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# INFORMATION ASYMMETRIES, EX-ANTE UNCERTAINTY, ECONOMIC DOWNTURNS, AND THE PRICING OF GERMAN INITIAL PUBLIC OFFERINGS

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**Abstract**

Based on asymmetric information theories, with a special emphasize on Rock's winner's curse model (1982, 1986) and ex-ante uncertainty explanations by Beatty and Ritter (1986), this thesis analyzed the effects of economic downturns on IPO underpricing in Germany across 192 IPOs from 2002-2022 using an economic sentiment indicator. It was found that, on average, German IPOs were underpriced by 5.22% over the period and that, after controlling for industry and year fixed effects, underpricing increases with decreasing economic sentiment, ultimately contradicting previous research. Overall, it is shown that ex-ante uncertainty theories are not able to explain German IPO underpricing.

Keywords: IPOs, underpricing, asymmetric information theories, ex-ante uncertainty, economic downturns, economic sentiment, equity capital markets, investment banking

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## 1. Introduction

An initial public offering (IPO) marks a remarkable milestone in a company's history. The underlying motives for offering the company's shares to the public for the first time are multifaceted and often interlinked, however, typically center around raising external (public) equity to finance growth investments, optimize the cost of capital, enable existing shareholders to trade the company's shares, to use the publicly traded shares as an acquisition currency and, finally, to increase the popularity as well as reputation of the firm (Brau and Fawcett 2006). While an IPO offers attractive strategic opportunities, the process itself is complex and companies get faced with a new set of disclosure, transparency, and regulatory requirements (Ljungqvist 2007).

In the academic IPO literature, the phenomena of IPO underpricing has been one of the most studied topics. According to Ritter and Welch (2002), IPO underpricing was first reported by Stoll and Curley (1970), Logue (1973), Reilly (1973) and Ibbotson (1975) in the 1970s. Researchers found that, on average, the issuance price of IPOs is set well below the closing price observed on the first trading day, leading to significant positive initial returns. For instance, IPOs in the US and Germany were underpriced by 17.5% (1960 to 2021) and by 21.8% (1978 to 2020) respectively (Loughran, Ritter and Rydqvist 2022). Underpricing is costly for the issuer and its shareholders since investors buying the shares in the secondary market right after issuance at rising prices implies that the offer price could have been set at a higher level, thus, potential proceeds for the firm are left on the table (Ljungqvist 2007).

Especially in the 1980s and 1990s, researchers focused on understanding the reasons behind the underpricing and developed various theories aimed at explaining the phenomena. According to Ljungqvist (2007), these theories can be categorized into four main groups, namely theories based on asymmetric information, institutional frameworks, ownership and control, as well as on behavioral reasons. However, asymmetric information theories received

the strongest empirical support, with Rock's (1982, 1986) winner's curse being the most popular model (Ljungqvist 2007). One of the most prominent extensions of this model, however, was formulated by Beatty and Ritter (1986), partially based on initial studies by Ritter (1984). Using Rock's model, they find evidence in their 1986 publication "Investment Banking, Reputation, and the Underpricing of Initial Public Offerings" that IPO underpricing increases the greater the so-called ex-ante uncertainty, i.e. the risk about the value of an issuing firm, is. This implication and Rock's model will be described later, however, in short, Beatty and Ritter (1986) argue that underpricing is a way of compensating investors for getting informed about the fair value of an issuer, which is more time-consuming when riskier firms with higher uncertainty linked to their valuation are involved. Therefore, higher underpricing is required on such occasions. As mentioned, this finding is partially derived from Ritter's 1984 publication "The "Hot Issue" Market of 1980" where he found evidence that the average underpricing is higher during so-called hot issue periods which are characterized by a high number of IPOs. He concluded that this is attributable to riskier firms taking advantage of better investor sentiment during such phases, therefore, the number of riskier firms (higher ex-ante uncertainty) is greater and, thus, the level of underpricing. Ljungqvist (1997), for instance, analyzed the German IPO market and used a business sentiment indicator as a proxy for ex-ante uncertainty and to identify hot issue periods. In line with Ritter (1984) and, hence, with Beatty and Ritter (1986), he found that the better the business climate, the higher the underpricing.

Against the backdrop of the Covid-19 pandemic and the associated economic downturn, the IPO underpricing phenomena attracted renewed attention. For instance, Baig and Chen (2021) as well as Mazumder and Saha (2021) analyzed the impact of the crisis on IPO underpricing in the US and found that IPOs during the pandemic faced higher underpricing. With regards to Ritter (1984) and Beatty and Ritter (1986), this makes sense as, according to PricewaterhouseCoopers (2021), US IPO activity was particularly strong in 2020. In total, 465

IPOs were completed which raised $177 billion despite the negative economic implications connected to the pandemic (see also chapter 2.1).

This thesis mainly builds upon the findings and theories of Rock (1982, 1986), Ritter (1984), Beatty and Ritter (1986) as well as Ljungqvist (1997) and was inspired by the recent research of Baig and Chen (2021) as well as Mazumder and Saha (2021), with the last two effectively providing the initial idea for this thesis. However, the scope of this thesis goes beyond the economic implications of Covid-19 and aims at analyzing the pricing behavior of IPOs during different periods of economic downturns with a focus on the German IPO market over the last 20 years (2002-2021). This thesis follows an approach comparable to Ljungqvist (1997) by using a sentiment indicator, effectively renewing his research while mainly focusing on economic downturns. For this purpose, the Economic Sentiment Indicator (ESI) as calculated by the "Directorate General for Economic and Financial Affairs" of the European Commission will be used as a proxy for identifying economic downturns. Figure A1 (Appendix A) provides a graph showing the development of the ESI over time.

In sum, this thesis is structured as follows: chapter 2 provides a literature review focused on asymmetric information theories and ex-ante uncertainty explanations. The following chapter 3 presents the research design and information on the data set, while chapter 4 will present the results of the empirical analysis. Finally, chapter 5 is dedicated to a conclusion. To provide additional information and a full picture, Appendix B provides the theoretical foundations of IPOs including an overview of the main players involved in the IPO process, the process itself (specifically focused on the German practice), and the different introduction methods which can be used to determine the issuance price.

## 2. Literature review on IPO underpricing and asymmetric information theories

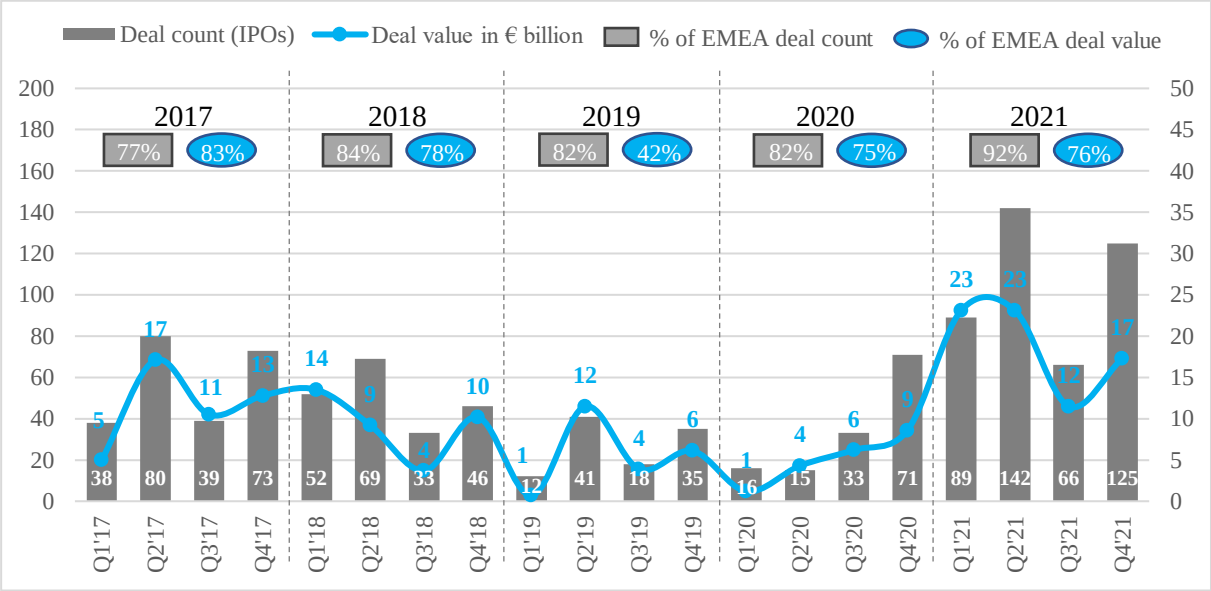
The IPO underpricing literature is broad and theories trying to explain IPO underpricing can be categorized into four, oftentimes not mutually exclusive groups, namely asymmetric

information theories, institutional theories, control theories and behavioral theories. Since asymmetric information theories, especially Rock's winner's curse (1982, 1986) in conjunction with Beatty and Ritter's (1986) findings, provide the theoretical framework for this thesis, the following literature review will be focused on the aforementioned. However, besides the winner's curse, asymmetric information theories further span information revelation theories, principal-agent models and signaling theories which are introduced in Appendix C. In principle, all theories assume that one of the parties involved in the IPO process, i.e. issuers, underwriters and investors (see also Appendix B), knows more than the others (Ljungqvist 2007). However, the models differ in terms of which parties the asymmetry is between.

### 2.1 Review of global IPO market activity

2021 set a record in global IPO activity, with 2,682 companies tapping public equity markets via an IPO, raising more than $ 600 billion. With 57% of the total proceeds raised globally ($ 346 billion), the dominance of the American IPO market was again manifested in 2021. The Asia-Pacific and EMEA regions followed with $ 162 billion and $ 99 billion in proceeds raised respectively (PricewaterhouseCoopers 2022a). Within EMEA, the majority of the proceeds (€ 75 billion) was raised in Europe where, in turn, most of the capital was raised in the UK, followed by Sweden, the Netherlands, Germany and Norway. The largest European offering in 2021 was InPost's Amsterdam IPO, raising € 3.2 billion. From a sectoral perspective, companies from the technology and consumer sectors priced the most IPOs (PricewaterhouseCoopers 2022b). According to an analysis from EY, IPOs in Germany reached their highest deal count since 2007, with 22 offerings priced on German exchanges and a total deal value of more than € 9 billion of which € 2.2 billion alone were raised by Vantage Towers, marking Germany's largest IPO in 2021 (Ernst & Young 2021). Figure 1 presents the IPO activity in Europe over time.

**Figure 1 – IPO activity in Europe per quarter**




Source: PricewaterhouseCoopers 2022a, PricewaterhouseCoopers 2022b, own calculations

## 2.2 Evidence of IPO underpricing

According to Ritter (2003a) underpricing is observable across all jurisdictions in which a stock market exists. Loughran, Ritter and Rydqvist (2022) provide a collection of data on IPO underpricing from various academic studies and calculate a country-specific composite, highlighting the existence and varying degrees of underpricing across 54 different countries. Figure A2 in Appendix A provides a graph based on an excerpt from the collection of Loughran, Ritter and Rydqvist (2022), compiled in a way to provide a global overview including countries from the Americas, APAC, EMEA, and Oceania, sorted by the degree of underpricing.

The authors state that the average equally weighted initial return of US IPOs in the period from 1960 to 2021 equaled 17.5%. Yet, the degree of underpricing depends heavily on the period under analysis. Loughran and Ritter (2004), for instance, report that US IPOs were, on average, underpriced by approximately 7% in the 1980's while initial returns equaled 65% in the period from 1999 to 2000, up significantly from the 15% reported in 1991 to 1998. With a sole focus on US internet stocks, Ljungqvist and Wilhelm (2003) showed that the average underpricing during the dotcom bubble was 89% in the years from 1999 to 2000.

Further, Loughran, Ritter and Rydqvist (2022) report that German IPOs were underpriced by 21.8% in the period from 1978 to 2020. Again, the level of initial returns varies significantly depending on the period analyzed. Earlier studies such as Ljungqvist (1997) report average initial returns from 1970 to 1993 of 9.2% while Wasserfallen and Wittleder (1994) report an average underpricing of 17.6% in the period from 1961 to 1987. Hunger (2003), for instance, analyzed German IPOs from 1997 to 2002. He reports that out of the 435 offerings he identified, 298 (69%) were performed in the so called "Neuer Markt" segment which mainly aimed at new economy firms, and which ceased to exist in the aftermath of the burst of the dotcom bubble. The average underpricing in this segment and period equaled 54% (42% across all segments and listings in 1997 to 2002), being "two to four times higher" than in previous studies of the German market (Hunger 2003, p. 22). Hunger hypothesizes that the extreme level of underpricing is associated to the fact that most of the offerings were made by companies from the new economy, typically characterized by higher ex-ante uncertainty, which chose the Neuer Markt as listing segment. The findings of Hunger are supported by Goergen, Khurshed, and Renneboog (2009). Finally, Hunger (2022), who regularly publishes IPO underpricing data for Germany on his website, reports an average IPO underpricing from 2004 to 2020 of 5.30%, significantly lower than the levels observed in other studies. Thus, it seems that IPO underpricing in Germany decreased in the more recent years.

### 2.3 The winner's curse and ex-ante uncertainty explanations

According to Ljungqvist (2007), Rock's winner's curse model (1982, 1986) is the most established asymmetric information theory, having received strong academic support. In Rock's model the information asymmetry is manifested a) within the group of investors, i.e. the model separates between informed and uninformed investors but also assumes that b) informed investors have an informational edge against the underwriters and the issuer, thus they can better estimate the fair value of the shares at offer than the rest of the parties involved.

Consequently, this type of investor will only participate in attractively priced issues, while Rock assumes that uninformed investors will bid for every offering, ultimately creating a winner's curse situation. This means that uninformed investors will receive a smaller allocation in attractively priced offerings as the informed investors will also participate, while uninformed investors will get most of the allocation in unattractively priced IPOs. Assuming a case in which the informed investors fully crowd-out the uninformed in attractive IPOs, the expected return for the latter group is negative. This will lead to uninformed investors not participating in IPOs, although the demand they generate is important to ensure an IPO's success. Ultimately, this implies that new offerings must at least be underpriced to such an extent that expected returns allow uninformed investors to break-even. Evidence is, for instance, provided by Keloharju (1993) who studied Finnish IPOs, stating that uninformed investors tend to receive large allocations in unattractively priced IPOs, leading to negative allocation-weighted returns. Further evidence is provided by Amihud, Hauser, and Kirsh (2003) who report that, overall, uninformed Israelian investors generated negative allocation-weighted returns.

One of the major implications of Rock's model was contributed by Beatty and Ritter (1986), based on initial research of Ritter (1984). In his publication "The "Hot Issue" Market of 1980", Ritter (1984) developed his changing risk composition theory. According to this theory, hot issue markets represent phases in which a high number of IPOs is conducted and that these periods show higher levels of underpricing while the opposite is true for cold issue markets. The rationale behind this theory is that during hot issue markets, riskier firms take advantage of investors' confidence, thus, the number of riskier firms is higher during such periods. This lays the fundament for Beatty and Ritter's (1986) theory. As summarized by Ljungqvist (2007, p.387), they argue that "an investor who decides to engage in information production implicitly invests in a call option on the IPO, which will be exercised if the 'true' price exceeds the strike price, that is, the price at which the shares are offered. The value of this

option increases in the extent of valuation uncertainty. Thus, more investors will become informed the greater the valuation uncertainty. This raises the required underpricing, since an increase in the number of informed investors aggravates the winner's curse problem". Thus, Beatty and Ritter (1986) state that higher ex-ante uncertainty about the valuation of an issuer leads to a higher degree of IPO underpricing. In simple terms, this means that underpricing is a form of compensation for investors who become informed. In a situation in which a high number of risky firms go public, this leads to higher overall levels of underpricing.

To test their theory, Beatty and Ritter used the logarithm of the number of uses of proceeds plus one as well as the natural logarithm of the inverse of the gross proceeds as proxies for ex-ante uncertainty (Beatty and Ritter 1986). As mentioned, the theory on ex-ante uncertainty and, hence, Rock's winner's curse model (1982, 1986) received strong academic support with several other commonly used proxies for ex-ante uncertainty having emerged over time in the academic literature. Barry et. al. (1990), Carter and Manaster (1990), Megginson and Weiss (1991), Ritter (1991), Michaely and Shaw (1994), Jegadeesh, Weinstein, and Welch (1993), Carter, Dark and Singh (1998), Lowry and Schwert (2002), Loughran and Ritter (2004), Hanley and Hoberg (2012) and Loughran and McDonald (2013), just to name a few, all provided empirical support for the ex-ante uncertainty theory using different proxies. Some of these proxies will be included in this thesis as control variables and are further explained in Appendix D.

As explained, Ritter's (1984) changing risk composition theory and Beatty and Ritter's (1986) implications about the positive relationship of ex-ante uncertainty and underpricing are central to this thesis. Further, Ljungqvist's (1997) study of the German IPO market is highly relevant for this thesis. Based on Ritter (1984) and Beatty and Ritter (1986), he investigated 189 IPOs from 1961 to 1987 and, among other proxies, he used the ifo Business Climate Index as a proxy to identify hot issue markets and found evidence that the better the business climate

is, the higher the average first day returns are, implying that fewer high ex-ante uncertainty firms go public during periods of downbeat business climate. Further empirical support, however not focused on Germany, came from Ritter (1991) who states that overoptimistic investors further drive up secondary market prices, leading to higher initial returns.

More recently, Baig and Chen (2021) analyzed the US IPO market during the Covid-19 crisis, basing their hypothesis on Beatty and Ritter (1986). 421 US IPOs from 2018 to the end of 2020 were investigated. Their regression analysis yielded the finding that IPOs conducted during the Covid pandemic in fact faced more underpricing than IPOs pre-pandemic. Further, they find that initial returns of firm's going public during the pandemic increased as the severity of the pandemic increased. Mazumder and Saha (2021) also analyzed the impact of the pandemic on IPO underpricing in the US using a data sample covering 81 IPOs during 2020. They reported an average underpricing of 27.30%, representing a 9.30 percentage points increase over the average US underpricing in the period 1980 to 2019. Unlike Baig and Chen (2021) they found a negative relationship between the intensity of the pandemic and underpricing. However, in general, the findings of both studies fit to the findings of Ritter (1984) and Beatty and Ritter (1986), as US primary equity markets saw a strong year despite the worst recession since the second world war with 465 IPOs priced and $177.4 billion in gross proceeds raised (PricewaterhouseCoopers 2021).

## 3. Research design

The following chapter provides insights into the design of the research underlying this thesis, including the formulation of the research question and the hypotheses, the data set, a description of the relevant variables as well as the regression models.

### 3.1 Research question and hypothesis

Since this thesis aims at analyzing the impact of economic downturns on the pricing of German IPOs in the time from 2002 to 2021, the first objective is to determine the level of average IPO

underpricing during the period under analysis. Therefore, the first hypothesis is formulated as follows:

*H1: During the period from 2002 to 2021, German IPOs were subject to IPO underpricing and, hence, German corporates left substantial amounts of money on the table.*

Further, based on the assumptions of Rock (1982, 1986), Ritter (1984), Beatty and Ritter (1986) and findings of Ritter (1991) as well as Ljungqvist (1997), it is argued that in times in which the economic sentiment is below average, i.e. in times of economic downturns, average first day returns are lower, as fewer risky firms go public during such periods. Ultimately, this leads to the following hypothesis which will be assessed using a dummy variable based on the ESI, as described later:

*H2: During economic downturns, the average level of IPO underpricing in Germany decreases.*

However, this also implies that initial first day returns are expected to be higher during times of above-average economic sentiment which is in line with Ljungqvist's (1997) findings. This will be assessed using the ESI in its raw form, i.e. the indicator values, complementing the second hypothesis as H2 solely focuses on downturns. Thus, the following hypothesis is further formulated:

*H3: The better the economic sentiment, the higher the underpricing of German IPOs and vice versa, indicating a positive relationship between the ESI value and the level of underpricing.*

Finally, the last hypothesis is more generally addressed to ex-ante uncertainty and the several control variables included in this research which are used as proxies for ex-ante

uncertainty. In accordance with the academic literature, it is expected that IPOs linked to higher ex-ante uncertainty face higher IPO underpricing. The hypothesis will be accepted when one or more of the ex-ante uncertainty control variables show a statistically significant relationship:

*H4: IPOs linked to higher ex-ante uncertainty faced higher underpricing in Germany from 2002 to 2021.*

### 3.2 Data

The following chapter is devoted to the dataset. First, an overview about the sample construction and the subsequent exclusion approach is provided. The starting point of the sample construction is the primary market statistics of Deutsche Börse AG which contains 705 completed new issuances on the Frankfurt Stock Exchange (FSE) across all market segments since 1997 (see Appendix B for more information regarding the market segments on FSE). After an initial analysis, the time period has been reduced to include the years 2002 to 2021, effectively 20 years of data. The exclusion is made mainly because the period from 1997 to 2001 captures both the transition to as well as the burst of the dotcom bubble which was characterized by a high number of firms from the new economy, especially technology firms (Carvalho, Pinheiro, and Sampaio 2017). As described in the literature review (e.g. Ljungqvist and Wilhelm (2003) for the US market and Hunger (2003) for the German market), this period is well researched with findings highlighting that the degree of underpricing was significantly higher during this period. Further, the period 1997 to 2002 comprises 428 out of the 705 (61%) IPOs included in the primary market statistics. Therefore, the period is not only excluded with the aim of providing complementary empirical research on the pricing of IPOs during the period after the dotcom bubble but also with the objective of avoiding this period's heavy weight and effects biasing the results. After excluding the years 1997 to 2002, 277 IPOs remain in scope.

In accordance with the academic IPO literature, several further exclusions are required to refine the dataset. In line with Loughran and Ritter (2004) and Lowry and Schwert (2004),

banks as well as financial services companies, closed-end funds, and real estate firms, including real estate investment trusts (REITs) are excluded from the analysis as their valuation can be affected by specific regulatory aspects. These firms can be identified based on the sector classification of Deutsche Börse. Further, IPOs issued at a price of less than €5 are excluded since these stocks are considered to be "penny stocks" which, according to Bradley et al. (2006) show higher initial returns than ordinary offerings. Finally, SPAC IPOs are not considered. After implementing these exclusions, 200 IPOs remain in the data set.

In a next step, Bloomberg, Compustat, the respective issuer's prospectus as well as press releases, equity research studies and newspaper reports are used to obtain the data required for the variables (see Table A1 in Appendix A). IPOs for which critical data cannot be obtained are excluded from the analysis. After all, 192 IPOs remain in the final data sample. In Appendix A, Figure A3 and Figure A4 provide a graphical presentation of the IPOs per year and sector while Table A2 provides more detailed tables, giving an overview of the characteristics of the final data set from a year and sector perspective.

### 3.3 Dependent and independent variables

In the following, the main variables used in the statistical analysis, i.e. the regression analyses, are described. Besides testing for the impact of economic downturns, as expressed by variables derived from the ESI (main explanatory variables) on IPO underpricing (dependent variable), additional control variables commonly used in academic underpricing research will be included to enhance the results of the analysis. An overview including all the variables and sources used to retrieve the required data is provided in Table A1 in Appendix A while the summary statistics for all included variables can be found in Table A3.

#### *3.3.1 Dependent variables*

The dependent variable on which the impact of economic downturns will be assessed is IPO underpricing as expressed by the simple initial returns, denoted throughout this thesis as

*IPOUP*. This approach is consistent with Loughran and McDonald (2013) who calculate simple initial returns as follows:

(1) $$IPOUP\ (simple\ initial\ returns) = \frac{Price_{First\ close} - Price_{Offering}}{Price_{Offering}}$$

Positive initial returns suggest that the offering was underpriced, as investors are willing to pay a higher price in the secondary markets. This implies that the company could have sold their shares at a higher price, thus, raising more IPO proceeds. The opposite is true for overpriced offerings. For the calculation the offering prices as well as first day closing prices are required. Offer prices were mainly obtained from the Deutsche Börse primary market statistics. In such cases were the database lacks offer prices, Bloomberg or the respective IPO prospectus was used. To identify the first day closing prices, mainly Bloomberg was used.

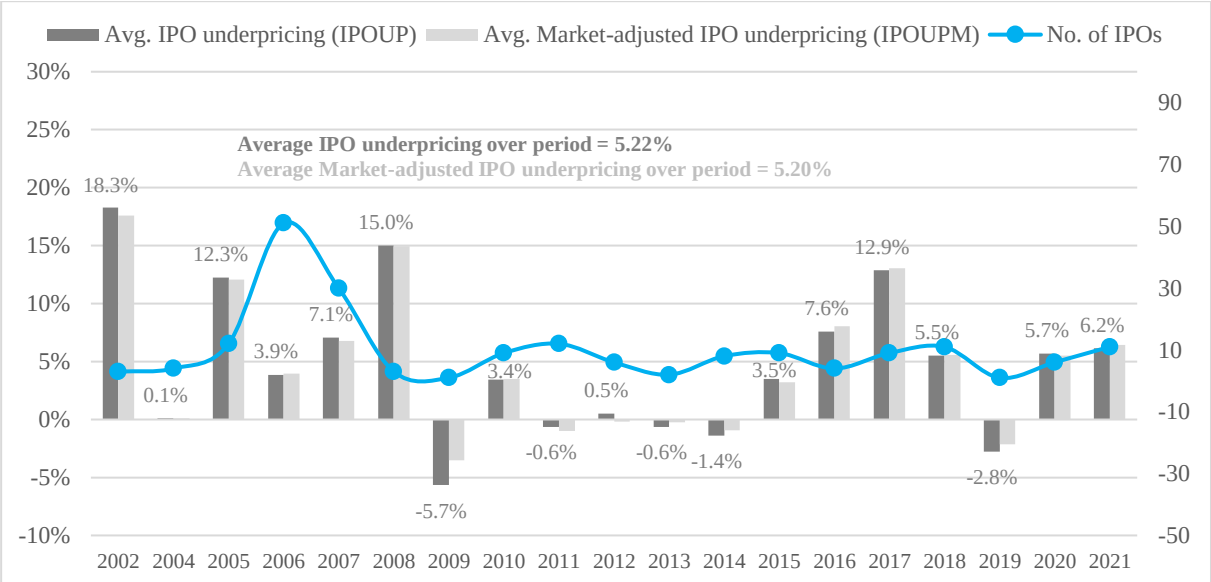
To ensure that the underpricing is not heavily impacted by general market movements, in two of the four regression models, introduced later, market-adjusted initial returns (*IPOUPM*) are used. However, these models are rather used as control models, while the main models are those using simple initial returns as dependent variable. The market return on the IPO date of the respective issuer is derived from the MSCI Germany index denoted in Euro. The index was chosen as it captures approximately 85% of the market capitalization in Germany which fits well since the market capitalization of the issuers included in the dataset range from $6 million to €29 billion, therefore, comprising small to large caps. The index data was retrieved from Bloomberg. The variable *IPOUPM* is calculated as follows:

(2) $$IPOUPM = \left(\frac{Price_{First\ close} - Price_{Offering}}{Price_{Offering}}\right) - Return_{Market}$$

The observed average first day simple initial return across all years included in the dataset equals 5.22% while the market-adjusted underpricing totals 5.20%, hence, showing no strong deviation from the simple initial returns. IPO underpricing was the highest in 2002, with average simple initial returns of 18.26% and the lowest in 2009 where IPOs were overpriced

by, on average, 5.67% and 3.53% on a market-adjusted basis. From a sectoral perspective, issuers from the energy and industrials sectors as classified by the Bloomberg Industry Classification Standard (BICS) were underpriced the most, with levels of 11.62% and 8.01% respectively.

**Figure 2 – Average IPO underpricing and market-adjusted IPO underpricing over time**




The results are statistically significant as tested with a t-test using a 99% confidence interval. The critical value of 2.60 is well-below the *IPOUP* t-test statistic of 5.78 (Appendix A – Table A4). The t-test statistic for the market adjusted first day returns equals 5.80, also well-above the critical value. Hence, the first research hypothesis of this thesis can be accepted, i.e. during the period from 2002 to 2021, German IPOs were subject to IPO underpricing and, thus, German corporates left substantial amounts of money on the table. The average over the whole period under analysis is significantly lower than levels found in previous studies such as Ljungqvist (1997) who reported average first day returns of 9.2% (1970 to 1993), Wasserfallen and Wittleder (1994) who reported 17.6% (1961 to 1987) or, most recently, Loughran, Ritter and Rydqvist (2022) who calculated an average underpricing of 21.8% in the period from 1978 to 2020. However, most of the previous studies focused on periods which go back later in the past and further include the dotcom bubble, hence, it appears that, although IPOs are still not

adequately priced, the level of average IPO underpricing in Germany has decreased in more recent years. This is also evidenced by Hunger (2022) who reports an average underpricing of 5.30% from 2004 to 2020.

This thesis focuses on the underpricing of IPOs, i.e. the short-run performance, however, several studies also focused on the long-run performance, mostly on a relative basis versus selected benchmarks or matching non-IPO firms. Although no widely acknowledged theory exists, the literature points towards the fact that IPOs are overpriced on a long-term basis, i.e. IPO firms underperform either a) the market or b) matching firms with similar characteristics (Ljungqvist, Nanda and Singh 2006). For instance, Ritter (1991) and Loughran and Ritter (1995) reported a long-run underperformance of IPO stocks. The latter documented an underperformance of IPO firms versus firms with a similar size of approximately 7% p.a. over both a three and a five-year time horizon. Carter, Dark and Singh (1998) found similar results and provided evidence that the long-run underperformance is lower for issues managed by reputable underwriters. Ljungqvist, Nanda and Singh (2006) state that especially firms performing an IPO in hot issue markets (see Ritter, 1984) underperform in the long run.

### *3.3.2 Main explanatory variables*

To test the second and third hypothesis, this thesis will follow the approach of Ljungqvist (1997) who used a sentiment indicator as proxy. Hence, the focus of the statistical analysis in this thesis will be the coefficient on economic downturns as expressed by ESI, calculated by the Directorate General for Economic and Financial Affairs of the European Commission with the aim of monitoring GDP growth. The indicator is computed as a composite which comprises several positive or negative responses to business and consumer surveys across the 27 European Union member states and five subsegments. The subsegments included are industry, services, consumers, retail, and construction which are assigned a 40%, 30%, 20%, 5% and 5% weighting respectively. The ESI is scaled to a long-term average of 100, meaning that readings above 100

imply above-average economic sentiment while readings below 100 represent the opposite (Eurostat 2022). As the ESI is reported monthly, data is only available for a respective month's end, thus, for all IPOs during a certain month, the ESI value at the end of the month is used. The data was retrieved from Bloomberg.

Two variables are derived from the ESI which are used across four different regression models, as presented later. Firstly, a dummy variable (*DESI*) was constructed which equals one if the ESI was below its long-term average of 100, indicating negative sentiment and, ultimately, used as proxy for economic downturns. This variable will primarily be used to test whether such periods have an impact on underpricing and whether this relationship is positive or negative (H2). Secondly, the index in its raw form (*INESI*) is used as a variable in different regression models. This variable allows for an analysis of the intensity of economic downturns as well as upswings and IPO underpricing (H3). A positive relationship is expected, meaning that a rising ESI value will lead to higher underpricing and vice versa.

One key advantage of the ESI can be found in its construction method based on surveys, as the indicator can be considered a leading indicator, while GDP growth, for instance, is a lagging indicator, i.e. measuring a past event. Thus, at the time of the pricing of an IPO, the economic sentiment could be in a downward trend which would not be captured in case GDP growth would be used as a proxy for economic downturns. In other words, a region or country can technically be in a recession, however, with a still above-average economic sentiment at the same moment and vice versa. As can be inferred from the graph attached in Figure A5 (Appendix A), an OECD GDP-based indicator and the ESI only showed a simultaneous reading of one in 20% of the time, implying a relatively low overlap. One example to highlight is the time from December 2017 to March 2020 where the OECD indicator flagged a recession while the ESI dummy was still at zero. All in all, it appears that the ESI better and more timely captures economic downturns.

Finally, another reason for choosing the ESI as proxy is the fact that the European capital markets are interconnected, and the investor base of an IPO in Germany is likely to include investors from other European jurisdictions. In addition, as Germany is Europe's largest economy, it is expected that the ESI captures the economic sentiment in Germany.

*3.3.3 Control variables*

The IPO underpricing literature suggests a variety of proxies for ex-ante uncertainty which might explain the positive initial returns, and which received empirical support. Thus, a selection of the most commonly used variables, as identified by analyzing various empirical studies, are integrated into the analysis as control variables, helping in measuring the marginal impact of the main explanatory variable. These variables fall mainly into three categories, namely firm, offer and aftermarket characteristics (Ljungqvist, 2007). However, as aftermarket characteristics use information not available at the time of the offer, Ljungqvist (2007, p. 388) states that "heavily underpriced IPOs tend to generate more investor interest and so more after-market trading, with the causation running from underpricing to after-market trading behavior rather than the other way around". Hence, aftermarket variables are not considered. Overall, 9 control variables are included (*LNAGE, LNSALES, LNMARCAP, VCB, PEB, HTECH, UWREP, LNGPRO, PREV).* In combination with Table A1 (Appendix A), Appendix D provides a separate literature review delivering insights into the theoretical background for these variables, including an overview of select academic literature related to these variables.

**3.4 Baseline regression models**

To estimate the relationship between economic downturns and IPO underpricing Ordinary Least Square (OLS) regressions are performed. The standard model of an OLS is determined as follows (Nokeri 2021):

(3) $$y_i = \beta_0 + \beta_1 X_1 + \cdots + \beta_n X_n + \varepsilon_i$$

As explained, *IPOUP* and *IPOUPM* serve as the dependent variables $y_i$ in the analysis while $X_1 - X_n$ denote the explanatory variables *DESI* and *INESI* as well as the control variables *LNAGE, LNSALES, LNMARCAP, VCB, PEB, HTECH, UWREP, PREV and LNGRPO* alongside their respective coefficients $\beta_1 - \beta_n$. To test whether a statistical relationship between economic downturns and IPO underpricing exists, four models are estimated. The first model (M1) will use a dummy variable based on the ESI as the main explanatory variable which equals one if the indicator is below its long-term average, ultimately a proxy for indicating economic downturns. This model is used to test the second hypothesis (H2). Further, all control variables are included. Thus, the empirical model is estimated as follows:

(M1) $$IPOUP = \beta_0 + \beta_1 DESI + \beta_2 LNAGE + \beta_3 LNSALES + \beta_3 LNMARCAP + \beta_5 VCB + \beta_6 PEB + \beta_7 HTECH + \beta_8 UWREP + \beta_9 PREV + \beta_{10} LNGRPO + \varepsilon_i$$

The second model (M2) uses the ESI in its raw form as denoted by *INESI.* This model aims at testing H3. Besides the explanatory variable *INESI*, all control variables are included, leading to the following estimation of the second model:

(M2) $$IPOUP = \beta_0 + \beta_1 INESI + \beta_2 LNAGE + \beta_3 LNSALES + \beta_3 LNMARCAP + \beta_5 VCB + \beta_6 PEB + \beta_7 HTECH + \beta_8 UWREP + \beta_9 PREV + \beta_{10} LNGRPO + \varepsilon_i$$

The third and fourth model (M3 and M4) rely on the same sets of variables but use market-adjusted initial returns (*IPOUPM*) as dependent variable:

(M3) $$IPOUPM = \beta_0 + \beta_1 DESI + \beta_2 LNAGE + \beta_3 LNSALES + \beta_3 LNMARCAP + \beta_5 VCB + \beta_6 PEB + \beta_7 HTECH + \beta_8 UWREP + \beta_9 PREV + \beta_{10} LNGRPO + \varepsilon_i$$

(M4) $$IPOUPM = \beta_0 + \beta_1 INESI + \beta_2 LNAGE + \beta_3 LNSALES + \beta_3 LNMARCAP + \beta_5 VCB + \beta_6 PEB + \beta_7 HTECH + \beta_8 UWREP + \beta_9 PREV + \beta_{10} LNGRPO + \varepsilon_i$$

## 4. Regression analysis

The estimated regression models are tested using the statistics software STATA. After performing the initial baseline regressions (Table A5 in Appendix A), White's test for heteroskedasticity was performed for all models (Table A6 in Appendix A), yielding the finding that heteroskedasticity might be an issue with all White test p-values below the 5%-level (for M2 and M4 below the 1%-level). Consequently, robust standard errors are used to account for the heteroskedasticity. Since the dataset contains too few clusters (i.e. no. of industries = 9; no. of years = 19), clustered robust standard errors are not used (Cameron and Miller 2015). To account for possible unobserved heterogeneity and its effects, as it is common in academic finance literature, additional regressions are performed which implement controls for industry and year fixed effects (Gormley and Matsa 2014). The full regression results are reported in Appendix A (Table A7).

### 4.1 Discussion of the results

As can be seen in table 1, the coefficient of the *DESI* dummy variable is slightly positive across the models M1 and M3, against the expectation of a negative relationship as derived from the academic literature. When controlled for industry and year fixed effects (FE) the coefficient in M1 remains slightly positive while the M3 coefficient turns slightly negative. However, across all models including those controlling for fixed effects, the results are not statistically significant, thus, it is not possible to accept H2 ("*during economic downturns, the average level of IPO underpricing in Germany decreases*"). The statistically unsignificant result and the positive sign could potentially be attributed to the *DESI* being an improper proxy for declaring economic downturns, highlighting one of the possible limitations of this analysis. The results for the OLS *INESI* models (M2 and M4) do not provide significance as well and the coefficients are negative which is further against expectations. However, after controlling for industry and year fixed effects, the *INESI* models provide significance at the 5%-level (M2 FE and M4 FE

model) with the coefficient remaining negative. Thus, factors linked to industry and year which are unobserved in the model seem to have an effect on the results which is further evidenced by the coefficients becoming more negative after controlling for fixed effects (M2 OLS: -0.0013 vs. M2 FE: -0.0077 and M4 OLS: -0.0011 vs. M4 FE: -0.0072). The results indicate that better economic sentiment, as expressed by a rising ESI value, leads to lower IPO underpricing, after controlling for fixed effects. In fact, an increase of one ESI unit leads to a decrease in IPO underpricing by 0.77% and 0.72% on a market-adjusted basis. Inversely, it can be inferred that during times of weak economic sentiment the average level of IPO underpricing increases. This finding contradicts previous literature, especially with regards to Ljungqvist (1997) who reported higher IPO underpricing in Germany during times in which the economic climate is rising. The findings further contradict Beatty and Ritter's (1986) implication of Rock's (1982, 1986) winner's curse model as it is assumed that during such periods a greater number of riskier firms tap public equity markets via an IPO, leading to higher overall levels of underpricing. Therefore, based on the dataset used in this research and the ESI as proxy, H3 ("*the better the economic sentiment, the higher the underpricing of German IPOs and vice versa, indicating a positive relationship between the ESI value and the level of underpricing*") cannot be accepted as well as the sign of the coefficient is the opposite of what was expected.

Since Ljungqvist (1997) used a sentiment indicator specifically linked to Germany, the question can be raised whether the ESI is the right proxy to capture the envisaged effects for Germany. Therefore, an additional regression model using a German economic sentiment indicator is estimated for which the results are presented in Appendix E (Table E2). An explanation including the estimation of the regression models can be found in Appendix E. However, the alternative regression models did not yield any significance while the signs of the respective coefficients linked to the German economic sentiment indicator equal to those found in the M1 and M4 OLS and FE models.

## Table 1 – OLS regression and fixed effects regression results

The table reports the OLS regression and fixed effects regression coefficients and, in parentheses, the t-statistics. IPOUP and IPOUPM as dependent variables are regressed on the variables introduced in chapter 4. This table shows the results for the dependent variables, for the full results, see Table A7 in Appendix A. Robust standard errors are used. The sources for the variables can be retrieved from Table A1 (Appendix A). *, **, *** refer to the statistical significance at the 10%, 5% and 1% level, respectively.

| | ***OLS regressions*** | | | | ***Fixed effects regressions*** | | | |
|---|---|---|---|---|---|---|---|---|
| | **M1** | **M2** | **M3** | **M4** | **M1** | **M2** | **M3** | **M4** |
| **Dependent variable** | **IPOUP** | **IPOUP** | **IPOUPM** | **IPOUPM** | **IPOUP** | **IPOUP** | **IPOUPM** | **IPOUPM** |
| *DESI* | 0.0060 | | 0.0027 | | 0.0062 | | -0.0011 | |
| | (0.28) | | (0.13) | | (0.18) | | (-0.03) | |
| *INESI* | | -0.0013 | | -0.0011 | | -0.0077** | | -0.0072** |
| | | (-0.83) | | (-0.73) | | (-2.52) | | (-2.42) |
| *Control variables* | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Industry FEs* | No | No | No | No | Yes | Yes | Yes | Yes |
| *Year FEs* | No | No | No | No | Yes | Yes | Yes | Yes |
| *No. of obs.* | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 |
| *R2* | 0.1580 | 0.1629 | 0.1642 | 0.1678 | 0.2953 | 0.3275 | 0.2976 | 0.3529 |

With regards to the control variables (see Table A7 in Appendix A), *LNAGE* is statistically significant at the 10%-level in all OLS and FE models, except for the M4 FE model although the positive sign of the coefficient is not in line with expectations and what the academic literature suggests. Further, *LNMARCAP* shows a statistical significance across all OLS models at the 10%-level. After controlling for industry and year fixed effects, significance only remains in the M1 FE and M3 FE models. The coefficients increase from 0.0321 (M1 OLS) and 0.0335 (M3 OLS) to 0.0474 (M1 FE) and 0.0391 (M3 FE) respectively, implying that a higher market capitalization at offering leads to higher levels of underpricing. Again, the coefficient sign and the conclusion is against what was expected based on the literature review. *PREV* shows a strong statistical significance across all OLS and FE models at the 1%-level. Different from *LNAGE* and *LNMARCAP*, the sign of the coefficient is in line with previous research, implying that a positive price revision leads to higher underpricing (Hanley 1993; see Appendix C). However, the *PREV* coefficient dropped across all models after controlling for fixed effects, indicating that unobserved heterogeneity had an impact on this variable. Although

no significance was provided for *LNGPRO* in none of the OLS regression models, the variable showed significance at the 5%-level after controlling for industry and year fixed effects. The coefficient is negative across all models and, thus, in line with expectations. Hence, after controlling for fixed effects, at least with regards to this proxy, it could be concluded that IPOs with higher ex-ante uncertainty in Germany faced higher underpricing while larger offerings, typically linked to more established firms, lead to decreasing levels of IPO underpricing. Therefore, H4 can be accepted when ex-uncertainty is measured by *LNGPRO* and fixed effects are considered. However, it is important to stress that *LNGPRO* is the only ex-ante uncertainty proxy which provides significance and a sign in line with previous studies while the other proxies contradict the findings from previous IPO underpricing studies. All remaining variables (*LNSALES, VCB, PEB, HTECH and UWREP*) do not show statistical significance in any of the OLS and FE models with their signs further contradicting previous research, except the sign of the *LNSALES* coefficient which complies with expectations.

### 4.2 Limitations and suggestions for further research

In the following, possible limitations linked to the methodology employed will be discussed. First, although a time horizon of 20 years is used, the number of IPOs performed in Germany is relatively low compared to other large capital markets such as the US. In addition, some IPOs needed to be excluded due to a lack in crucial datapoints, further reducing the number of issues. Thus, it is possible that the German market and, therefore, the data sample has intrinsic weaknesses and is not able to serve as a proper foundation to examine the question whether and how economic downturns affect IPO underpricing as not enough data points exist. This is also underlined when looking at the regression results for the control variables where several of the proxies show no significance in the German market while these proxies received strong academic support during the last decades. In addition, the level of underpricing is, on average, relatively low in Germany compared to other countries. A suggestion for further research is to

compare the characteristics of the German IPO market more closely to other international markets, especially over the last two decades, to find explanations why the level of underpricing is significantly lower in Germany and, hence, also answer the question whether the proxies used in the international academic IPO literature are appropriate for the German market. In addition, future research could build upon the findings from the regression analyses by performing qualitative research via interviews targeted at understanding investor behavior during economic downturns with respect to initial public offerings to answer the question whether investors demand a discount during such phases or to find other explanation which could explain the results of regression analyses presented in this thesis. Finally, the decision to choose the ESI as proxy for detecting economic downturns can be challenged. Although the indicator measures the economic sentiment of the Eurozone, it is possible that it does not fully capture the sentiment in Germany in particular. Future research could employ alternative, potentially better suited measures in a comparable analysis.

## 5. Conclusion

The goal of this thesis was to analyze the impact of economic downturns on IPO underpricing in Germany based on strongly empirically supported ex-ante uncertainty theories originally developed by Beatty and Ritter (1986) and the findings for the German market of Ljungqvist (1997) who, similar to the approach employed in this thesis, used a sentiment indicator as proxy. A first important, statistically significant finding is that IPO underpricing existed in Germany during the period under analysis, although the level of underpricing is far lower in Germany than in other countries. In addition, the underpricing of, on average, 5.22% over the last 20 years identified in this thesis is also significantly lower than the initial first day returns identified in the German market when analyzing earlier time periods.

While no significance for any of the proxies linked to economic downturns could be identified in the OLS regressions, the *INESI* FE models (M2 FE and M4 FE) provided statistical

significance at the 5%-level in combination with negative coefficients, implying that, when controlled for industry and year fixed effects, a rising economic sentiment as measured by the ESI led to lower levels of average IPO underpricing in Germany during the period 2002 to 2021 and vice versa. In general, the findings contradict Ritter's (1984) as well as Beatty and Ritter's (1986) theory of higher levels of IPO underpricing during such times as more firms linked to higher ex-uncertainty go public and, specifically, Ljungqvist's research focused on the German market from 1997. One possible conclusion based on the findings could be that the underlying theories do not apply to Germany in general as the market activity is rather low, at least with respect to the dataset underlying this thesis (also see limitations in chapter 4.2). However, another possible conclusion could be that investors rather demand a discount in times of weak economic conditions and high market uncertainty in general, as implied by the negative *INESI* coefficient. Further, with regards to the ex-ante control variables, the results of the regressions provide mixed results. While *LNAGE* and *LNMARCAP* show statistical significance, the sign of the coefficient is the opposite of what was expected based on the literature review. However, *LNGPRO*, the proxy suggested by Beatty and Ritter (1986), provides significance after controlling for fixed effects and a sign in line with earlier research. Therefore, on a standalone basis, only using *LNGPRO* as ex-ante uncertainty proxy, Beatty and Ritter's (1986) implication (the higher the ex-ante uncertainty, the higher the level of underpricing) can be supported. However, in conjunction with the results of the other ex-ante uncertainty proxies, including the main explanatory variables, it becomes harder to support the ex-ante uncertainty theory for the German market in the period from 2002 to 2022 since the signs of most of the proxy coefficients are the inverse of what the literature suggests. Overall, this leads to the conclusion that Beatty and Ritter's (1986) ex-ante uncertainty theory and, thus, Rock's winner's curse (1982, 1986) cannot fully explain the IPO underpricing in Germany over the last 20 years.

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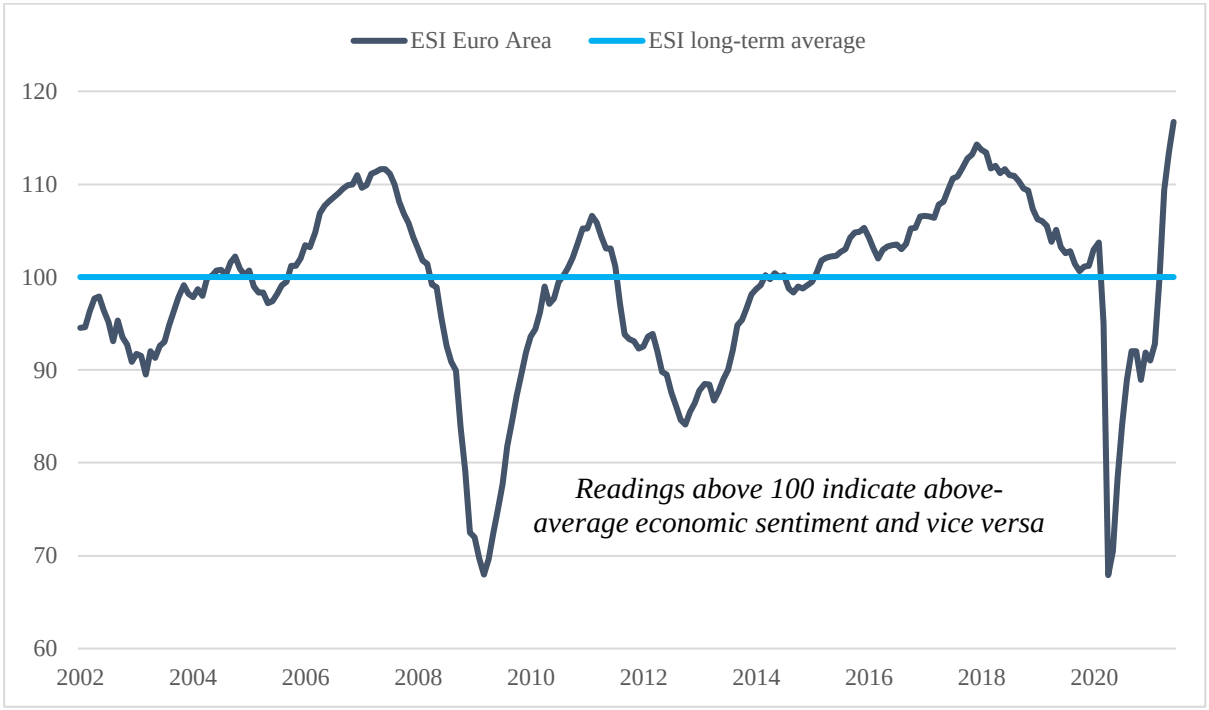
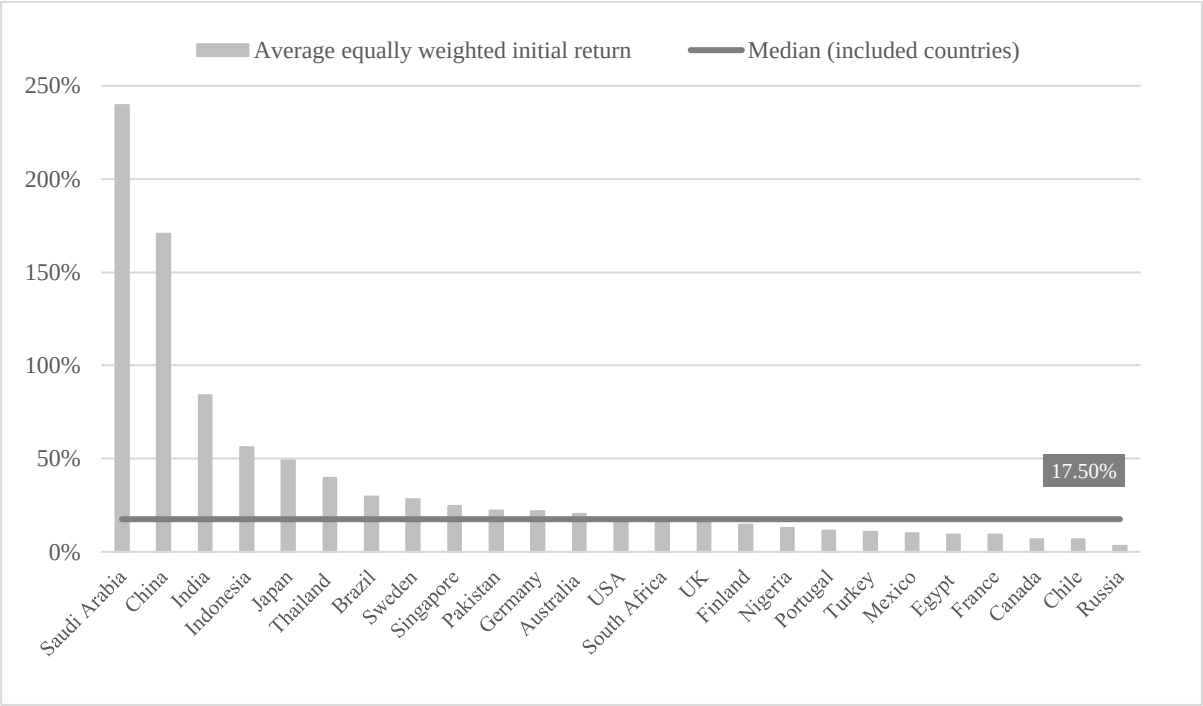
# Appendix A – Figures and tables

**Figure A1 – Economic Sentiment Indicator (ESI) from 2002 to 2021**




Source: Bloomberg (2022a), for more information on the calculation of the indicator, see chapter 3.3.2

**Figure A2 – Global levels of IPO underpricing in comparison**




Source: Loughran, Ritter and Rydqvist (2022)

**Figure A3 – Number of IPOs included in the dataset per year**

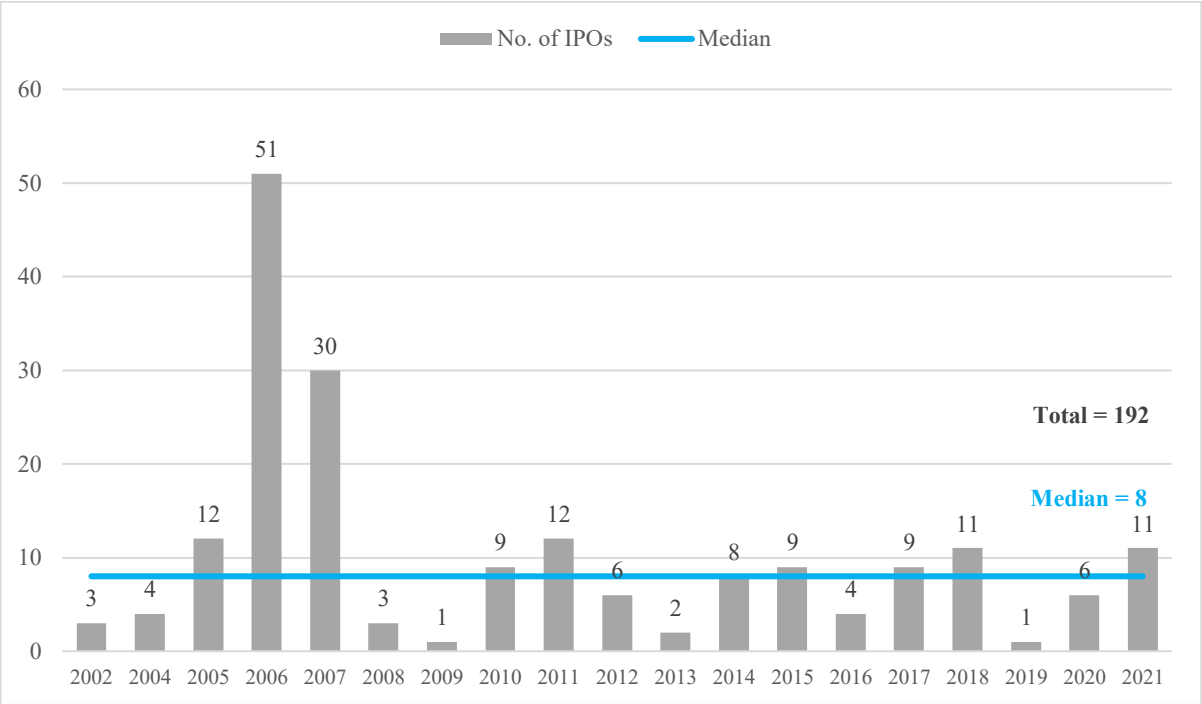


**Figure A4 – Number of IPOs included in the dataset per BICS sector**

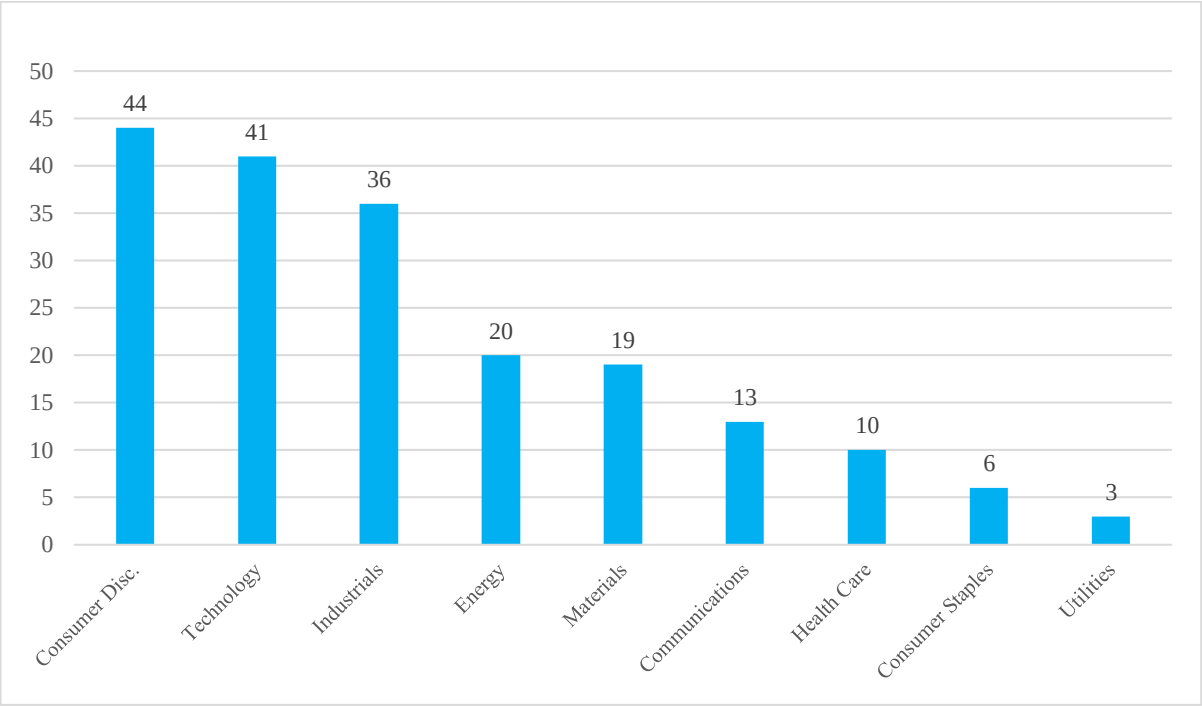
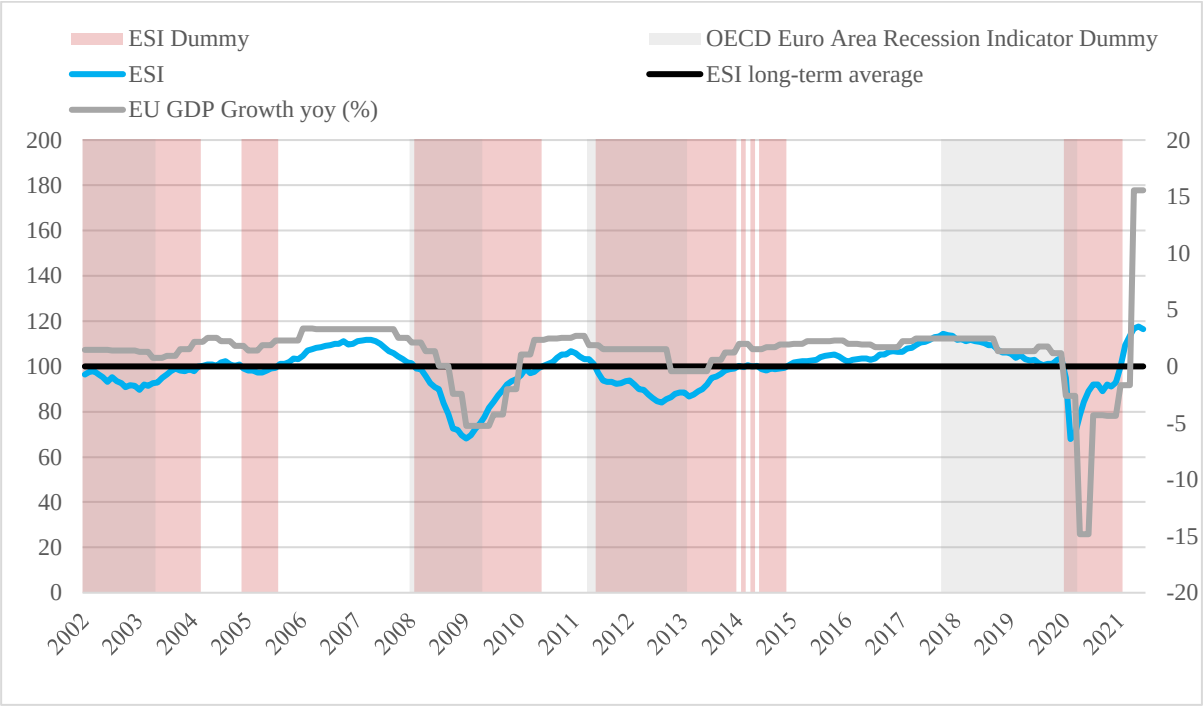


**Figure A5 – Economic Sentiment Indicator (ESI) versus other indicators**




Source: Bloomberg (2022a), Federal Reserve Bank of St. Louis (2022), own calculations

## Table A1 – Overview of the variables and sources used in this thesis

| Variable | Expectation | Sources | Calculation |
|---|---|---|---|
| *IPOUP* | --- | Bloomberg | See chapter 3.3.1 |
| *IPOUPM* | --- | Bloomberg | See chapter 3.3.1 |
| *DESI* | (-) | Bloomberg | Equals 1 in case ESI is below its long-term average of 100, zero otherwise |
| *INESI* | (+) | Bloomberg | Raw indicator value |
| *ZEWD* | (-) | Bloomberg | Equals 1 in case ZEW CCI is below its threshold of 0 (see Appendix E for information on ZEW CCI) |
| *ZEW* | (+) | Bloomberg | Raw index value (see Appendix E for information on ZEW CCI) |
| *LNAGE* | (-) | Prospectus, corporate website, annual reports, press releases, newspapers, equity research reports | ln (firm age + 1) |
| *LNSALES* | (-) | Prospectus, COMPUSTAT, annual reports, press releases, newspapers, equity research reports | ln (sales one FY prior to IPO) |
| *LNMARCAP* | (-) | Bloomberg, Deutsche Börse primary market statistics | ln (market cap at offering) |
| *VCB* | (-) | Prospectus, annual reports, equity research reports | Equals 1 if IPO company is venture capital backed and zero otherwise |
| *PEB* | (-) | Prospectus, annual reports, equity research reports | Equals 1 if IPO company is private equity backed and zero otherwise |
| *HTECH* | (+) | Bloomberg | Equals 1 if company is from the technology sector and zero otherwise |
| *UWREP* | (+)/(-) | Migliorati and Vismara(2014) | Proceeds weighted score of Migliorati's and Vismara's European underwriter ranking |
| *LNGPRO* | (-) | Deutsche Börse primary market statistics | ln (gross proceeds) |
| *PREV* | (+) | Deutsche Börse primary market statistics | Final offer price / midpoint of pricing range |

## Table A2 – IPOs included in the data sample per sector and year

| | No. of IPOs | Avg. market cap at offering (in €m) | Avg. total sales in IPO year -1 (in €m) |
|---|---|---|---|
| **Panel A: IPOs split by Bloomberg Industry Classification Standard (BICS) sector** | | | |
| Communications | 13 | 2,332 | 883 |
| Consumer Discretionary | 44 | 558 | 264 |
| Consumer Staples | 6 | 523 | 188 |
| Energy | 20 | 488 | 84 |
| Health Care | 10 | 3,565 | 1,704 |
| Industrials | 36 | 1,316 | 840 |
| Materials | 19 | 988 | 1,495 |
| Technology | 41 | 451 | 119 |
| Utilities | 3 | 7,310 | 14,584 |
| **Total Panel A** | **192** | **1,094** | **782** |
| | | | |
| **Panel B: IPOs per year** | | | |
| 2002 | 3 | 130 | 61 |
| 2004 | 4 | 225 | 380 |
| 2005 | 12 | 697 | 540 |
| 2006 | 51 | 300 | 243 |
| 2007 | 30 | 499 | 209 |
| 2008 | 3 | 584 | 113 |
| 2009 | 1 | 172 | 39 |
| 2010 | 9 | 704 | 988 |
| 2011 | 12 | 202 | 161 |
| 2012 | 6 | 1,143 | 905 |
| 2013 | 2 | 1,246 | 2,412 |
| 2014 | 8 | 1,811 | 485 |
| 2015 | 9 | 1,539 | 2,308 |
| 2016 | 4 | 5,332 | 10,908 |
| 2017 | 9 | 1,127 | 241 |
| 2018 | 11 | 4,190 | 1,959 |
| 2019 | 1 | 5,250 | 258 |
| 2020 | 6 | 481 | 346 |
| 2021 | 11 | 3,271 | 686 |
| **Total Panel B** | **192** | **1,094** | **782** |

## Table A3 – Summary statistics

| | Variable | Obs. | Mean | Std. dev. | Min. | Max. |
|---|---|---|---|---|---|---|
| **Dependent variables** | *IPOUP* | 192 | 0.0522 | 0.1251 | -0.2120 | 0.8686 |
| | *IPOUPM* | 192 | 0.0520 | 0.1243 | -0.2149 | 0.8661 |
| **Main expl. variables** | *DESI* | 192 | 0.2292 | 0.4214 | 0.000 | 1.000 |
| | *INESI* | 192 | 104.7437 | 7.3823 | 70.5000 | 117.6000 |
| **Control variables** | *LNAGE* | 192 | 2.6799 | 1.182 | 0.000 | 5.3799 |
| | *LNSALES* | 192 | 4.1826 | 2.306 | -4.6052 | 10.6795 |
| | *LNMARCAP* | 192 | 19.2472 | 1.6816 | 15.6037 | 24.094 |
| | *VCB* | 192 | 0.1719 | 0.3783 | 0.000 | 1.000 |
| | *PEB* | 192 | 0.4427 | 0.4980 | 0.000 | 1.000 |
| | *HTECH* | 192 | 0.2135 | 0.4109 | 0.000 | 1.000 |
| | *UWREP* | 192 | 0.3332 | 0.4024 | 0.000 | 1.000 |
| | *PREV* | 192 | -0.0298 | 0.0771 | -0.2727 | 0.1613 |
| | *LNGPRO* | 192 | 17.9593 | 1.9269 | 13.1224 | 22.2583 |

## Table A4 – Test statistics for IPOUP and IPOUPM

**Summary statistics and t-test**

| Variable | Obs. | Mean | Std. dev. | Skewness | Kurtosis | Std. err. | T-test statistics | Critical value (99%; df=191) |
|---|---|---|---|---|---|---|---|---|
| *IPOUP* | 192 | 0.0522 | 0.1251 | 2.2329 | 12.6488 | 0.0090 | 5.7816 | 2.602 |
| *IPOUPM* | 192 | 0.5202 | 0.1243 | 2.2571 | 12.8144 | 0.0090 | 5.8005 | 2.602 |

## Table A5 – Baseline OLS regression results

The table reports the baseline OLS regression coefficients and, in parentheses, the t-statistics. *IPOUP* and *IPOUPM* as dependent variables are regressed on the variables introduced in chapter 4. The sources for the variables can be retrieved from Table A1 in Appendix A. *, **, *** refer to the statistical significance at the 10%, 5% and 1% level, respectively.

| | **M1** | **M2** | **M3** | **M4** |
|---|---|---|---|---|
| **Dependent variable** | **IPOUP** | **IPOUP** | **IPOUPM** | **IPOUPM** |
| *DESI* | 0.0060 | | 0.0027 | |
| | (0.28) | | (0.12) | |
| *INESI* | | -0.0013 | | -0.0011 |
| | | (-1.07) | | (-0.90) |
| *LNAGE* | 0.0129 | 0.0137* | 0.0123 | 0.0130 |
| | (1.60) | (1.70) | (1.54) | (1.63) |
| *LNSALES* | -0.0071 | -0.0081 | -0.0064 | -0.0073 |
| | (-1.05) | (-1.19) | (-0.96) | (-1.09) |
| *LNMARCAP* | 0.0321** | 0.0309* | 0.0335** | 0.0321** |
| | (2.01) | (1.97) | (2.12) | (2.07) |
| *VCB* | 0.2167 | 0.0215 | 0.0229 | 0.0227 |
| | (0.90) | (0.90) | (0.96) | (0.96) |
| *PEB* | 0.0113 | 0.0111 | 0.0138 | 0.0136 |
| | (0.63) | (0.62) | (0.78) | (0.77) |
| *HTECH* | -0.0110 | -0.0119 | -0.0094 | -0.0100 |
| | (-0.51) | (-0.55) | (-0.43) | (-0.47) |
| *UWREP* | 0.0001 | 0.0002 | -0.0022 | -0.0019 |
| | (0.00) | (0.01) | (-0.07) | (-0.07) |
| *PREV* | 0.5418*** | 0.5445*** | 0.5509*** | 0.5533*** |
| | (4.57) | (4.60) | (4.69) | (4.72) |
| *LNGPRO* | -0.0252* | -0.0234* | -0.0265** | -0.0247* |
| | (-1.91) | (-1.80) | (-2.03) | (-1.92) |
| Observations | 192 | 192 | 192 | 192 |
| R-squared (adjusted) | 0.1580 | 0.1629 | 0.1642 | 0.1678 |

**Table A6 – White's test for heteroskedasticity (baseline regressions)**

H0: Homoskedasticity

H1: Unrestricted heteroskedasticity

| | **M1** | **M2** | **M3** | **M4** |
|---|---|---|---|---|
| Chi2 (61 df) | 87.86 | 94.49 | 89.12 | 95.36 |
| p-value | 0.0138 | 0.0049 | 0.0109 | 0.0041 |

## Table A7 – OLS regression results using robust standard errors and fixed effects regression results

The table reports the OLS regression and fixed effects regression coefficients and, in parentheses, the t-statistics of the alternative model. *IPOUP* and *IPOUPM* as dependent variables are regressed on the variables introduced in chapter 4 and Appendix D. Robust standard errors are used in all models. The sources for the variables can be retrieved from Table A1 in Appendix A. *, **, *** refer to the statistical significance at the 10%, 5% and 1% level, respectively.

| | ***OLS regressions*** | | | | ***Fixed effects regressions*** | | | |
|---|---|---|---|---|---|---|---|---|
| | **M1** | **M2** | **M3** | **M4** | **M1** | **M2** | **M3** | **M4** |
| **Dependent variable** | **IPOUP** | **IPOUP** | **IPOUPM** | **IPOUPM** | **IPOUP** | **IPOUP** | **IPOUPM** | **IPOUPM** |
| *DESI* | 0.0060 | | 0.0027 | | 0.0062 | | -0.0011 | |
| | (0.28) | | (0.13) | | (0.18) | | (-0.03) | |
| *INESI* | | -0.0013 | | -0.0011 | | -0.0077** | | -0.0072** |
| | | (-0.83) | | (-0.73) | | (-2.52) | | (-2.42) |
| *LNAGE* | 0.0129* | 0.0137* | 0.0123* | 0.0130* | 0.0137* | 0.0130* | 0.0133* | 0.0126 |
| | (1.81) | (1.90) | (1.70) | (1.78) | (1.90) | (1.73) | (1.80) | (1.63) |
| *LNSALES* | -0.0071 | -0.0081 | -0.0064 | -0.0073 | -0.0020 | -0.0021 | -0.0014 | -0.0015 |
| | (-0.92) | (-1.03) | (-0.83) | (-0.93) | (-0.25) | (-0.26) | (-0.17) | (-0.19) |
| *LNMARCAP* | 0.0321* | 0.0309* | 0.0335* | 0.0321* | 0.0474* | 0.0387 | 0.0391* | 0.0404 |
| | (1.73) | (1.70) | (1.78) | (1.72) | (1.92) | (1.62) | (1.95) | (1.65) |
| *VCB* | 0.0217 | 0.0215 | 0.0228 | 0.0227 | 0.0319 | 0.0311 | 0.0322 | 0.0314 |
| | (0.69) | (0.69) | (0.73) | (0.73) | (0.82) | (0.82) | (0.83) | (0.83) |
| *PEB* | 0.0113 | 0.0111 | 0.0138 | 0.0136 | 0.0196 | 0.0220 | 0.0215 | 0.0240 |
| | (0.52) | (0.52) | (0.65) | (0.65) | (0.86) | (0.97) | (0.95) | (1.06) |
| *HTECH* | -0.0110 | -0.0119 | -0.0094 | -0.0100 | 0.0166 | 0.0295 | 0.0175 | 0.0308 |
| | (-0.47) | (-0.52) | (-0.41) | (-0.45) | (0.51) | (1.00) | (0.55) | (1.06) |
| *UWREP* | 0.0001 | 0.0002 | -0.0022 | -0.0019 | -0.0211 | -0.0198 | -0.0231 | -0.0218 |
| | (0.00) | (0.01) | (-0.08) | (-0.07) | (-0.51) | (-0.50) | (-0.57) | (-0.55) |
| *PREV* | 0.5418*** | 0.5445*** | 0.5509*** | 0.5533*** | 0.4626*** | 0.4091*** | 0.4706*** | 0.4199*** |
| | (4.69) | (4.69) | (4.85) | (4.85) | (3.81) | (3.62) | (3.94) | (3.76) |
| *LNGPRO* | -0.0252 | -0.0234 | -0.0265 | -0.0247 | -0.0406** | -0.0334** | -0.0421** | -0.0350** |
| | (-1.59) | (-1.50) | (-1.62) | (-1.54) | (-2.35) | (-2.00) | (-2.36) | (-2.02) |
| Industry FEs | NO | NO | NO | NO | YES | YES | YES | YES |
| Year FEs | NO | NO | NO | NO | YES | YES | YES | YES |
| Observations (N) | 192 | 192 | 192 | 192 | 192 | 192 | 192 | 192 |
| R-squared | 0.1580 | 0.1629 | 0.1642 | 0.1678 | 0.2953 | 0.3275 | 0.2976 | 0.3529 |

## Appendix B – Theoretical background of initial public offerings with a focus on German market specialties

The following information shall serve as supplementary information for a better understanding of initial public offerings. An IPO describes the process of selling shares of a company to the public for the first time. In general, the transaction can either be structured as a primary or a secondary offering. In a primary offering the company issues and sells new shares, thus, raising new equity capital and receiving financing, while in a secondary offering existing shareholders partially sell their existing shares to generate profits and diversify their asset allocation or fully exit their investment. In a secondary offering, no proceeds flow to the company conducting the IPO. However, most IPOs combine the sale of existing and the issuance of new shares (Berk and DeMarzo 2019).

### Main players involved in an IPO transaction

An IPO process is a highly complex process and, thus, requires the involvement of many parties and advisors who help safeguarding the success of the IPO (Lowry, Michaely and Volkova 2017). However, the main parties involved in an IPO process are generally the issuer, one or more underwriters and the investors (Ljungqvist 2007). However, besides these main parties, further players include legal advisors, auditors, and specialized IPO advisors (Carbonare 2021).

The issuer is the legal entity which conducts the IPO and sells the shares. After deciding to go public and whether the IPO will be performed as a primary, secondary, or blended offering, the management of the entity must assess the IPO readiness of the company which typically revolves around accounting requirements and the change to a suitable legal form (Carbonare 2021). For instance, in Germany a company can only go public if the entity operates as a *Aktiengesellschaft* (AG), *Kommanditgesellschaft auf Aktien* (KGaA) or *Societas Europaea* (SE), with the AG being the most common choice (Baumgartner 2021). Further, and central to the IPO process, the issuer selects the underwriters (Berk and DeMarzo 2019).

Underwriters are financial institutions, typically investment banks, that act as intermediary between the issuer as well as the investors and which are responsible for advising the issuer on the structure and execution of the transaction as well as for performing underwriting functions. The so called "firm commitment" and "best effort" underwriting agreements are the most prevailing forms of underwriting functions. Under the first, the underwriter commits to purchasing the full stock issuance from the issuer and subsequently sells them to the public, effectively ensuring that the issuer raises the equity it seeks. In a "best-effort" underwriting agreement the underwriter does not purchase the entire issuance but rather tries to sell the stocks for the highest achievable price to investors, hence, without the guarantee that a certain amount of equity gets raised (Berk and DeMarzo 2019). Therefore, one of the key responsibilities of the underwriter is setting the issue price for the stocks being sold (Corelli 2018). IPOs are oftentimes managed and placed by more than one underwriter, with banks combining in a syndicate. The syndicate is typically lead by one underwriter, acting as a so-called global coordinator, which includes the main responsibility for executing the whole process while coordinating with the other syndicate members (Carbonare 2021). For their services underwriters receive a fee which typically amounts to 7% of the gross proceeds in the US (Lowry, Michaely and Volkova 2017). However, fees in Europe tend to be lower (Ljungqvist, Jenkinson and Wilhelm 2003). For instance, Abrahamson, Jenkinson, and Jones (2011) report an average fee of 4% paid for European IPOs conducted between 1998 and 2007.

Investors, on the other end, are generally divided into institutional and retail investors in most research studies (Ljungqvist 2007). Institutional investors are "companies or organization that invest money on behalf of other people. These entities regularly trade in large quantities and, consequently, qualify for preferential treatment and cheaper transaction costs" (Pyles 2021, p.12). Typical institutional investors are asset managers, both long-only and hedge

funds, pension funds and insurance companies. Retail investors are individuals who invest their own funds, and who are not classified as professional or institutional investors (Pyles 2021).

**IPO process overview and specialties in Germany**

The IPO process can vary between jurisdictions due to different regulatory environments and domestic laws. In the US, for instance, Lowry, Michaely and Volkova (2017) divide the process into five steps, including the selection of the underwriters and the listing venue as first step, followed by preparing the required regulatory filings such as the prospectus, performing due diligence, developing the equity story, and performing a valuation as second step. The equity story which summarizes the investment case, the issuer's business model including key strengths and opportunities and, alongside the valuation, is crucial for the third step, the so-called marketing phase. During the marketing phase the issuer and the offering are showcased to potential investors, mainly via management roadshows. The marketing phase is key to assess the demand for the IPO, hence, providing the required information whether the valuation and price expectations of the underwriters and the issuers are feasible. The pricing and the subsequent listing are the fourth step along the process. Finally, after the listing the underwriters provide aftermarket services, including price stabilization by exercising the so called overallotment option ("Greenshoe") and by initiating the research coverage on the stock.

The IPO process in Germany is comparable to the US procedure, however, Carbonare (2021), Lowry, Michaely and Volkova (2017) and Ritter (2003b) highlight some important differences between European, especially German, and US IPOs. While the first two steps are equal, except that issuers file with the German regulatory body BaFin ("Federal Financial Supervisory Authority") the third step, i.e. the marketing phase, differs. For instance, according to Carbonare (2021) there is a so-called pre-marketing phase in Germany. As part of this stage, it is market standard in Germany to conduct several early-look meetings with selected investors as early as possible during the IPO process to gather valuable information from investors to

further refine the equity story, valuation and to assess potential demand. Moreover, the marketing phase of German IPOs differs to US standards. In Germany, the marketing phase can be split into two sub-phases: before the actual marketing starts, the so-called pre-deal investor education phase (PDIE) takes place which is different to the pre-marketing phase introduced earlier. This phases' starting point are presentations held by the management to the research analysts affiliated with the underwriters to provide them with information to write pre-deal research. These pre-deal research studies are used by the analysts to educate the sales force of the underwriting banks and potential investors on the upcoming transaction before the actual marketing phase starts to create higher investor engagement and to collect further information on the potential demand as well as the feasible pricing range of the offer. Typically, these meetings with the analysts take place when the company announced to go public through an intention-to-float (ITF) announcement (Carbonare, 2021). The analyst involvement is one of the major differences to the US IPO process where analysts are only allowed to write research about an issuer after a quiet period of typically 25-40 calendar days post-IPO, depending on the size of the offer (Ritter 2003b). However, this quiet period was relaxed by the Jumpstart Our Business Startups Act (JOBS Act) from April 2012. In case a company files as an "Emerging Growth Company", the underwriter's analysts are allowed to attend several pre-deal events (Lowry, Michaely and Volkova 2017). The following steps, i.e. the pricing and the aftermarket support are comparable to US standards.

**Pricing and allocation mechanisms for IPOs**

The first step in determining the final offer price is usually a valuation performed by the underwriting banks using either comparable companies analysis, i.e. determining the value of the company via multiples, or by performing a discounted cash flow analysis, i.e. determining the intrinsic value by forecasting expected free cash flows. This initial indication serves as first guidepost for determining the offer price which later gets refined and adjusted based on the

constant dialogue with investors along the IPO process and the pricing method chosen (Berk and DeMarzo 2019).

As described by Ljungqvist, Jenkinson, and Wilhelm (2003), the final offer price is typically determined either through auctions, fixed-price mechanisms, or bookbuilding. Each pricing method also has its individual implication on the allocation of the shares. In auctions, the final offer price is determined through "either a mandatory or a discretionary clearing rule but allocations to bidders are non-discretionary, i.e. any two bidders with the same bid will receive the same allocation of shares" (Ljungqvist, Jenkinson, and Wilhelm 2003, pp. 70-71). In a fixed-price mechanism, the price is, as the name suggests, fixed before the marketing phase starts and investors are approached. The allocation of the shares is generally not carried out at the discretion of the underwriters. Finally, in a bookbuilding process the final offer price is determined by analyzing the demand for the issuance (Ljungqvist, Jenkinson, and Wilhelm 2003). During the bookbuilding phase, which takes place during the marketing phase while the management is on its roadshow, investors indicate their interest by informing the underwriters about how many shares they would like to buy and at which price, based on the price range set by the underwriters. The underwriters use these insights to set an offer price at which the likelihood of the offering being successful is high (Berk and DeMarzo 2019). Finally, the underwriters are able to use discretion in allocating shares. According to Carbonare (2021) as well as Aussenegg and Pichler (2006) bookbuilding is the most used pricing method in Germany with the initial price range typically set six to seven days prior to the listing.

**Market structure and listing requirements in Germany**

There are seven listing venues across Germany, however, the Frankfurt Stock Exchange (FSE) is the largest and most important venue (Carbonare 2021). Deutsche Börse AG operates FSE at which companies can choose between two main listing segments, namely the EU-regulated Market as well as the Open Market. The EU-regulated market is further split into the two

subsegments General Standard and Prime Standard (Deutsche Börse 2019). Carbonare (2021) argues that most conventional IPOs in Germany opt for a listing in the Prime Standard. The admission requirements for the Prime and General Standard are equal but differ with regards to the obligations post-listing. The post-listing requirements for a listing in the General Standard are equal to the minimum standards applicable by EU and German law, while the Prime Standard obligations go further than that (Carbonare 2021). For instance, companies listed in the Prime Standard must publish quarterly statements two months after the end of the respective period while General Standard listed companies are not obliged to submit quarterly statements (Deutsche Börse 2019).

On the other hand, the Open Market is a so-called regulated unofficial market, meaning the listing requirements are determined by the FSE's directives (Deutsche Börse n.d.). The Open Market is also split into two subsegments, the Quotation Board and Scale. With regards to IPOs, only the Scale segment plays a role since the admission to the Quotation Board is only possible in case the shares of a company are listed at a different stock exchange elsewhere (Carbonare 2021). Scale is a market segment focused on SMEs and, thus, the listing and post-listing obligations are adjusted to suit such companies (Deutsche Börse 2019). A detailed overview of the admission and post-listing requirements for all market segments can be found on the website of Deutsche Börse (link: *https://www.deutsche-boerse-cash-market.com/resource/blob/1514900/3741d89481450eff301b97c66d23f0fb/data/Factsheet-EU-regulated-market-GS-PS-Scale-for-shares.pdf*).

## Appendix C – Other explanation approaches from the asymmetric information theories

### Information revelation theories

Information revelation theories mainly center around the increased use of the bookbuilding pricing method across many countries. It is assumed that investors have superior information about the true value of the offering, making their knowledge an important contribution to the potential success and accurate pricing of an offering. A key framework within the information revelation theories was developed by Benveniste and Spindt (1989). They argue that investment banks underwriting the issue can make use of the bookbuilding mechanism to induce investors to reveal their information as they have discretion with regards to both the offering price and the final allocation, i.e. by underpricing the stock and allocating more shares to investors sharing their insights. Support for this theory was also provided by Benveniste and Wilhelm (1990) as well as Spatt and Srivastava (1991). Hanley (1993) builds on the framework and argues that the truthful revelation of information will enable the underwriter to perform price revisions as a result. However, the underwriter can only adjust the price upward to that extend that there is still enough room for an attractive degree of underpricing, necessary to induce investors. In fact, Hanley (1993) found that the price revisions and the initial first day returns are positively correlated. Further empirical support was provided by Aggarwal, Prabhala, and Puri (2002) which reported that institutional investors, deemed to be informed investors, received the largest allocations in IPOs within their data sample and that the degree of underpricing rose the higher the allocation towards informed investors was, ultimately providing support for the inducement argument provided by Benveniste and Spindt (1989). Similar findings were provided by Ljungqvist and Wilhelm (2003).

### Principal-agent models

Principal-agent theories trying to explain IPO underpricing by highlighting the moral hazard situation in which investment banks find themselves during the IPO process were among the

first approaches dedicated to this topic. Popular examples describing the agency problems include Baron and Holmström (1980) and Baron (1982). In these models underwriters are assumed to have superior information on the issue and investor demand, especially compared to the issuer, i.e. its client. The agency problem arises since underwriters can underprice the offering and subsequently allocate it to its clients, aiming at securing future business with them (Ljungqvist 2007). One example, according to Loughran and Ritter (2002), is the promise of an increase in trading activity with the underwriter in unrelated securities, generating commission income for the bank. To avoid such principal-agency problems, issuers and underwriters can contractually align their interests, which should lead to a decrease in underpricing (Ljungqvist 2007). However, Muscarella and Vetsuypens (1989) published a study in which they examined 38 IPOs of investment banks which were self-underwritten, ultimately eliminating the principal-agent problem. They found that these IPOs were equally underpriced as other IPOs during the period under analysis. On the other hand, empirical support for a decrease in underpricing after an alignment of interests was provided by Ljungqvist (2003) who found that the underpricing of IPOs in which the underwriter's fees were more closely tied to the valuation, i.e. the offering price, in fact decreased. Further support was provided by Ljungqvist and Wilhelm (2003).

**Signaling theories**

Finally, signaling theories assume the informational advantage about the true value of the offering to be on the issuer's side (Ljungqvist 2007). As early as 1975, Ibbotson developed the basis for signaling theories, arguing that issuers knowingly underprice their IPOs and, thus, allow for high initial returns for investors such that these investors positively recall the issue. This positive association is assumed to pave the way for successful, future equity raisings through seasoned equity offerings (SEOs) in which the money left on the table at the time of the IPO is regained (Ljungqvist 2007). To test signaling theories, Jegadeesh, Weinstein, and

Welch (1993) analyzed IPOs between 1980 and 1986. They found that those companies having underpriced their IPOs the least showed a likelihood of 15.6% of engaging in a SEO, while those who underpriced their offering the most had a probability of 23.9% of returning successfully to the equity markets. However, the authors state that, although statistically significant, the economic significance is low, raising the question whether signaling theories have explanatory power (Jegadeesh, Weinstein, and Welch 1993). Further, Michaely and Shaw (1994) found evidence consistent with this.

## Appendix D – Literature review for the control variables

The following literature review aims at providing background information on the several control variables included in the statistical analysis. As mentioned in chapter 3.3.3 the control variables commonly used in IPO underpricing research can be categorized in three groups, namely firm, offer and aftermarket characteristics. As also described in chapter 3.3.3, control variables based on aftermarket characteristics are not considered in this thesis.

With regards to the firm characteristics, firm age is widely used as a proxy for uncertainty, following the intuition that younger firms are riskier. Ritter (1984) was one of the first to propose this proxy which is obtained by calculating the natural logarithm of the issuing firm's age at the time of the offering plus one (*LNAGE*). Empirical evidence was also provided, for instance, by Ritter (1991), Carter, Dark and Singh (1998) as well as by Megginson and Weiss (1991) who document higher initial returns for younger firms. Thus, in accordance with academic literature, it is expected that the *LNAGE* coefficient will be negative in the regression analysis. Firm age was obtained by investigating the respective company's IPO prospectus. Following a similar intuition, Ritter (1984) also proposes firm size, measured as the natural logarithm of total sales prior to the IPO (*LNSALES*), as a proxy for uncertainty, arguing that more established firms face less risk. The coefficient is also expected to be negative. This proxy was also widely used and was empirically supported by Loughran and Ritter (2004), Loughran and McDonald (2013) and Jegadeesh, Weinstein, and Welch (1993), among others. Data for *LNSALES* was obtained from Compustat or the respective prospectus or annual report in case Compustat lacks the data. Following the same logic, *LNMARCAP*, the natural logarithm of the market capitalization at the time of the offer, i.e. after the pricing and before the trading of the newly issued shares started, is used as a further proxy. The data was obtained from Bloomberg and the Deutsche Börse primary market statistics. Another common control variable is VC-backing (*VCB*), which is typically a dummy variable equaling one if the issuing firm was backed

by a venture capital fund (VC) and zero otherwise. This proxy assumes, backed by findings from Barry et. al. (1990), Megginson and Weis (1991) and Loughran and Ritter (2004) that VC-backed IPOs show a lower level of underpricing due to a lower level of risk as VC funds are recognized as monitoring entities which provide certification to third parties. Thus, the coefficient is expected to be negative. VC ownership was identified by investigating the respective issuer's prospectus. During the collection of the data for *VCB*, data on private equity (PE) ownership was collected simultaneously. Based on the collected data, pre-IPO PE ownership is more common in Germany than pre-IPO VC ownership. Due to the similarities in their business models, pre-IPO PE investors could also be considered as monitoring entities. Therefore, it was decided to further include an additional control variable indicating PE ownership (*PEB*) which follows the same logic as *VCB*. For *PEB*, also a negative relationship is expected. Moreover, Lowry and Shu (2002), Loughran and Ritter (2004), Hanley and Hoberg (2012) and Crain, Parrino, and Srinivasan (2021), just to name a few, further use a high-tech dummy (*HTECH*) equaling one in case of a firm from the technology industry. The rationale is based on the idea that firms from the technology sector are harder to value and, thus, face higher ex-ante uncertainty (ultimately, higher underpricing). Therefore, the coefficient is expected to be positive. For the identification of technology firms, the BICS was used, with the dummy equaling one for such firms which fall into the BICS technology sector. The BICS technology sector comprises the subsectors hardware, semiconductors, software, technology services and technology-specific design, manufacturing, and distribution services. In such cases where no BICS sector can be identified for a given entity, the respective prospectus or company website was used to retrieve the industry which was subsequently matched to one of the BICS sectors. Finally, underwriter reputation (*UWREP*) is the last firm specific control variable included in this analysis. According to Booth and Smith (1986), Carter and Manaster (1990), Michaely and Shaw (1994) and Ljungqvist (2007), relying on a reputable underwriter can help to reduce

information asymmetries and, thus, ex-ante uncertainty. However, several studies provide mixed results depending on the respective period analyzed. For instance, Ljungqvist (2007) states that studies focused on the US markets in the 1970s and 1980s such as Johnson and Miller (1988) or Carter and Manaster (1990) report a negative relationship between reputation and underpricing, however, studies targeted at the 1990s, such as Beatty and Welch (1996) rather report that IPOs are higher underpriced when reputable underwriters are engaged. In the German market, Schmidt's (1988) studies showed empirical support for a negative relationship, while Kaserer and Kempf (1995) as well as Hunger (2001) rejected the theory. Loughran and Ritter (2004) hypothesize that investment banks started to strategically underprice the issues they are underwriting (see also principal-agent models in Appendix C). Migliorati and Vismara (2014) provide a reputation ranking for underwriters who were active in the European IPO markets across different listing venues (London Official List, London AIM, Euronext Paris, Paris Marché Libre, Frankfurt am Main, and Milan). To create the ranking, they calculate both a proceeds-weighted and equally weighted reputation score for each listing venue for the period from 1995 to 2016. For the purpose of this thesis, the proceeds-weighted reputation score from listings performed in Frankfurt am Main is used. In case an issuance was managed by more than one lead-underwriter, the lead-underwriter with the highest reputation score is used. Further, when the lead underwriter is not listed in Migliorati's and Vismara's (2014) ranking at all, a reputation score of 0 is assumed. In such cases where the underwriter is listed but no score for the FSE is provided, the score for another stock exchange will be used as a proxy. Finally, if an underwriter got acquired, the score of the buyer is assumed. The underwriters involved in the offering have been sourced from the primary market statistics.

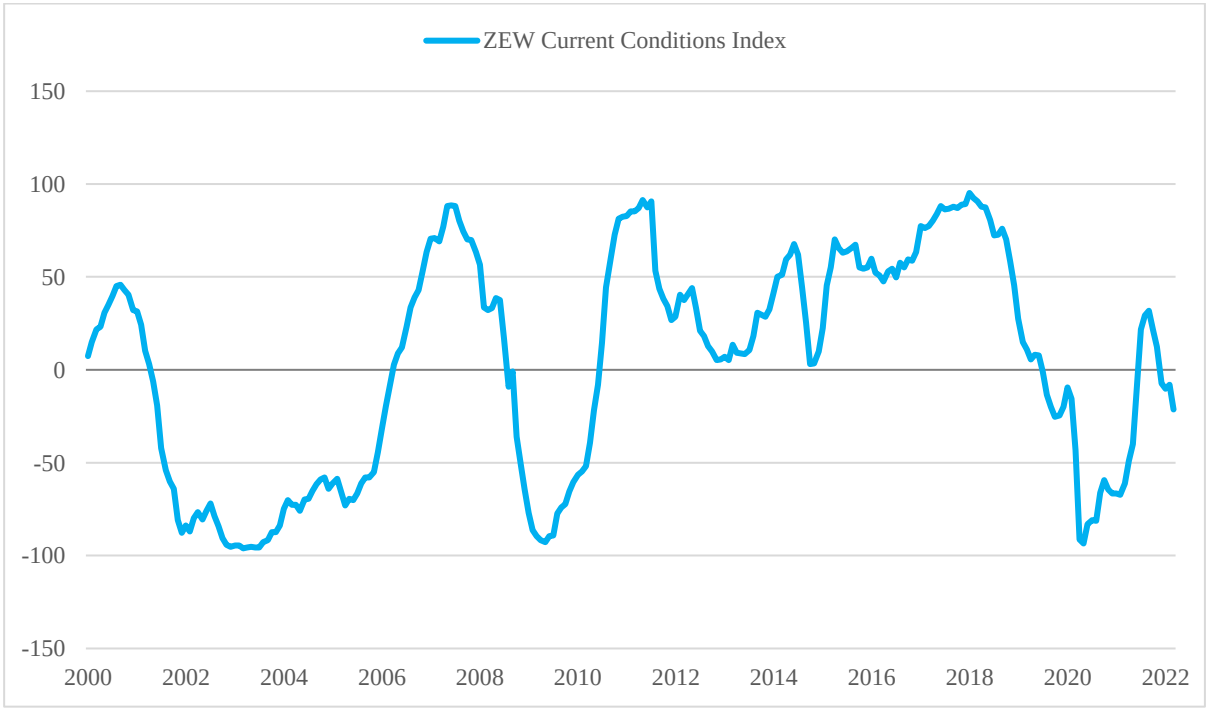
With regards to the offer characteristics, two control variables are used. The first and one of the most widely used control variables is the natural logarithm of the IPO gross proceeds (*LNGPRO*) which was defined by Beatty and Ritter (1986). They argue that larger IPOs are

commonly performed by larger firms, hence, such firms associated with lower ex-ante uncertainty. Therefore, the coefficient is expected to be negative. Although Beatty and Ritter (1986) proposed to use the natural logarithm of the inverse of gross proceeds, this thesis rather follows the approaches of various other studies such as Carter, Dark and Singh (1998), Ljungqvist, Jenkinson and Wilhelm (2003), Abrahamson, Jenkinson, and Jones (2011) or Hanley and Hoberg (2012) who all use the natural logarithm of gross proceeds. Gross proceeds are sourced from the primary market statistics. Second, in accordance with Hanley (1993) and Lowry and Schwert (2002), among others, a variable on price revision (*PREV*) is included. Although this proxy is assigned to the information revelation theories (compare Appendix C) and not to the winner's curse, it was found to be one of the most widely used proxies and, hence, will be considered in this research. Hanley (1993) argues that the truthful revelation of information by investors will enable the underwriter to perform price revisions as a result. However, the underwriter can only adjust the price upward to that extent that there is still enough room for an attractive degree of underpricing, necessary to induce investors. Hanley (1993) reported a positive relationship of upward price revisions and IPO underpricing. The variable is calculated as the percentage change from the midpoint of the price range at the start of the bookbuilding and the final offer price. The ranges and offer prices were obtained from the primary market statistics of Deutsche Börse.

## Appendix E – Details on the alternative regression models

Against the backdrop of the regression results which contradict Ljungqvist's (1997) findings, it seems legitimate to question whether the ESI is an appropriate proxy. Therefore, after the analysis of the initial OLS and FE regression results, additional regression models (M5 and M6) were estimated, using an alternative proxy solely incorporating information on the German economy. The ZEW Current Conditions Index (ZEW CCI) was selected which aims at assessing the level of optimism of approximately 350 financial and economic analysts. The ZEW CCI is constructed by calculating the difference of the percentage share of optimistic and the percentage share of the pessimistic analysts, ultimately leading to scale of -100 to 100. Thus, a reading of zero indicates neutral sentiment (ZEW – Leibniz Centre for European Economic Research 2022). A graph showing the ZEW CCI over time can be found in Figure E1.

**Figure E1 – ZEW Germany Current Conditions Index (ZEW CCI)**




Source: Bloomberg (2022b), for more information on the calculation of the indicator

The regression models follow the same structure as the models M1-M4, meaning both a dummy of the ZEW CCI (*ZEWD*) and the raw index (*ZEW*) are used as main explanatory variables, supplemented with the control variables. The dummy (*ZEWD*) equals one when the value of the ZEW CCI falls below 0, believed to be able to identify economic downturns. After running the baseline (alternative) regressions, again White's test showed the need for robust standard errors (see Table E1). Further, models controlling for industry and year fixed effects are also performed for these alternative models. The models are estimated as follows:

$$\text{(M5)} \quad IPOUP = \beta_0 + \beta_1 ZEWD + \beta_2 LNAGE + \beta_3 LNSALES + \beta_3 LNMARCAP + \beta_5 VCB + \beta_6 PEB + \beta_7 HTECH + \beta_8 UWREP + \beta_9 PREV + \beta_{10} LNGRPO + \varepsilon_i$$

$$\text{(M6)} \quad IPOUP = \beta_0 + \beta_1 ZEW + \beta_2 LNAGE + \beta_3 LNSALES + \beta_3 LNMARCAP + \beta_5 VCB + \beta_6 PEB + \beta_7 HTECH + \beta_8 UWREP + \beta_9 PREV + \beta_{10} LNGRPO + \varepsilon_i$$

**Table E1 – White's test for heteroskedasticity (alternative regressions)**

H0: Homoskedasticity
H1: Unrestricted heteroskedasticity

| | **M5** | **M6** |
|---|---|---|
| Chi2 (61 df) | 90.95 | 103.54 |
| p-value | 0.0077 | 0.0007 |

The full results can be found in Table E2. Across all models, including the FE models, no significance for the ZEW based variables can be found. However, the signs of the coefficients match those from the main OLS and FE regression models M1-M4, again contradicting Ljungqvist (1997), Ritter (1984), as well as Beatty and Ritter (1986). With regards to the control variables, *LNAGE* shows significance at the 5%-level (M5) and 10%-level (M6), but no significance across the FE models. *LNMARCAP* is significant across all models, with the significance increasing from the 10%-level (M5 and M6) to the 1%-level in the FE models

M5 and M6. The same increase in significance can be observed with regards to *LNGPRO,* although the significance in the M5 FE models increases to the 1%-level and to the 5%-level in M6 FE. As in the main OLS and FE regressions, *PREV* is significant at the 1%-level in all models.

### Table E2 – Alternative OLS and fixed effects regression results

The table reports the OLS regression coefficients and, in parentheses, the t-statistics of the alternative regression model. *IPOUP* and *IPOUPM* as dependent variables are regressed on the variables introduced in chapter 4 and Appendix D. Robust standard errors are used. The sources for the variables can be retrieved from Table A1 in Appendix A. *, **, *** refer to the statistical significance at the 10%, 5% and 1% level, respectively.

| | ***OLS regressions*** | | ***Fixed effects regressions*** | |
|---|---|---|---|---|
| | **M5** | **M6** | **M5** | **M6** |
| **Dependent variable** | **IPOUP** | **IPOUP** | **IPOUP** | **IPOUP** |
| *ZEWD* | 0.0350 | | 0.0306 | |
| | (1.61) | | (1.00) | |
| *ZEW* | | -0.0002 | | -0.0004 |
| | | (-1.14) | | (-0.95) |
| *LNAGE* | 0.0136** | 0.0135* | 0.0135* | 0.0132* |
| | (2.03) | (1.94) | (1.86) | (1.79) |
| *LNSALES* | -0.0075 | -0.0076 | -0.0023 | -0.0023 |
| | (-1.00) | (-0.99) | (-0.28) | (-0.28) |
| *LNMARCAP* | 0.0343* | 0.0338* | 0.0482* | 0.0456* |
| | (1.87) | (1.81) | (1.96) | (1.92) |
| *VCB* | 0.0197 | 0.0194 | 0.0339 | 0.0325 |
| | (0.63) | (0.62) | (0.86) | (0.83) |
| *PEB* | 0.0061 | 0.0076 | 0.0196 | 0.0197 |
| | (0.28) | (0.37) | (0.86) | (0.87) |
| *HTECH* | -0.0148 | -0.0128 | 0.0169 | 0.0190 |
| | (-0.64) | (-0.55) | (0.49) | (0.56) |
| *UWREP* | 0.0008 | -0.0017 | -0.0229 | -0.0224 |
| | (0.03) | (-0.06) | (-0.55) | (-0.54) |
| *PREV* | 0.5385*** | 0.5289*** | 0.4533*** | 0.4372*** |
| | (4.65) | (4.61) | (3.67) | (3.58) |
| *LNGPRO* | -0.0279* | -0.0261* | 0.0409** | -0.0389** |
| | (-1.80) | (-1.68) | (-2.38) | (-2.29) |
| Industry FEs | NO | NO | YES | YES |
| Year FEs | NO | NO | YES | YES |
| Observations (N) | 192 | 192 | 192 | 192 |
| R-squared | 0.1702 | 0.1639 | 0.2971 | 0.2985 |