Table 7 a more detailed description can be found of the industry averages and medians of both the U.S. and Germany together. Over the total sample, size healthcare is by far the highest represented industry with 26.84% of the contribution during normal economic times. This is followed by Consumer Products and Services with 14.03% and Industrials with 12.67%. Furthermore, Consumer Products and Services and Telecommunications have the highest average initial return of 22.95% and 32.87%, respectively. Consumer Products and Services and Telecommunications also have the highest median initial return. However, with 10.42% and 12.50% respectively, we once again see that a substantial difference between the average and median. Therefore, it can be assumed that these industries also contribute to the biggest set of outliers in the IPO market.

Table 7: Industry Averages and Medians during normal economic times

Industry	Total IPOs	Average Initial Return	Average Closing Price	Average Offer Price	Median Initial Return	Median Closing Price	Median Offer Price
Consumer Products and Services	539	22.95%	$17.04	$13.22	10.42%	$14.38	$13.00
Consumer Staples	198	11.82%	$14.84	$13.23	8.34%	$13.00	$13.00
Energy and Power	341	9.92%	$18.11	$16.43	5.73%	$17.75	$16.00
Healthcare	1031	13.32%	$13.51	$11.65	5.85%	$12.00	$11.00
Industrials	487	14.03%	$15.11	$13.16	6.67%	$13.91	$13.00
Materials	247	7.38%	$16.08	$14.62	3.57%	$14.04	$14.00
Media and Entertainment	299	19.73%	$15.80	$13.11	7.95%	$14.00	$13.00
Retail	413	18.69%	$16.16	$13.23	10.00%	$14.80	$13.00
Telecommunications	291	32.87%	$19.21	$13.62	12.50%	$15.00	$13.00
Total	**3844**	**16.59%**	**$15.74**	**$13.19**	**7.01%**	**$13.94**	**$13.00**

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In Figure 3 and Figure 4 we see the distribution of IPOs per industry during an economic recession. For the U.S. it is shown from the period of 1990 up to and till 2018 and for Germany, the distribution is shown for the period of 2002 up to and till 2018.

In Figure 3 we immediately notice that the pie is not as evenly distributed in times of recession as in normal economic times. The contribution of the Healthcare industry in the IPO market nearly doubled from 26% to 49% of the total IPO market. Furthermore, the Consumer Products and Services industry only contributed to 7% of the total IPO market, which is half of its contribution compared to normal economic times. Besides Telecommunications, Energy and Power and Healthcare, we see a decrease in contribution in every other industry.
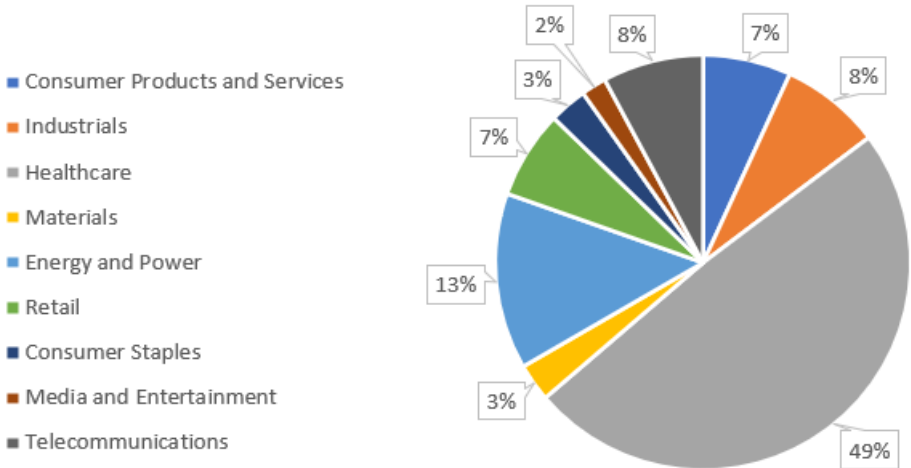
Figure 3: IPO quantity in the U.S. by industry from 1990 up and till 2018 during times of recession

In Figure 4, the contribution in Germany per industry in times of recession for the period of 2002-2018 can be found. In Figure 4 we can see that the largest contributor to the German IPO Market - Industrials - actually shrunk when comparing normal economic times to economic recession, from 33% to 26%. This in contrast to the U.S. IPO market where the largest contributor grew in contribution during times of recession. In Germany, however, we see that Industrials makes place for larger contributions in the Materials industry, that grew from 14% to 22% and Healthcare industry, that grew from 11% to 19%. All other industries see only marginal changes in their contributions except for the

Consumer Staples industry, in which not a single IPO took place during our sample period.

Furthermore, when comparing the two countries during recession we find that the Materials and Industrials industry play a much grander part of the IPO market in Germany than it does in the United States. Contradictory to that, Healthcare IPOs play a much grander part of the IPO market in the United States than it does in Germany.
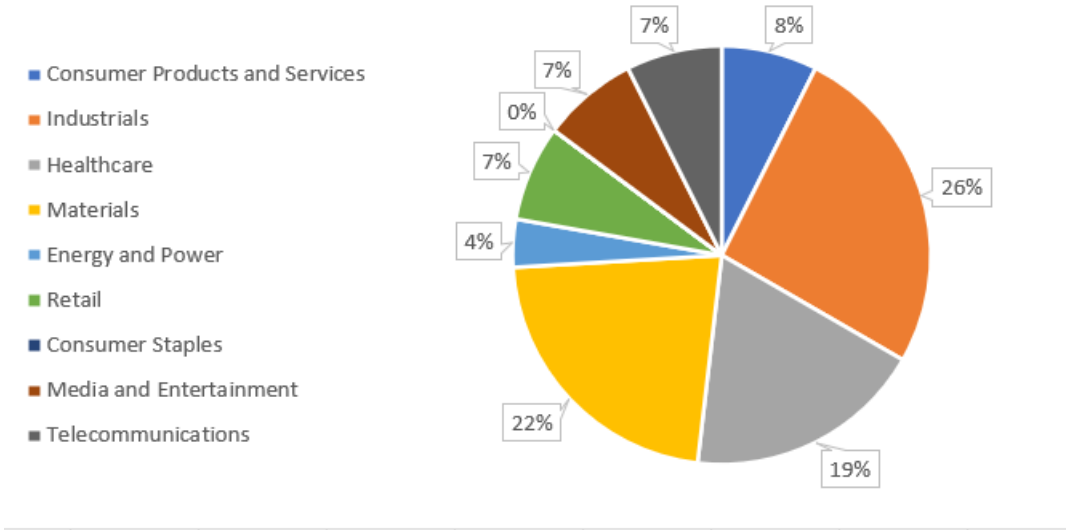
Figure 4: IPO quantity in Germany by industry from 2002 up to and till 2018 during times of recession

In Table 8, I visualized a more detailed description of the industry averages and medians during economic recession of both the U.S. and Germany together. Similar to normal economic times Healthcare is the highest represented industry. In case of economic recession, however, the contribution goes up to 45.45% of the total IPO market. Energy and Power and Industrials make up for the second and third highest contribution, with both of the industries contributing to 12.39% of the total IPO market during times of recession. The medians tell us the same story about right-skewness as previously mentioned. Only in the case of Media and Entertainment, Consumer Products and Services and Telecommunications, we find that the median is higher than the average initial.

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Table 8: Industry Averages and Medians during economic recession

Industry	Total IPOs	Average Initial Return	Average Closing Price	Average Offer Price	Median Initial Return	Median Closing Price	Median Offer Price
Consumer Products and Services	9	20.56%	$17.96	$14.50	27.27%	$19.26	$16.00
Consumer Staples	2	59.98%	$16.94	$11.50	59.98%	$16.94	$11.50
Energy and Power	15	9.90%	$22.14	$18.77	3.00%	$18.08	$19.50
Healthcare	55	15.07%	$14.12	$12.16	10.13%	$12.63	$12.00
Industrials	15	21.85%	$37.97	$25.69	10.18%	$14.98	$14.00
Materials	9	36.54%	$23.27	$17.56	31.22%	$18.19	$15.00
Media and Entertainment	4	41.28%	$29.26	$20.13	51.22%	$31.55	$20.25
Retail	9	31.88%	$22.69	$16.61	29.02%	$19.69	$17.00
Telecommunications	3	25.82%	$17.32	$14.20	31.87%	$20.50	$18.00
Total	**121**	**20.40%**	**$20.30**	**$15.87**	**12.20%**	**$15.15**	**$13.50**

4.2 Regressions

For the regression section of this thesis, I analyze 3841 IPOs for the United States and 124 IPOs for Germany. For the regressions, I first did a univariate regression, for both countries, of all independent variables(i.e. Company Age, Offer Price, Issue Size, Market Capitalization, Total Shares Issued), including the matching control variable (Return on S&P500 DAX), on the dependent variable Initial Return. After this, I proceeded to perform multivariate regressions with fixed effects for industry. Finally, I performed separate multivariate regressions with fixed effects for industry for each country and each economic situation. The results of the different regressions will now be discussed further.

In Table 9 we see the univariate regressions of the U.S. The regressions of the United States show us a couple of significant results. Looking at it on a univariate level our dummy variable Recession has a negative sign but does not appear to be significant at any level. This would indicate that recessions actually reduce the level of underpricing, however, this cannot be proved. The variable Company Age appears to be significant at the 1% level with a negative sign. Company Age appears to reduce the level of underpricing by about 1.40% per year. Offer Price is significant at a 1% level also with a positive sign meaning that Offer Price increases the level of underpricing. In our dataset for every 1$ increase in Offer Price, Initial Return increases by 1.20%. Issue Size does not seem to have a significant effect on the level of underpricing. Market Capitalization has a significant effect on the level of underpricing at a 1% level. Market Capitalization has a positive sign and increases the level of underpricing by 0.07% per million of Market Capitalization. Total Shares Issued is barely short of being significant at a 10% level. The sign is negative meaning the level of underpricing decreases by 0.1% per 1 million of Total Shares Issued. Finally, our control variable is significant at a 5% level. It has a positive sign, this variable should be interpreted as for every 100% daily increase in Return on S&P500 we see an increase of 173.3% in the level of underpricing. We rarely see a daily increase of 100% in the S&P500. The constants of these univariate regressions

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Table 9: Univariate Regression Models of the U.S. with Initial Return as dependent variable.

	Model 1 b/t	Model 2 b/t	Model 3 b/t	Model 4 b/t	Model 5 b/t	Model 6 b/t	Model 7 b/t
Recession	-0.012 (-0.309)						
Company Age		-0.014*** (-5.425)					
Offer Price			0.012*** (10.600)				
Issue Size				-0.000 (-0.182)			
Market Capitalization					0.000*** (5.095)		
Total Shares Issued						-0.001 (-1.443)	
Return on S&P500							1.733** (2.338)
Constant	0.161*** (26.076)	0.187*** (24.150)	0.009 (0.587)	0.161*** (25.213)	0.151*** (23.515)	0.166*** (24.111)	0.161*** (26.268)

*Under the estimated coefficients of the explanatory variables, the t-statistics are given between parentheses. *, **, And *** indicate significance at a 10%, 5%, and 1% level respectively.*

are all significant at 1% except for Model 3 which is not significant at any level.

In Table 10 we see the univariate regressions of Germany. The regressions of Germany show us a lot less significant results compared to the U.S. Looking at it on a univariate level our dummy variable Recession has a positive sign in the case of Germany, in contrast to that of U.S. This would indicate that recessions increase the level of underpricing, however, this cannot be proved. The variable Company Age appears to be significant at the 1% level with a negative sign. Company Age appears to reduce the level of underpricing by about 1.60% per year. Offer Price is insignificant at all levels with a positive sign meaning that Offer Price increases the level of underpricing. In our dataset for every 1$ increase in Offer Price, Initial Return increases by 0.1%, however, this cannot be proved. Issue Size does not seem to have a significant effect on the level of underpricing, similar to the United States. Market Capitalization does not have a significant effect on the level of underpricing at any level. Total Shares Issued is insignificant at any level. The sign is negative meaning the level of underpricing decreases by 0.1% per 1 million of Total Shares Issued, however, this cannot be proved. Finally, our control variable is barely short of being significant at a 10% level. It has a positive sign, this variable should be interpreted

Table 10: Univariate Regression Models of Germany with Initial Return as dependent variable.

	Model 1 b/t	Model 2 b/t	Model 3 b/t	Model 4 b/t	Model 5 b/t	Model 6 b/t	Model 7 b/t
Recession	0.068 (1.006)						
Company Age		-0.016*** (-2.858)					
Offer Price			0.001 (0.562)				
Issue Size				-0.000 (-0.721)			
Market Capitalization					-0.000 (-0.307)		
Total Shares Issued						-0.001 (-0.525)	
Return on DAX							3.387 (1.255)
Constant	0.327*** (10.394)	0.395*** (12.033)	0.322*** (7.174)	0.350*** (11.649)	0.346*** (11.400)	0.348*** (11.496)	0.341*** (11.981)

*Under the estimated coefficients of the explanatory variables, the t-statistics are given between parentheses. *, **, And *** indicate significance at a 10%, 5%, and 1% level respectively.*

as for every 100% daily increase in Return on DAX we see an increase of 338.7% in the level of underpricing. Similarly to the United States and its S&P500 we rarely see a daily increase of 100% in the DAX. The constants of these univariate regressions are all significant at 1% and are nearly double the value compared to the United States, indicating that underpricing in Germany might be a lot higher.

In Table 11 we see the multivariate regressions with dependent variable Initial Return and independent variables Company Age, Offer Price, Issue Size, Market Capitalization, Total Shares Issued, Recession and Return on S&P500 / DAX. For this multivariate regression, the data has been transformed into panel data with fixed effects for Industry, as to reduce standard error and also help with the OVB of the model, as mentioned in 3.5. In this model, no distinction between business-cycle has been made yet this will be further explored in Table 12.

In Table 11 the independent variables coefficient and their corresponding t-statistic can be found. We observe that for both the United States and Germany, Company Age has a significant effect on the level of underpricing at the 5% level. In both countries, the

Table 11: Panel Data Regression with Fixed Effects for Industry

	Panel Data Regression Fixed Effect United States b/t	Panel Data Regression Fixed Effect Germany b/t
Company Age	-0.001**	-0.002**
	(-2.312)	(-3.049)
Offer Price	0.004	-0.000
	(1.259)	(-0.083)
Issue Size	-0.003***	-0.002**
	(-6.999)	(-2.822)
Market Capitalization	0.003***	0.002**
	(9.284)	(2.855)
Total Shares Issued	0.002	-0.002
	(0.230)	(-1.547)
Return on S&P500	1.410**	
	(2.741)	
Recession	0.020	0.002
	(1.345)	(0.029)
Return on DAX		2.717
		(1.062)
Constant	0.103**	0.392***
	(2.544)	(7.797)

Under the estimated coefficients of the explanatory variables, the t-statistics are given between parentheses. *, **, And *** indicate significance at a 10%, 5%, and 1% level respectively.

sign is negative indicating that as the age of the company increases the level of underpricing reduces, although more strongly in the case of Germany. While the Offer Price was significant in the univariate regression for the U.S., neither Germany nor the United States sees a significant effect in Offer Price on the level of underpricing when correcting for fixed effects. In the case of the U.S., the sign remains positive and is barely short of being significant at the 10% level. The sign in Offer Price for Germany reversed and is also not significant in the slightest. Issue Size is significant at the 1% and 5% level for the United States and Germany, respectively. After using fixed effects the magnitude also increased for both countries. Germany did not see a significant effect for Issue Size in the univariate model but does see one in the multivariate model. Market Capitalization is also significant at the 1% and 5% level for the United States and Germany, respectively. Neither countries saw significant effects in the univariate model but do in the multivariate model. The Total Shares Issued does not seem to significantly affect the Initial Return.

However, Germany is just barely short of significant with a p-value of 0.16. Recession does not seem to significantly alter the level of underpricing, neither the U.S. nor Germany show significant results to support this. However, both signs are positive and in the case of the United States the notion that recessions alter the level of underpricing cannot be fully dismissed as there does seem to be an effect in play. The control variable for the Returns is significant for the United States at the 5% level and insignificant for Germany. Finally, the constant for both the United States and Germany appear to be significant at the 5% and 1% level respectively. However, important to note is that Germany its constant is nearly 4 times as high as that of the U.S.

For our final regression, we observe the differences in the effects of the independent variables between different business-cycles. The results for these regressions can be observed in Table 12. Again both the coefficient and the t-statistic are denoted in this table to get a clear view of the different effects of the independent variables on the dependent variable Initial Return. I will discuss this regression by addressing the differences within a countries business-cycles.

In the United States during normal economic business-cycles we observe significant effects for Company Age, Issue Size, Market Capitalization and for the control variable Return on S&P500, also the constant is significant. These results are similar to what we found in Table 11. Comparing the results from normal business-cycles to those of economic recession we notice a couple of differences. Firstly, Company Age does not appear to be significant any longer when compared to normal economic times. Moreover, Issue Size and Market Capitalization coefficients double during recessions and remain significant, albeit at a 5% level. Meaning that instead of reducing the level of underpricing by 0.3% per 1 million Issue Size it reduces by 0.6% during economic recessions. For Market Capitalization, the opposite is true. For every 1 million increase in Market Capitalization, we see an increase of 0.6% in the level of underpricing during economic recessions. This was 0.3% during normal economic times. The other independent variables do not appear to have a significant effect on Initial Return during economic recessions. However, it appears as if the sign of the control variable reverses between the two business-cycle, although this cannot be proven.

Table 12: Panel Data Regressions U.S. and Germany separated by economic business-cycle

	Panel Data Regression Fixed Effects Industry U.S. Normal Ecnomics b/t	Panel Data Regression Fixed Effects Industry U.S. Recession b/t	Panel Data Regression Fixed Effects Industry Germany Normal Economics b/t	Panel Data Regression Fixed Effects Industry Germany Recession b/t
Offer Price	0.004 (1.224)	0.002 (0.455)	-0.005 (-1.167)	-0.001 (-0.566)
Company Age	-0.001** (-2.304)	-0.001 (-0.793)	-0.002** (-3.315)	-0.001 (-0.962)
Issue Size	-0.003*** (-6.710)	-0.006** (-2.367)	-0.002* (-2.277)	-0.014*** (-3.542)
Market Capitalization	0.003*** (9.404)	0.006** (2.487)	0.002** (2.560)	0.010*** (3.548)
Total Shares Issued	0.002 (0.238)	-0.007 (-0.828)	-0.007** (-2.688)	0.004* (1.979)
Return on S&P500	1.531** (2.847)	-1.307 (-1.262)		
Return on DAX			2.844 (1.578)	17.383 (1.056)
Constant	0.104** (2.538)	0.093 (1.476)	0.489*** (6.321)	0.388*** (5.391)

*Under the estimated coefficients of the explanatory variables, the t-statistics are given between parentheses. * , ** , And *** indicate significance at a 10%, 5%, and 1% level respectively.*

In Germany, during normal economic times, we find significant results for Company Age, Issue Size, Market Capitalization, Total Shares Issued and for the control variable Return on DAX. The constant is also significant. These results are similar to those we found in Table 11, except for Total Shares Issued which appears to be significant in this instance. For every million of shares issued the level of underpricing reduces by 0.7%. When we compare the results between the two different business-cycles we notice a couple of important differences. First of all, Company Age does not appear to be significant anymore in the case of a recession. Also, Issue Size plays a far more important role in times of recession compared to normal economic times. The significance increases drastically and the coefficient becomes 7 times the value of that of normal economic times, increasing from -0.2% to -1.4%. Similar effects can be seen for the importance of Market Capitalization which increases the level of underpricing from 0.2% during normal economic times to 1% during recessions, per million of market capitalization. Another difference between the two different business cycle is the reversal of signs for the independent variable Total Shares Issued. During normal economic times, it decreases the level of underpricing while during recessions it appears to increase the level of underpricing, a curious finding.

5   Conclusions

The aim of this thesis was to see how the IPO market is affected by recessions and especially how it affected the U.S. IPO market and the German IPO market differently, the research question was as follow: What can we expect of the U.S. and German IPO market of the U.S. and Germany in relation to recessions?. For this, I took a look at 3841 U.S. IPOs from 1990 until 2018 and 124 German IPOs from 2002 until 2018. To measure how the IPO market was affected by recessions, I focused on different variables affecting the underpricing of IPOs and aimed to answer my hypotheses. In short, I found proof to assume recessions significantly alter the IPO market. I will now look back at my hypotheses and summarize my findings accordingly.

Hypothesis 1: Recessions significantly decrease the first-day return on IPOs

To answer this hypothesis I look back at Table 7 and Table 8 and also look at the multivariate regression in Table 12. When we look at Table 7 and Table 8 we see that the descriptive statistics show us that the total average initial return over all industries is 16.59% during normal economic times and 20.40% during economic recessions. Moreover, the median initial return is also higher in the case of recessions, with 12.20% in normal economic times the median initial return is only a meagre 7.01%. The descriptive statis-

tics, therefore, would imply that my first hypothesis does not hold. In Table 12, however, we see that the constant diminishes in the case of a recession. This does not necessarily mean that the hypothesis holds but does imply that this hypothesis might need further exploring and testing with different data as the conclusion is now ambiguous at best. The second hypothesis I wanted to test in this thesis was as follow:

Hypothesis 2: Recessions significantly alter the effects and significance of IPO characteristics affecting initial return.

This question is a little less straight forward compared to the first hypothesis. To answer this hypothesis several regressions were performed the results of these can be found in Table 12. For this hypothesis, we separated the results of Germany and the United States to see whether these two countries saw different reactions in the IPO characteristics between the two different business-cycles. For the United States, we observed a couple of changes in the IPO characteristics. First of all, I observed that the company age was only of significance during normal economic times. Furthermore, both the coefficient of Market Capitalization and Issue Size doubled during a recession. Those two variables were thus of much more importance to the level of underpricing during times of recession compared to normal economic times. Finally, we saw a reversal of the sign of our control variable, which is, of course, a curious finding. However, this was not a significant finding so I will reserve judgement on it.

In the case of Germany, I also observed a couple of noticeable differences between the IPO characteristics of normal economic business-cycles and recessions. Similar to the United State the age of the company is only significant for normal business-cycles. Furthermore, we saw in the U.S. that the coefficient of market capitalization and issue size doubled. In the case of Germany, the coefficients of these two IPO characteristics increased drastically between the two different states of the economy. Moreover, another interesting find is that the sign of Total Shares Issued reverses from negative - underpricing decreasing - to positive - underpricing increasing - and that this characteristic remains significant in both economic states.

In conclusion, this hypothesis holds for some IPO characteristics. Especially Market Capitalization and Issue Size see their coefficient change drastically. Also, the age of the company appears to be less significant during a recession compared to a normal state of the economy. In the case of Germany, the number of shares issued change from being first-day return decreasing to first-day return increasing.

The third and final hypothesis was the following:

Hypothesis 3: The United States sees a significantly greater alteration during a recession, in the effects of IPO characteristics on initial return and the distribution per industry, compared to Germany

The reverse of this hypothesis was partially answered in the previous paragraphs, but in short, I observed that Germany appeared to see a greater alteration in the IPO characteristics during recessions compared to the United States, especially in the effects of market capitalization and issue size. On the matter of the distribution per industry, I observed several things. For the United States, we observed that the distribution of IPOs per industry was a lot less evenly distributed during times of recession compared to a normal economic state. Especially the Healthcare industry appeared to dominate the IPO market during an economic session with 49% of the total contribution up from 26% during normal economic times. In general, the United States sees a more unevenly distributed IPO market per industry. In Germany, we saw the largest industry, Industrials, shrink from 33% to 26%. This is in contrast to the U.S. where the biggest industry contributor grew. In Germany, we saw a more evenly distributed IPO per industry during times of recession compared to a normal economic state. In summary, Germany sees greater alterations in IPO characteristics and while the United States sees greater discrepancies in the distribution per industry, Germany becomes more evenly distributed. Therefore, we can conclude that the third hypothesis is not true.

6 Discussion

In Ritter and Welch (2002) the notion of business-cycles affecting the level of underpricing of an IPO is highly debated and in the end, they do not find a definitive answer. I tried to find answers for these questions and found that the average and median initial return is higher during times of recession. However, this hypothesis was answered ambiguously at best, thus this encourages future research to explore this hypothesis more. Furthermore, we saw how business-cycles alter the proxies for ex-ante uncertainty such as market capitalization and issue size. Finally, we saw how the distribution of the IPO market per industry altered drastically between the two different states of the economy, becoming increasingly unevenly distributed in the U.S. and more evenly distributed in Germany.

But what do these results imply and why are they important? The results are important

in the sense that they contribute to the literature on the IPO market and the unsolved puzzle of the underpricing mystery. The results of this paper showed that recession does not significantly alter underpricing directly but rather affects the different proxies for ex-ante uncertainty that in their turn do affect the level of underpricing. In contrast to Sohail et al. (2010) we find that initial return is higher for IPOs during recessions. This might be due to the differences between the observed countries financial systems or due to some other reasons. This could be explored in future research. Nevertheless, this thesis brings new insights into the relationship between recessions and IPO. On top of that in the narrative of the coronacrisis, these results could be taken in to account to adapt expectations.

However, these results and implications should not be taken without acknowledging the limitations of this research. First of all, there was a limited amount of recession periods in my data set. This was due to a fairly stable economy for the period of my choosing. This greatly limited the number of observations of IPOs I could gather from periods of recessions. This might have caused some results to be insignificant and other results significant, but not in line with what literature tells us about these effects. Furthermore, the idea of this paper was to explore and compare German IPO market with the widely researched IPO market of the U.S. Unfortunately due to the unavailability of data on the German IPO market it was difficult to make a proper comparison of the same periods. Even though, it was expected that Germany had fewer observations the lack of data also caused the German observations to be on the lower side, especially compared to the United States.

In conclusion, I would like to make a few suggestions for future research to add to the literature of IPO markets. This paper could be considered for future studies to revise the independent variables used for the proxies of ex-ante uncertainty as it can be considered to both add new variables and to perhaps consider dropping variables. More research is needed to see how exactly business-cycles affect the IPO market landscape. Future research should take into account a larger period as the period of choosing for this thesis was limited by the number of observations. To have sufficient different business-cycles and IPOs taking place in these different business-cycles will be crucial for future research.

7 Appendix

Table 13: (Descriptive Statistics) IPO's in U.S. during normal economic times

Variable	n	Mean	S.D.	Min	.25	Mdn	.75	Max
OfferPrice	3747	12.99	5.46	5.00	9.00	13.00	16.00	97.00
ClosingPrice	3747	15.43	10.41	0.00	9.50	13.85	19.00	269.00
ClosingPrice1Week	3747	15.37	10.59	0.00	9.38	13.75	18.88	315.75
InitialReturn	3747	0.16	0.38	-1.00	0.00	0.07	0.22	5.70
Initial1WeekReturn	3747	0.16	0.37	-1.00	0.00	0.06	0.23	5.70
TotalSharesIssued (mln)	3747	6.55	12.78	0.17	2.11	3.70	6.61	478.00
IssueSize ($ mln)	3747	109.25	351.43	2.00	22.00	46.20	100.00	15774.00
MarketCapitalization ($ mln)	3747	126.69	385.28	0.00	23.05	51.56	119.93	16376.28
CompanyAgeGoingPublic	3747	19.17	24.52	0.00	5.00	9.00	23.00	165.00

Table 14: (Descriptive Statistics) IPO's in Germany during normal economic times

Variable	n	Mean	S.D.	Min	.25	Mdn	.75	Max
OfferPrice	97	21.04	14.98	5.00	10.75	17.00	26.00	80.00
ClosingPrice	97	27.51	20.70	4.93	12.73	22.99	35.40	113.00
ClosingPrice1Week	97	27.37	21.25	4.41	12.45	22.65	34.56	116.17
InitialReturn	97	0.33	0.32	-0.87	0.20	0.32	0.41	1.73
Initial1WeekReturn	97	0.31	0.32	-0.88	0.18	0.31	0.40	1.64
TotalSharesIssued (mln)	97	10.63	21.02	0.06	1.50	4.00	10.05	130.43
IssueSize ($ mln)	97	271.11	690.90	0.56	17.49	77.82	215.08	4545.43
MarketCapatilization ($ mln)	97	341.26	839.76	0.60	23.73	100.49	286.45	5027.75
CompanyAgeGoingPublic	97	39.11	52.99	0.00	6.00	14.00	60.00	216.00

Table 15: (Descriptive Statistics) IPO's in US during economic recession

Variable	n	Mean	S.D.	Min	.25	Mdn	.75	Max
OfferPrice	94	13.07	5.19	5.00	9.00	12.00	16.00	30.00
ClosingPrice	94	15.17	7.07	4.38	9.00	14.19	19.26	41.12
ClosingPrice1Week	94	14.93	6.69	3.65	9.30	14.12	18.25	33.98
InitialReturn	94	0.15	0.26	-0.20	0.00	0.09	0.22	1.74
Initial1WeekReturn	94	0.14	0.24	-0.27	-0.02	0.09	0.24	1.27
TotalSharesIssued (mln)	94	9.62	16.69	0.60	3.20	5.56	9.25	126.20
IssueSize ($ mln)	94	180.19	492.11	3.60	37.20	66.00	126.00	3786.00
MarketCapatilization ($ mln)	94	198.57	508.88	3.60	42.90	72.00	168.00	3927.34
CompanyAgeGoingPublic	94	19.26	19.46	0.00	7.00	13.00	27.00	104.00

Table 16: (Descriptive Statistics) IPO's in Germany during economic recession

Variable	n	Mean	S.D.	Min	.25	Mdn	.75	Max
OfferPrice	27	26.01	24.63	5.60	9.00	18.00	32.00	130.00
ClosingPrice	27	38.61	48.79	7.71	16.19	24.84	41.99	259.26
ClosingPrice1Week	27	37.61	46.71	7.50	17.56	24.87	42.24	249.48
InitialReturn	27	0.40	0.28	-0.06	0.28	0.36	0.51	1.16
Initial1WeekReturn	27	0.37	0.31	-0.16	0.27	0.36	0.49	1.39
TotalSharesIssued (mln)	27	14.91	44.22	0.10	0.75	2.30	6.70	225.00
IssueSize ($ mln)	27	186.94	337.72	0.72	16.40	44.95	213.30	1260.00
MarketCapitalization ($ mln)	27	272.29	483.89	1.09	20.66	61.36	294.61	1750.33
CompanyAgeGoingPublic	27	14.78	25.75	0.00	3.00	8.00	13.00	130.00

Table 17: The average IPO per quarter per economic situation (U.S.)

U.S.	Quarters	IPOs	Averages
Normal	104	3747	36.03
Recession	12	94	7.83
Total	116	3841	33.11

Table 18: The average IPO per quarter per economic situation (Germany)

Germany	Quarters	IPOs	Averages
Normal	52	97	1.87
Recession	16	27	1.69
Total	68	124	1.82

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