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BACHELOR THESIS

**IPO Underpricing and Sentiment
of Investors**

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Declaration of Authorship

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Prague, May 22, 2013

Signature

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Abstract

The thesis investigates investor sentiment, proxied by grey market prices, being a common source for IPO underpricing, long-term underperformance of IPOs, and cycles in IPO volume. The paper contributes to the field of research by an updated German dataset from 2000 to 2010, and by investigating all main IPO market anomalies together with their common trigger. The results show evidence of a positive relationship between the investor sentiment and IPO underpricing, indicating the investor sentiment being an explanation for it. Moreover, the study shows investor sentiment being positively linked to offer prices – an evidence of issuers exploiting that sentiment. However, the long-term underperformance relative to the aftermarket price of IPOs from high underpricing periods - another evidence of investor sentiment being a source for IPO underpricing - has not been confirmed. Other hypotheses have also not been verified. They include higher IPO volume following high underpricing periods and long-term underperformance relative to the offer price of IPOs from high underpricing periods. Both these hypotheses would represent another confirmation of firms exploiting the investor sentiment. The statistically significant results are consistent with other papers. The insignificance might have been caused by the method of calculation or specifics of the German IPO market.

JEL Classification G10, G14, G32

Keywords IPO underpricing, investor sentiment, long-term underperformance, grey IPO markets, overoptimism, fundamental value, German market

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Abstrakt

Práce zkoumá, zda sentiment investorů, měřený cenami z šedého IPO trhu, může být společnou příčinou pro podhodnocení IPO, dlouhodobou špatnou výkonnost IPO a cykly v počtu IPO. Studie přispívá do oblasti výzkumu aktuálními německými daty od roku 2000 do 2010 a tím, že zkoumá všechny významné anomálie na IPO trhu dohromady s jejich společnou potenciální příčinou. Výsledky dokládají kladný vztah mezi sentimentem investorů a podhodnocením IPO, což indikuje, že sentiment

investorů je možným důvodem podhodnocení IPO. Práce dále ukazuje kladný vztah mezi sentimentem investorů a cenami stanovenými emitentem – možný doklad o tom, že emitenti využívají sentiment investorů. Dlouhodobá špatná výkonnost vzhledem k ceně po prvním dni obchodování IPO z období vysokého sentimentu investorů, což by podruhé indikovalo sentiment investorů jako důvod pro podhodnocení IPO, nebyla potvrzena. Ostatní hypotézy se také nepotvrdily. Mezi ně patří vyšší počet IPO následující po obdobích s vysokým podhodnocením IPO a dlouhodobá špatná výkonnost vzhledem k cenám stanoveným emitentem IPO z období vysokého podhodnocení IPO. Obě hypotézy by sloužily jako další ověření, že firmy využívají sentimentu investorů. Statisticky signifikantní výsledky jsou v souladu s výsledky ostatních prací. Malá signifikance mohla být způsobena metodami výpočtů nebo specifiky německého IPO trhu.

Klasifikace JEL

G10, G14, G32

Klíčová slova

podhodnocení IPO, sentiment investorů, dlouhodobá špatná výkonnost, šedé trhy IPO, přehnaný optimismus, fundamentální hodnota, německý trh

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Contents

List of Tables	ix
List of Figures	x
Acronyms	1
Thesis Proposal	2
1. Introduction	1
2. Theoretical background	3
2.1. IPO underpricing	3
2.2. Investor sentiment	5
2.3. Long-term performance	6
3. German IPO market specifics	9
4. Literature Review	11
5. Methodology and data	15
5.1. Model	15
5.2. Empirical implications	19
5.2.1. Hypotheses	19
5.2.2. Variables	20
5.2.3. Regressions	21
5.3. Data	23
6. Empirical results	25
6.1. Statistical properties testing	25
6.1.1. Multicollinearity	25
6.1.2. Heteroskedasticity	25

6.1.3. Normality of residuals	26
6.2. Hypotheses testing	27
6.2.1. Hypothesis 1	27
6.2.2. Hypothesis 2	27
6.2.3. Hypothesis 3	28
6.2.4. Hypotheses 4 and 5	28
7. Conclusion	30
Bibliography	32
A. Tables	36

List of Tables

5.1. Hypotheses	23
A.1. Correlation matrix for Regression 1	36
A.2. Correlation matrix for Regression 2	36
A.3. Heteroskedasticity testing	36
A.4. Normality testing	37
A.5. Estimated Regression 1	37
A.6. Estimated Regression 2	37
A.7. Summary statistics	38

List of Figures

A.1. Monthly IPO volume	38
A.2. Histogram-residuals from Regression 1	39
A.3. Histogram-residuals from Regression 2	39

Acronyms

IPO Initial public offering
BHAR Buy-and-hold abnormal return
CAR Cumulative abnormal return
PCA Principal component analysis
PwC PricewaterhouseCoopers

Bachelor Thesis Proposal

Author	Lucie Scheerová
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Proposed topic	IPO Underpricing and Sentiment of Investors

Topic characteristics The aim of the thesis is to introduce a possible explanation for the IPO underpricing and other notable and frequent anomalies in the IPO market. The anomalies are expected to be linked to the underpricing of IPOs by having a common driver - investor sentiment. The German IPO market is chosen as a data sample source for conducting the investigation. Considerable amount of empirical evidence shows the existence of the aforementioned anomalies. However, a consensus has not been reached about what causes them. In recent years researchers' attention has shifted from the traditional explanations of IPO underpricing assuming investor rationality, onto explanations related to behavioral factors.

The thesis will consist of a theoretical and an empirical part. In the theoretical part I will summarize a conceptual background essential for understanding the topic, and a relevant research. Also, I will state the model I assume to hold true, and explain its empirical implications. The empirical part will include an analysis of the data gathered from a sample of initial public offerings in Germany.

I would like to contribute to the field of research by summarizing and clarifying, how the investor sentiment may explain the underpricing of IPOs, the higher IPO volume that follows periods of high IPO underpricing, and the long-term underperformance of firms going public in high underpricing periods. In my thesis I will discuss the linkages, and test the hypotheses which the linkages imply, as outlined in the following lines.

Summary of the model In periods of rising investor sentiment, overoptimistic investors are willing to purchase IPOs for prices higher than their fundamental values,

thus causing an increase in IPO underpricing. Since the IPOs are priced above their fundamental value, a long-term underperformance is a reasonable result of the price approaching the fundamental value in a long run. Being aware of the created demand even for overpriced IPOs, companies in turn try to exploit it and duly set the IPO offer prices above their fundamental values. Moreover, companies that did not plan to go public at the time might change their mind in order to exploit the favourable environment. Therefore, more companies are expected to go public in the near future.

Should the model hold true, I may find evidence that investor sentiment is high in periods of high underpricing of initial public offerings, and that the IPOs that took place in such periods tend to underperform in the long run. Moreover, the higher IPO volume following periods of high IPO underpricing, and higher offer prices in these periods are expected to be shown.

Hypotheses

- H1: Investor sentiment and the aftermarket price are positively related
- H2: Investor sentiment and the offer price are positively related
- H3: Investor sentiment and the future IPO volume are positively related
- H4: Investor sentiment and the long run performance are negatively related

Outline

1. Introduction
2. Theoretical Background
3. Literature Review
4. Model and data
5. Empirical Verification and Discussing Results
6. Conclusion

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Chapter 1

Introduction

The frequent phenomena of IPO underpricing, describing a jump in the price of an initial public offering (IPO) during first days after trading begins, belongs to the most investigated puzzles in the field of economy in the past decades. Various theories exist trying to explain the IPO underpricing, ranging from ones focusing on institutional reasons to others investigating irrationality of market players. Other various anomalies in the IPO market, alongside with the IPO underpricing, can be found. Among them we can mention especially cycles in an IPO volume and a long-run underperformance of IPOs. Increasing number of studies attempt to find a common source for these empirical findings. Among others, a theory centred around investor sentiment has become widely popular. The idea is that in some time periods the portion of irrational overly optimistic investors rises in the IPO market, and therefore during the first trading days investors bid the prices of IPOs up above their fundamental values. Such conceptual framework has the ability to theoretically explain most of the notable puzzles in the IPO market, as outlined in the following lines. There are cycles in a magnitude of the investor sentiment in the IPO market. In periods of high investor sentiment, investors are willing to pay more for IPOs than their fundamental values and, as noted earlier, push the aftermarket price up. Therefore, the IPO underpricing occurs and also long-term underperformance relative to the aftermarket price of such overpriced IPOs is present. These conditions are favourable for issuing firms, thus there are more companies going public in periods of high investor sentiment, and IPO volume rises. Also, rational issuers set their offer prices higher than they would have in other periods, in order to exploit the excess demand. Therefore, the IPOs underperform in the long run even relative to the offer price.

The purpose of the thesis is to investigate whether the behaviour of initial public offerings, including the main IPO anomalies – IPO underpricing, long-term un-

derperformance of IPOs experiencing high underpricing, and high IPO volume following periods of high IPO underpricing - can be explained by investor sentiment. Therefore, the paper focuses on finding empirical evidence for the existence of the aforementioned patterns of IPOs, for the existence of investor sentiment in high underpricing periods and on proposing a model consistent with the behaviour. The IPO market in Germany is one of the most liquid ones in Europe and it provides enough data for empirical investigation. Also, Germany has the most active unofficial grey market (also called pre-IPO market) and prices quoted there may serve as a good tool for assessing the sentiment of investors. Moreover, Germany belongs to the major economic and political players in the European continent. Therefore, Germany has been chosen to provide the sample of data. Although there are several studies examining German market in this field of research, most of them focus only on some of the aforementioned puzzles and do not intend to investigate all of them. Therefore, my study is unique especially in its attempt to explain all most popular anomalies together in one work, and in that it uses an updated dataset reaching from year 2000 until 2010.

The rest of the thesis is organised as follows. Chapter 2 summarises a theoretical background for the study. It includes a description of IPO underpricing and other important anomalies related to IPO underpricing, and a summary of possible explanations for them. The chapter also contains a description of the investor sentiment with a summary of the commonly used proxies for it. Moreover, a discussion about the long-run performance and the most popular ways of calculating the performance is present. Chapter 3 briefly explains the process of going public in Germany, the German IPO market specifics, and its institutional characteristics. Chapter 4 contains a literature review relevant to the topic. In Chapter 5 a data description and a methodology containing a model specification and its empirical implications can be found. The empirical results including also testing statistical properties of the data is contained in Chapter 5. The last Chapter 6 represents a conclusion of the thesis.

Chapter 2

Theoretical background

2.1. IPO underpricing

The Initial public offering (IPO) when privately held companies become publicly traded enterprises belongs to the most important milestones in a company's life. It provides a new source of capital from the public and serves as a sign of prestige because of the high requirements future public companies must face. Along with its magnitude this represents the reason why underpricing of IPOs is one of the most studied phenomena in financial economics, puzzling researchers since 1970's. The term describes the empirical fact that a price of an IPO during the first trading days is often significantly higher than the issue price at which the IPO shares were introduced in a primary market. The phenomenon has been named IPO underpricing, because the IPOs seem to be underpriced by the issuer, the issuer gathers less funds from the IPO than they could have if the issue price was set higher. Therefore, companies repeatedly go public at a price lower than the one which would still be accepted in the market. It is often called the way that companies voluntarily „leave money on the table“. The IPO underpricing is usually expressed in percentages, and according to Gajewski and Gresse (2008, page 27), as one of the following formulas:

$$U = \frac{P_A - P_O}{P_O} \quad (2.1)$$

$$U = \ln\left(\frac{P_A}{P_O}\right) \quad (2.2)$$

where P_O denotes the offer price, P_A is the first day closing price and \ln stands for the natural logarithm.

Academics introduced many potential explanations, which can be divided into two

main groups defined by whether investors are assumed to be rational or irrational. Earlier the mainstream view was based on the assumption of rationality of all economic agents, including investors. The theories, notably asymmetric information theories where some of the key economic agents are assumed to know more than others, have been yielding convincing explanations for many years. Recently, however, the behavioral approach to IPO underpricing has gained much more attention. The behavioral approach is based on the assumption of occasional irrationality of at least part of the investors. There are periods when the proportion of irrational investors, also called sentiment investors, rises for some reason in the market. The IPO market, due to its specifics, is very prone to sentiment investors since IPO companies are usually young, unknown and therefore hard to value. Decisions of sentiment investors are led by feelings and emotions rather than by a rational decision making process. Sometimes, they tend to be overly optimistic and exuberant about new IPOs and bid up the market price above its fundamental value.

The calculation of fundamental, also called the intrinsic value of a security is defined, according to Chandra (2008, page 166) as: *"the present value of the cash flow stream expected from the security, discounted at a rate of return appropriate for the risk associated with the security"*. The real fundamental value is not observed, because the cash flow stream is only expected and it did not take place yet. The rational investors always value the security according to its "expected" fundamental value and irrational investors do not. However, the fundamental value expected by the rational investors is assumed to be the best possible predictor of a real fundamental value. Therefore, if the security is valued according to the expected fundamental value, there is no theoretical reason for it to underperform or overperform in the future.

One of the triggers for the shift from the traditional explanations to the behavioral theories is that there are still puzzling problems related to IPO underpricing, which seem to stay unexplained by the traditional theories. Among them we can mention the fact that according to empirical studies, periods of high IPO volume often follow periods of high IPO underpricing in the IPO market. It makes an impression that firms want to issue their shares in times when they leave most money on the table. The other puzzling fact is that IPOs issued during the periods of high IPO underpricing in the market are more prone to long-term underperformance. If the investors were rational in the period when these IPOs were issued, they would price IPOs according to their fundamental value and there would be no reason for shares to underperform in the long run. Last but not least, traditional explanations based on rationality of investors fail to explain periods when both IPO volume and IPO underpricing have

risen to unexpected extreme values like in the start of the millennium during the dot-com bubble.

2.2. Investor sentiment

The core of the behavioral theories related to IPO underpricing is a term called investor sentiment. According to Baker and Wurgler (2007, page 129): *"Investor sentiment, defined broadly, is a belief about future cash flows and investment risks that is not justified by the facts at hand."* Therefore, investors do not rationally assess a fundamental value of an investment and do not invest according to it. They rather follow their emotions when buying or selling an asset. It is assumed that there are two types of investors in the market - the irrational sentiment investors and so called "arbitrageurs", who represent the rational investors. The other important assumption about the investor sentiment, according to Baker and Wurgler (2007, page 129), is: *"betting against sentimental investors is costly and risky"*. This is the reason why the rational investors do not trade against the sentiment investors fully, and therefore: *"there are limits to arbitrage"*. Thus, the prices do not have to coincide with the fundamental values.

There are concerns about the efficiency of various tools and proxies measuring investor sentiment. As mentioned in Finter et al. (2010), two basic approaches can be undertaken to measure the sentiment. Firstly, there are so called explicit sentiment proxies based on surveys, where individuals are being asked about their opinion regarding the economic conditions of the time. Indices constructed by consumer confidence surveys, particularly GFK consumer confidence index, are the ones being used the most in various studies. Secondly, implicit sentiment proxies are useful for capturing the investor sentiment. They are called implicit, because they measure the investor sentiment indirectly, based on market statistics. Among them, aggregate trading volume, net fund flows, equity-to-debt ratio, put-call ratio, discount on closed-end-funds, but also IPO returns and IPO volume are most popular. The problem with the implicit sentiment proxies is that there is a possibility of sample non-randomness, misunderstanding the question or other typical difficulties connected to conducting a survey. On the other hand, the implicit sentiment proxies capture only a part of the investor sentiment, and they include also non-sentiment related constituent.

Many more recent researchers, notable Baker and Wurgler (2007), choose a procedure of so called principal component analysis (PCA). PCA is a widely used statistical procedure that extracts the uncorrelated components from a multivariate data. The

uncorrelated components are called principal components and are represented by a specific linear combination of the original variables. In this case, it allows to compress the sentiment-related information from various proxies of investor sentiment and construct a single indicator of investor sentiment.

In recent studies the pre-IPO or when-issued prices are increasingly used as a unique proxy for the investor sentiment. Grey markets allow retail investors to speculate on the future price of particular IPOs during the book-building period. They are unofficial and organised by large brokers. The drawback of this approach is that pre-IPO markets are not allowed in the United States, where the IPO markets are very liquid and thus often preferred by researchers. Moreover, although allowed, they are not organised in many countries and even if they are, only a portion of IPOs from the particular country gets involved.

2.3. Long-term performance

There are many various ways of assessing long-run performance of a stock. In this study, buy-and-hold abnormal return is being used. It is defined, according to Barber and Lyon (1997, page 343), as: “*the compound return on a sample firm less the compound return on a reference portfolio*”. The formula for buy-and-hold abnormal returns, as in Barber and Lyon (1997, page 344), is expressed as follows:

$$BHAR_{iT} = \prod_{t=1}^T (1 + R_{it}) - \prod_{t=1}^T [1 + E(R_{it})] \quad (2.3)$$

where $BHAR_{iT}$ represents a buy-and-hold abnormal return for a stock i and time period t , R_{it} denotes the return on the stock for a daily or monthly period t and $E(R_{it})$ is an expected return on the stock for the same period. The expected return is computed as a return on a reference portfolio, which can be a return on a comparable firm's stock, return on an industry index or broad market index. In this study, t denotes the monthly return on an IPO, the broad German market index *DAX* has been chosen as a reference portfolio and the R_{it} has been computed simply as:

$$R_{it} = \frac{P_{it} - P_{i,t-1}}{P_{i,t-1}} \quad (2.4)$$

where P_{it} is the price of an asset (stock) i at the end of month t .

Among others, buy-and-hold abnormal returns and cumulative abnormal returns

(*CARs*) are the most widely used approaches how to assess the long-run performance of a stock or a portfolio. However, an increasing number of researchers argue that these approaches are subject to biases and therefore they are not very suitable. According to Lyon et al. (1999), the major sources of problems related to these models are the new listing bias, the rebalancing bias and the skewness bias. The new listing bias is based on the idea that there are firms in the sample, chosen intentionally according to a particular rule and their price development after an investigated event is tracked for a certain long period of time. However, the index used as a reference portfolio usually comprises newly listed companies which started being traded after the event and which tend to perform poorly in general. Therefore, relative to poorly performing new issues, the sample firms seem to perform better than they actually do. Due to the fact that in this study the event is an IPO and therefore both the sample and the index constitute of newly listed companies, the newly listed bias is of minor importance. The other issue mentioned earlier is the rebalancing bias. The bias arises because the equally weighted indices are being regularly rebalanced. However, when calculating the return from the sample of firms, no rebalancing takes place. Since the *DAX* index is a market-value-weighted index, which does not require any rebalancing, no rebalancing bias is expected to occur. Last, since the long-run abnormal return distribution is skewed positively, the skewness bias occurs. In addition, buy-and-hold abnormal return is by definition bounded from below. The negative relation between the skewness bias and the sample size has been shown in many studies, for example in Cowan and Sergeant (1997). Since the sample size used in the regression mentioned further contains just 128 observations, the skewness bias may be a notable problem in the empirical analysis of this study.

Cumulative abnormal returns differ substantially from the buy-and-hold abnormal returns, which is a result of the way of computing. Therefore, they can yield different performance magnitude and statistical tests results. *CAR* does not include compounding of monthly returns, it considers summing them instead. Therefore, *CAR* ignores the compounding effect which considers reinvesting the former returns instead of spending them. The formula for *CAR*, as in Barber and Lyon (1997, page 344), can be written as following:

$$CAR_{it} = \sum_{t=1}^T R_{it} - E(R_{it}) \quad (2.5)$$

There have been concerns about which of the approaches for calculating abnormal returns is more suitable. Many researchers, notably Fama (1998), argue that the buy-and-hold return is. According to Fama (1998, page 294): “*Long-term investor*

experience is better captured by compounding short-term returns to obtain long-term buy-and-hold returns.” Moreover, Barber and Lyon (1997) use buy-and-hold abnormal return as an endogenous variable and cumulative abnormal return as an exogenous variable in a simple time series regression, and found that cumulative abnormal return is a biased predictor of buy-an-hold abnormal return. Therefore, *CAR* is prone to be subjected to a measurement bias. Conceptually, *BHAR* is concluded to be more suitable in measuring long-term performance than *CAR*.

Chapter 3

German IPO market specifics

The information about the German IPO market has been gathered from Gajewski and Gresse (2008). Deutsche Börse, alongside with Euronext and London Stock Exchange, belongs to the group of three largest stock exchanges in Europe. It provides two regulated market segments: the Official Market designed for large companies and the Regulated Market focusing on middle and small issuers. The New Market, in Germany called the Neuer Markt, designed for growth companies was closed in 2003. The division of the market segments is important for this study, because each of them has different listing requirements related to the size or capitalization. Since the size of issuing companies belongs to possibly important factors influencing the scale of IPO underpricing or long-run performance, it is necessary to know that Deutsche Börse provides markets for all large, medium and small companies.

A company desiring to get listed in Deutsche Börse must first choose the investment bank to be its underwriter in the so called “beauty contest”, where the banks propose their offers. Especially when the issue is significantly large, an underwriter syndicate can be formed. The syndicate is consequently led and coordinated by a lead underwriter and the other members of the syndicate usually only undertake a placement. Before the listing, the company must file its introduction IPO prospectus, which is created after a due diligence is conducted on the firm, and contains all information about the business and the offering. Moreover, in order to get listed, the company must receive an approval from the Frankfurt Stock Exchange - the admission authority.

There are three main types of the offerings - book-building offerings, fixed-price offerings and auctions. In Germany, however, auctions are not used nowadays. Fixed-price offering is a procedure, where the underwriter offers the IPO shares to both private and institutional investors at a price, which is pre-set and does not change.

The strongly prevailing procedure in Germany is the book-building, in which the IPO shares are offered solely to institutional investors. Therefore, the book-building procedure is the one which the model of this thesis is based on. In the beginning of the book-building period, the underwriter sets the filing range, which denotes the price range in which the offer price is going to be set at the end of the period. The institutional, also called book-building investors are obliged to place their orders for an IPO within this range.

One of the most significant features of German stock market relative to this study is the German grey IPO market. On the grey market, the forward trades on IPO shares are conducted on a so called “when issued basis” at time before an IPO takes place. The term means that the shares traded are going to be delivered on the first day of aftermarket trading after the IPO issuance. Since the grey market is open for both retail and large investors, it is a convenient way for issuers to assess the demand for their shares in advance, at a time when the offer price is not yet set. The grey market trading is organised only for chosen IPOs, for which the organiser expects a large demand and highly active trading. According to Schnigge Wertpapierhandelsbank AG, a large German investment bank which is also a major German grey market organiser, the magnitude of the grey market trading can reach up to 20% of the size of the following issue. After the bookbuilding range for an IPO is set, Schnigge AG can begin the grey market trading by setting the initial quotation. Consequently, the market participants start placing buy or sell-orders, by which the first grey market prices are set.

Chapter 4

Literature Review

The IPO-underpricing was first documented by Stoll and Curley (1970) followed by Logue (1973) and Ibbotson (1975). Logue (1973) tries to explain the phenomenon by the prestige of an underwriter supporting the process of an IPO. Ibbotson (1975) offered several potential explanations for IPO underpricing examined by later papers. Later on, many studies focused on answering whether IPO underpricing is a persistent worldwide anomaly. A vast majority of papers investigating the aforementioned question reached a positive conclusion. Jenkinson (1990) and Loughran et al. (1994) or Ritter (2003) found that the phenomenon is present in all of the examined countries, although on a different scale. In addition, Oehler et al. (2004) find evidence of underpricing being present in most of the companies regardless of an industry they belong to.

After the Ibbotson (1975) paper was published, a large body of literature emerged trying to find evidence for the proposed explanations included in the paper, which also triggered activity yielding other new theories. The traditional theories assuming rationality of investors and all other IPO market players were prevailing in earlier periods with a leading role of asymmetric information theory. The crucial studies investigating various forms of explanations based on the asymmetric information alongside with a well-known paper by Rock (1986) are Welch (1989), Benveniste and Spindt (1989), Brennan and Franks (1997), Cornelli and Goldreich (2001) or Loughran and Ritter (2004).

In the beginning of the millenium, a few heralds of future shift to behavioral approach appeared, notably Ritter and Welch (2002), who review the whole theory of IPO activity with a focus on IPO underpricing and long-term performance of IPOs. They argue that the theories based on the asymmetric information do not yield the leading reasons for IPO underpricing. Moreover, according to the paper, they see the

future of the studies in behavioral realms. Some researchers are interested in a theory, that issuers are subjected to certain behavioral biases and fail to price their IPOs properly. However, most of the studies in the field focus on the assumption of irrationally exuberant investors, who bid the prices of an IPO up above its fundamental value in the first days of trading.

The term investor sentiment was firstly used in Welch (1992) in the theory of informational cascades where in the case when shares are being sold sequentially, later investors condition their demand on the demand of earlier investors while not taking into account their own information.

As mentioned before, it has been shown in various studies that investor sentiment might serve as a potential explanation for a puzzling behaviour of IPO market. It has been noticed already by Ibbotson and Jaffe (1975) that the IPO market is cyclical, wherein so called hot IPO periods defined by high IPO underpricing and IPO volume, take turns with opposite cold IPO periods. The presence of overly optimistic investors in hot IPO periods has been proposed for example by Ritter (1991), who finds evidence that many companies which went public experienced first day initial returns and subsequently long-run underperformance. He finds the pattern consistent with a presence of investor sentiment. Since then, long-term underperformance of companies experiencing high initial returns became a widely investigated phenomenon and appeared in many studies alongside with IPO underpricing itself. Loughran and Ritter (1995) documented that companies issuing equity, including both IPOs and SEOs, tended to underperform comparable non-issuing companies during a period 1970-1990. Krigman et al. (1999) tried to link the company-specific IPO underpricing with the long-run underperformance and found, consistent with Ritter (1991), the positive relation between these two variables, for the values of IPO underpricing higher than 70%.

Firstly, IPO volume and its fluctuations did not attract that much attention as IPO underpricing did. However, we can find papers connecting the two phenomena together. Lowry (2003) finds that both a company's demand for capital and investor sentiment are significant determinants of IPO volume fluctuations. There have been concerns that the high IPO volume following periods of high IPO underpricing is a result of companies timing their IPOs in order to issue during high underpricing times when the sentiment of investors is high. The idea has been proposed for example by Lee et al. (1991), Loughran et al. (1994) or Baker and Wurgler (2007). Moreover, recently the idea that the IPOs during high underpricing periods are actually overvalued relative to the offer price became fairly popular. One of the possible

reasons for this novel empirical fact is that companies or underwriters try to exploit the investor sentiment and gather part of the excess money for themselves. Purnanandam and Swaminathan (2004) find that IPOs are systematically overvalued relative to the offer price over time and across industries. They argue that behavioral theories might provide an answer to the overvaluation found in their paper. Ljungqvist et al. (2006) go further and explain the overvaluation in a model which assumes firms to raise the IPO prices in order to exploit the occasional presence of irrational investors. Their idea is consistent with the one of Santos (2010).

Many recent studies focusing on investor sentiment already attempt to connect more of the anomalies together, notably Derrien (2005), Ljungqvist et al. (2006), Cornelli et al. (2006) or Oehler et al. (2004).

Derrien (2005) investigates how investor sentiment affects IPO pricing of French companies in hot periods. Consequently, a conclusion is reached that high investor sentiment is positively related to the magnitude of initial returns and issue price, and negatively related to long-term performance. In his framework, when investors tend to be bullish and therefore the investor sentiment is high, an underwriter sets the price of an IPO based partially on information from informed institutional investors about the fundamental value of an IPO, and partially on the publicly observable level of investor sentiment, which is positively related to IPO underpricing. The price depends on the investor sentiment only partially because an underwriter has an obligation to support an IPO whose aftermarket price drops below the issue price, if the sentiment turns bearish. The support is expensive and underwriters try to avoid it. This yields a conservative IPO price setting between the fundamental value and the price overoptimistic investors are willing to pay. Therefore, the IPO shares are overpriced relative to the offer price and experience a long-run underperformance. The results of the study are consistent with what I expect to find in my thesis on a German sample.

Ljungqvist et al. (2006) find an investor sentiment with an assumption of short sale restrictions being a possible common source for IPO underpricing, long-run underperformance and hot issue markets. Moreover, they model an optimal response of a company to the presence of investor sentiment which is based on an inventory holding strategy. The optimal outcome for an issuer emerges if institutional investors, to whom the shares were allocated in the primary market, sell the shares to sentiment investors gradually. Therefore, by restricting the IPO shares availability they maintain the prices high, which results in a possibility to set the offer prices higher. For institutional investors holding IPO shares and selling them gradually is risky, because there is always the chance of the market turning into a bearish state with low

investor sentiment. Therefore, IPO underpricing is regarded as a compensation to institutional investors for holding the shares in their inventory.

Papers using grey market data as a proxy for the investor sentiment are mostly focused on the European or Asian market. The proxy used by the ones investigating the American market, is predominantly the discount on closed-end funds. The leading paper using grey market data on twelve European countries is Cornelli et al. (2006). They examine whether the investor sentiment is a determinant of IPO underpricing and find the asymmetric relation between these two variables. While high grey market prices drive the IPO underpricing significantly, low grey market prices do not. One of the papers that focused only on the German market is Oehler et al. (2004). While proxying the investor sentiment for closing prices in a German grey market, they documented initial returns to be mainly influenced by investor sentiment. Moreover, they came to a conclusion that the IPO underpricing is driven more significantly by the uncertainty about the demand for the IPO and less by the uncertainty about the fundamental value of a company.

Chapter 5

Methodology and data

5.1. Model

The model used is taken from Cornelli et al. (2006), which is a paper investigating the European region including the German market. Therefore, their model is relevant for the following empirical investigation. However, some changes and adjustments have been made in the model in order it to fit better into the framework of this study.

All economic agents present in the IPO market, except for a part of investors in certain time periods, are assumed to be rational. The issuing company expects to sell X shares in the coming initial public offering. Each share has a fundamental value $f \in [0, \bar{f}]$, which is not observable. The book-building period begins after an underwriter's announcement of the filing range in which the issuing company expects to set the offer price P_O . During a book-building period the issuing company with its underwriter gathers information from informed institutional investors about the expected fundamental value and grey market trading on the IPO takes place. A weighted average of the information from institutional investors $f_I \in [0, \bar{f}]$ and the information from the grey market $f_G \in [0, \bar{f}]$ is an expected fundamental value of IPO from the issuing company's and underwriter's point of view. Therefore:

$$E(f \mid f_I, f_G) = \alpha f_I + (1 - \alpha) f_G, \text{ where } 0 < \alpha \leq 1 \quad (5.1)$$

Alpha cannot equal zero, because the information from the rational institutional investors is always relevant for the issuing company and the underwriter. The grey market information is publicly available during and after the book-building period, but the information gathered from the institutional investors is private and is observable by the public only after the actual IPO when the offer price is set.

In the presence of the investor sentiment, investors overweight their own information, and consequently their estimate for the fundamental value of an IPO is:

$$E_{G1}(f | f_I, f_G) = \tilde{\alpha}E(f_I) + (1 - \tilde{\alpha})f_G, \text{ where } \alpha \geq \tilde{\alpha} \quad (5.2)$$

The price of an IPO in the grey market is therefore $P_G = E_{G1}(f | f_I, f_G)$. The periods of high investor sentiment are assumed to be defined as periods when the signal from the grey market f_G is higher than the one from the bookbuilding investors f_I , together with existence of irrationality among grey market investors. The investors are irrational, only if $\alpha > \tilde{\alpha}$. The source of irrationality is $\tilde{\alpha} \neq \alpha$ and not $E(f_I)$, so the grey market investors rationally predict the expected value of the signal from institutional investors. The issuing company and the underwriter can easily observe f_G as:

$$f_G = \frac{P_G - \tilde{\alpha}E(f_I)}{(1 - \tilde{\alpha})} \quad (5.3)$$

After the offer price is set and before the trading in the aftermarket starts, f_I is revealed to the investors, who consequently adjust their expectations of the IPO's fundamental value:

$$\hat{P}_G = E_{G2}(f | f_I, f_G) = \tilde{\alpha}f_I + (1 - \tilde{\alpha})f_G, \text{ where } \alpha \geq \tilde{\alpha} \quad (5.4)$$

When the trading in the aftermarket begins, the rational book-building investors knowing the expected value $E(f | f_I, f_G)$ sell their shares to the sentiment investors only if $\hat{P}_G > E(f | f_I, f_G)$. If $\hat{P}_G \leq E(f | f_I, f_G)$, the aftermarket price equals expected fundamental value $E(f | f_I, f_G)$, because the valuation by sentiment investors, who are not included in the trade, is then irrelevant. The aftermarket price also depends on the number of investors willing to buy X shares at the price \hat{P}_G , known as depth of the market. Depth of the market indicates how liquid the market is. The market is recognized as deep if the price in the market does not change much with a single large order. The less the investors and thus the lower the depth of the market, the lower the price in the aftermarket.

Therefore, the aftermarket price is set as a maximum of the expected fundamental value of an IPO and the price grey market investors are willing to pay, discounted by an amount depending on the depth of the market and the amount of shares offered in the IPO:

$$P_{AM} = \text{Max} \{E(f | f_I, f_G); \hat{P}_G - \beta X\} \quad (5.5)$$

The aftermarket price behaves assymmetrically in relation to grey market prices that

are higher or lower than the expected fundamental value. The formula (5.5) summarizes this asymmetric nature of the aftermarket price, and also the importance of the depth of the market. The discount from the price grey market investors are willing to accept is βX , where X is number of shares offered by the issuing company and β is a coefficient indicating the depth of the market. The market is deep enough for $\beta = 0$ and β increases for less deep markets. Thus, the discount from \hat{P}_G increases with an increasing number of offered shares or with a decreasing depth of the market. Such behaviour is consistent with a basic economic theory. With increasing supply, represented by the number of shares, the price slumps so the discount rises. The depth of the market represents a demand for IPO. The higher the depth of the market, the more investors willing to buy an IPO in the market. Therefore, when the depth of the market increases, the price rises so the discount slumps.

In the long run, the initially irrational grey market investors gradually adjust the importance of their own signal relative to the one of book-building investors as the irrationality fades. Therefore, in the long run, a price is approaching its fundamental value. In the model is assumed that the valuations of the aftermarket investors are the same as the ones of grey market investors. According to Cornelli et al. (2006), but also many others, the grey market is highly informative about the demand of retail investors, concretely, according to Cornelli et al. (2006, page 1187): “*Conversations with grey market brokers confirm that grey market investors are primarily retail investors and smaller institutions.*”.

The model considers the setting of the offer price P_O as a result of a bargaining process between the underwriter with its book-building investors and the issuing company in a framework of game theory. A payoff which is divided between the parties is P_{AM} and the way how it is split depends on the bargaining power of each party included. Issuing company always obtains the offer price P_O , the underwriter with a network of bookbuilding investors obtains the rest, concretely $P_{AM} - P_O$. If the deal does not take place, the issuing company obtains its shares back and keeps them. Therefore, the issuer obtains shares valued at $E(f \mid f_I, f_G)$. However, the underwriter receives 0 as a payoff. According to Osborne and Rubinstein (1990), there is exactly one bargaining solution in a fairly simple form. The solution maximizes the product of parties' gains less the outcome when the deal is cancelled. Generally, the formula is:

$$\arg \max_{p_1, p_2} (p_1 - o_1)^\lambda (p_2 - o_2)^{1-\lambda} \quad (5.6)$$

where p_1, p_2 represent payoffs to the parties included in a game and o_1, o_2 denote outside options for the parties when no agreement is reached and thus the deal is

cancelled. λ with $1 - \lambda$ represent the relative bargaining powers of the party 1 and 2, respectively.

In the particular case for the model used in this thesis, the formula has a concrete form of:

$$\arg \max_{P_O, P_{AM}} (P_O - E(f | f_I, f_G))^\lambda (P_{AM} - P_O)^{1-\lambda} \quad (5.7)$$

where λ represents the bargaining power of the issuing company, and $1 - \lambda$ is the one of the underwriter with its book-building investors.

The solution of the previous formula is:

$$P_O = E(f | f_I, f_G) + \lambda (P_{AM} - E(f | f_I, f_G)) \quad (5.8)$$

When there is a high investor sentiment in the IPO market and investors tend to pay more than a fundamental value of an IPO, $P_{AM} - E(f | f_I, f_G)$ is positive. The term $\lambda (P_{AM} - E(f | f_I, f_G))$ represents a part of the surplus, which is received by the issuing company by the way of setting the offer price higher than $E(f | f_I, f_G)$. If $\lambda = 1$, an issuing company receives the whole surplus, while an underwriter with book-building investors obtain nothing. If $\lambda < 1$, the parties share the surplus and therefore the issuing company “leaves money on the table”, as many authors like saying. This case is consistent with so called “partial adjustment puzzle”, answering why issuers do not fully utilize the investor sentiment. According to Cornelli et al. (2006, page 1199): “as long as the underwriter has some bargaining power, partial adjustment results”.

According to the formula (5.8) and the aforementioned assymetric relation between P_G and P_{AM} , there is also an assymetric relation between P_G and P_O . For low investor sentiment and therefore low P_G and \hat{P}_G , the aftermarket price equals the expected fundamental value $E(f | f_I, f_G)$. Consequently, as per the formula (5.8), $P_{AM} - E(f | f_I, f_G) = 0$ and $P_O = E(f | f_I, f_G)$. On the other hand, for high investor sentiment with high P_G and \hat{P}_G , the price in the aftermarket is $\hat{P}_G - \beta X$, while the offer price equals $E(f | f_I, f_G) + \lambda (P_{AM} - E(f | f_I, f_G))$, where $P_{AM} - E(f | f_I, f_G) > 0$.

5.2. Empirical implications

5.2.1. Hypotheses

The proposed hypotheses are consistent with the model used. In the empirical part only periods of high investor sentiment are investigated. The reason for the separation of high and low investor sentiment is the assymetric relation between the variables for the high and low investor sentiment mentioned in the model. More detailed investigation and discussion of the assymetric relation and periods of low investor sentiment can be found for example in Cornelli et al. (2006).

Hypothesis 1 : The grey market price and the aftermarket price are positively related for periods of high investor sentiment.

High investor sentiment in the market means that investors are irrational and, according to the model, they overweight their own information, therefore $\alpha > \tilde{\alpha}$. Moreover, it means that the signal about the fundamental value of an IPO from the grey market is higher than the one from institutional investors: $f_G > f_I$. It implies that:

$$P_G = E_{G1}(f | f_I, f_G) = \tilde{\alpha}E(f_I) + (1 - \tilde{\alpha})f_G > \alpha f_I + (1 - \alpha)f_G = E(f | f_I, f_G) \quad (5.9)$$

The higher the investor sentiment, the higher the signal from the grey market and therefore the higher the grey market price. Since P_G and \hat{P}_G are positively related and the aftermarket price is set according to the model as in the formula (5.5), we can expect that, for grey market prices high enough, the first hypothesis holds true.

Hypothesis 2 : The grey market price and the offer price are positively related for the periods of high investor sentiment.

In the first hypothesis it is assumed that the grey market price and the aftermarket price are positively related. According to the formula (5.8) it is visible that if the issuing company has some bargaining power, the offer price and the aftermarket price are positively related too. The two links mentioned clearly imply the positive relation between the grey market price and the offer price. The intuitive interpretation is that issuing companies simply see the overoptimism among the retail investors and try to exploit it by setting a higher offer price than the expected fundamental value $E(f | f_I, f_G)$ of the share and enjoy more payoff they actually “deserve”, which is $E(f | f_I, f_G) + \lambda(P_{AM} - E(f | f_I, f_G))$.

Hypothesis 3 : The grey market price and the future IPO volume are positively related for periods of high investor sentiment.

The model does not explicitly imply the third hypothesis. However, setting the offer price higher than $E(f \mid f_I, f_G)$ is favourable due to the reasoning mentioned in the explanation of the previous hypothesis. The favourable environment is recognized by all companies, the ones currently going public, but also by the ones that did not plan to have IPO at that time. Therefore, in the situation of high investor sentiment, more companies exploiting this favourable environment in the recent future is a reasonable hypothesis.

Hypothesis 4 : The grey market price and the long run performance relative to the aftermarket price are negatively related for the periods of high investor sentiment.

In the periods of high investor sentiment for the grey market prices high enough, the aftermarket price exceeds the expected fundamental value of the IPO. It happens, as mentioned in the model, because although the grey market investors adjust their expectations by the revealed signal from the book-building investors, they still fail to stop overweighting their own signal. The adjustment of $\tilde{\alpha}$ comes in a long run. As the gradual adjustment arises, the price of an IPO starts approaching the its fundamental value, which is lower than the aftermarket price.

Hypothesis 5 : The grey market price and the long run performance relative to the offer price are negatively related for the periods of high investor sentiment.

Consistent with the second hypothesis, in certain circumstances, the offer price might exceed the fundamental value of an IPO. In the long run, according to the reasoning related to the fourth hypothesis, the price of an IPO is approaching the fundamental value lower than the offer price. Therefore, the long term underperformance relative to the offer price may occur.

5.2.2. Variables

Grey market price normalised by the midpoint of the filing range pg/mid is an endogenous variable in the used regressions.

The exogenous variables are following:

<i>po/mid</i>	offer price normalised by the midpoint of the filing range
<i>pam/mid</i>	closing price after the first day of trading normalised by the midpoint of the filing range
<i>dax</i>	german market index DAX (control variable)
<i>vol6</i>	IPO volume in the following 6 months after an IPO
<i>abhar</i>	buy-and-hold abnormal return starting from the aftermarket price returns on IPO
<i>obhar</i>	buy-and-hold abnormal return starting from the offer price returns on IPO

The grey market price has been chosen as an endogenous variable in order for one regression to be sufficient for all hypotheses tested. However, due to multicollinearity problem explained in the Empirical results section, the two regressions have been eventually constructed. The grey market price is defined as a last closing price in a grey market before the initial public offering takes place. The offer price, also called the subscription price, is a price which is set by the issuer with its underwriter and at which the issuing company sells its shares to the book-building investors in the primary market. Aftermarket price is considered as a closing price after the first day of trading in the aftermarket. The grey market price, offer price and aftermarket price are normalised by the midpoint of the filing range in order to minimise the effect of heteroskedasticity and differing scales. Market index serves as a control variable, because many exogenous variables used in the regression are dependent on the general market conditions. The aim of the thesis is, however, to assess the effects holding general market conditions fixed. The IPO volume during six months after an IPO has been selected as an exogenous variable. The minimum time for conducting an IPO is considered to be around six months. Since the aim of the thesis is to investigate the effects in periods of high investor sentiment when investors are overly optimistic and there are favourable conditions for going public, the required time for going public likely shrinks. Therefore, the period of six months becomes a reasonable time frame for the potential reaction of future issuers.

5.2.3. Regressions

Multivariate cross-sectional regressions are used in the study, due to the fact that the time intervals between particular IPOs do not coincide, which makes time-series or panel regressions hard to work with. Due to the aforementioned asymmetry in

the model, observations from periods of high and low investor sentiment must be separated. This study focuses only on periods of high investor sentiment. There are two main ways how to investigate the variables for the period of high sentiment of investors.

First possibility is an inclusion of interaction terms. Consistent with a theory in Woolridge (2009), in a cross-sectional regression $y = \alpha_0 + \alpha_1 x + \alpha_2 x \cdot z + u$ with the interaction term $x \cdot z$, the partial effect of x on y is following:

$$\frac{\Delta y}{\Delta x} = \alpha_1 + \alpha_2 z \quad (5.10)$$

Therefore, in the case when z stands for a dummy variable, the partial effect of x on y is α_1 if $z = 0$ and it is $\alpha_1 + \alpha_2$ if $z = 1$. In the case of this thesis, consistent with the general case, the partial effect of each investigated variable po/mid , pam/mid , $vol3$, $vol6$, $abhar$ and $obhar$, representing x in the example, is going to be $\alpha_1 + \alpha_2$ for high investor sentiment $high = 1$, representing the dummy variable. However, the interaction terms have not been used due to a multicollinearity problem between each variable, and the interaction term of the same variable with the dummy for high sentiment of investor.

A second option has been chosen for the thesis, although at the expense of a smaller sample size. In the regression only observations in periods of high sentiment of investors have been taken into account. Since the aim of the thesis is to study only companies in periods of high investor sentiment, such procedure does not violate the random sampling assumption for multivariate cross-sectional data, so it does not cause bias or inconsistency. High investor sentiment appears when the grey market price exceeds the fundamental value of an IPO. The fundamental value is not observable, therefore it has been substituted by a midpoint of a filing range, consistent with Cornelli et al. (2006). Buy-and-hold abnormal returns variables are used to assess the long-run performance of an IPO.

The chosen regressions are following:

$$\text{Regression 1 : } \frac{pg}{mid} = \beta_0 + \beta_1 \left(\frac{pa}{mid} \right) + \beta_2 \left(\frac{po}{mid} \right) + \beta_3 dax + \beta_4 vol6 + \beta_5 abhar + u$$

$$\text{Regression 2 : } \frac{pg}{mid} = \alpha_0 + \alpha_1 \left(\frac{pa}{mid} \right) + \alpha_2 \left(\frac{po}{mid} \right) + \alpha_3 dax + \alpha_4 vol6 + \alpha_5 obhar + u$$

Due to the multicollinearity between the variables $abhar$ and $obhar$, only one variable from the couple has been considered in each regression. The first regression is used for assessing the first, second, third and fourth hypotheses. The second regression serves as a tool for assessing the last fifth hypothesis.

The formal form of the aforementioned hypotheses is placed in the following table:

Table 5.1.: Hypotheses

<i>null Hypothesis 1</i>	$H_1 : \beta_1 \leq 0$
<i>alternative Hypothesis 1</i>	$H_{1a} : \beta_1 > 0$
<i>null Hypothesis 2</i>	$H_2 : \beta_2 \leq 0$
<i>alternative Hypothesis 2</i>	$H_{2a} : \beta_2 > 0$
<i>null Hypothesis 3</i>	$H_3 : \beta_4 \leq 0$
<i>alternative Hypothesis 3</i>	$H_{3a} : \beta_4 > 0$
<i>null Hypothesis 4</i>	$H_4 : \beta_5 \geq 0$
<i>alternative Hypothesis 4</i>	$H_{4a} : \beta_5 < 0$
<i>null Hypothesis 5</i>	$H_5 : \alpha_5 \geq 0$
<i>alternative Hypothesis 5</i>	$H_{5a} : \alpha_5 < 0$

5.3. Data

The dataset contains observations on 128 companies that went public in German market during the period 2000-2010. The time frame 2000-2010 has been chosen in order to combine the usage of the most current data, and to provide an opportunity to assess the long-run performance of IPOs. For the assessment of the long-run performance the buy-and-hold returns over two years time horizon are computed. In order to obtain the long-run performance for each company in the sample, the time period must end by year 2010. The list of companies for which the grey market data are available was taken from the German investment bank Schnigge Wertpapierhandelsbank AG. Although many research papers claim the grey market prices for the German market can be obtained from this bank, it does not hold true anymore. According to a discussion with one of their employees, Schnigge AG used to publish the data until 2004, but due to a low demand from public it terminated the service. The access is not so easily available as some researchers claim, especially for those without the access to Reuters or Bloomberg paid databases. Therefore, the grey market prices have been gathered from the printed archive of the German daily newspaper Börsen-Zeitung. Consequently, the list of companies obtained from Schnigge AG forms the data sample. For them the offer price and the filing range has been obtained from Deutsche Börse website. The first day closing price of IPOs and their prices in each of 24 following months, prices of the german DAX index at the time

of offerings, on first day of trading, and in each of 24 consecutive months have been gathered manually from Yahoo finance historical price data. The IPO volume has been calculated from the Deutsche Börse website.

Chapter 6

Empirical results

6.1. Statistical properties testing

6.1.1. Multicollinearity

Multicollinearity is investigated via the correlation matrices, present in Table A.1 and Table A.2, for all variables used in each regression. Since neither in Regression 1 nor in Regression 2 no correlation exceeds 0.7 for any couple of different explanatory variables, no severe multicollinearity is present.

6.1.2. Heteroskedasticity

Testing for heteroskedasticity in the regressions is conducted by Breusch-Pagan test. It is assumed that the random sampling and zero conditional mean assumptions hold true. Linearity and sample variation conditions are fulfilled. The null hypothesis is stated as:

$$H_0 : \text{Var}(u \mid \frac{pa}{mid}, \frac{po}{mid}, vol6, abhar, dax) = \sigma^2 \quad (6.1)$$

$$H_0 : \text{Var}(u \mid \frac{pa}{mid}, \frac{po}{mid}, vol6, obhar, dax) = \sigma^2 \quad (6.2)$$

for the Regression 1 and Regression 2, respectively.

Under the null it is assumed that the homoskedasticity assumption holds true and therefore the variance of error term is constant given all the explanatory variables. Since generally, according to Woolridge (2009), $\text{Var}(u \mid x_1, \dots, x_k) = E(u^2 \mid x_1, \dots, x_k)$, it is possible to test the hypotheses via the regressions:

$$u^2 = \delta_0 + \delta_1 \frac{pa}{mid} + \delta_2 \frac{po}{mid} + \delta_3 abhar + \delta_4 vol6 + \delta_5 dax + v$$

$$u^2 = \gamma_0 + \gamma_1 \frac{pa}{mid} + \gamma_2 \frac{po}{mid} + \gamma_3 obhar + \gamma_4 vol6 + \gamma_5 dax + v$$

for Regression 1 and Regression 2, respectively.

Then the aforementioned null hypothesis can be stated as following:

$$H_0 : \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$$

$$H_0 : \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$$

for Regression 1 and Regression 2, respectively.

The results of the F-statistic for overall significance show p-values 0.4172 and 0.4429 for Regression 1 and Regression 2, respectively. Therefore, the null hypothesis of homoskedasticity is not rejected at any reasonable significance level and there is enough evidence to consider the data homoskedastic. The results of Breusch-Pagan test are present in Table A.3.

6.1.3. Normality of residuals

The normality assumption is crucial for this thesis due to the fact that the data sample contains only 128 observations and therefore relying on the asymptotic normality for large samples would not be a reasonable argument. The Shapiro-Wilk test is conducted for testing the null hypothesis which says that the residuals are normally distributed against the alternative claiming otherwise. Generally, the significant departure of residuals from normality occurs if the p-value of the test is lower than 0.05. The p-value of the Shapiro-Wilk test for the data sample is 0.20646 and 0.21750 for Regression 1 and Regression 2, respectively. The results of Shapiro-Wilk test are included in Table A.4. Since Shapiro-Wilk test is recommended for very small sample sizes, the Shapiro-Francia test is conducted consequently, which is also present in Table A.4. P-values of 0.21933 and 0.23230 for Regression 1 and Regression 2, respectively, only confirm the conclusions from the Shapiro-Wilk test. Thus, it is reasonable to consider the residuals as normally distributed, consistent with histograms in Figure A.2 and Figure A.3.

6.2. Hypotheses testing

6.2.1. Hypothesis 1

According to the results from the Regression 1 present in Table A.5, the null hypothesis is rejected in favour of the alternative even at 1% significance level. Therefore, there is a significant evidence of the positive effect of the aftermarket price on the grey market price in high underpricing periods. The magnitude of the effect is 1.217685 which means that the increase of the normalized aftermarket price by one unit is associated with an increase of the normalized grey price by approximately 1.2 unit.

The result of the magnitude is more complex from the model's point of view. In the model, the source of the relationship between P_A and P_G lies in the formulas (5.2), (5.4) and (5.5).

The grey market price observed in the sample of data is the one set before the offer price is published: P_G . The formulas (5.2) and (5.4) imply: $P_G = \hat{P}_G + \tilde{\alpha}E(f_I) - \tilde{\alpha}f_I$ and both $\tilde{\alpha}E(f_I)$ and $\tilde{\alpha}f_I$ are treated as constants relative to change in P_G . Thus, the change in P_G should equal the change in \hat{P}_G : $\Delta P_G = \Delta \hat{P}_G$. The formula (5.5) can be written as $P_{AM} = \hat{P}_G - \beta X$ for the high investor sentiment. Since neither the number of shares offered by the issuing company X nor the coefficient indicating the depth of the market β is a function of P_G , they can be again treated as constants. Thus, the change of P_G should equal also change of P_{AM} : $\Delta P_G = \Delta \hat{P}_G = \Delta P_{AM}$.

Therefore, it makes also sense to test if there is enough evidence for $\beta_1 = 1$. The t-statistic for this case is computed as: $t_{\hat{\beta}_1} = \frac{\hat{\beta}_1 - 1}{se(\hat{\beta}_1)} = \frac{1.211841 - 1}{0.321427} = 0.659$. Consequently, the hypothesis $H_0 : \beta_1 = 1$ is not rejected at any significance level and there is a significant evidence of the effect being equal to one, consistent with what the model implies.

6.2.2. Hypothesis 2

The results show that the second null hypothesis can be rejected at any significance level. Therefore, the outcome gives a very strong evidence of the positive effect of the offer price on the grey market price. The coefficient from the regression is 3.020739 and therefore the change of the normalized offer price by one unit implies the change of the grey market price by approximately 3 units.

Taking into account the formula (5.8) from the model for how the offer price is

set, and the fact that the expected value $E(f \mid f_I, f_G)$ does not depend on the grey market price and consequently on the aftermarket price, the change of the offer price should equal the change of the aftermarket price multiplied by the indicator of the bargaining power of the issuing company λ : $\Delta P_O = \lambda \Delta P_{AM}$. Since the variable indicating bargaining power always belongs to an interval $[0, 1]$, the change in the aftermarket price must always be greater or equal to the change of the offer price: $\Delta P_O \leq \Delta P_{AM} = \Delta P_G$. To assess the relationship, the null hypothesis $H_0 : \beta_2 \geq 1$ is tested against the alternative hypotheses $H_a : \beta_2 < 1$. The t-statistic is computed as: $t_{\hat{\beta}_2} = \frac{\hat{\beta}_2 - 1}{se(\hat{\beta}_2)} = \frac{3.020739 - 1}{0.6255304} = 3.2304$. Thus, the null hypothesis is not rejected at any reasonable significance level and there is significant evidence for $\beta_2 \geq 1$.

6.2.3. Hypothesis 3

There is little evidence of any effect of the IPO volume on grey market prices. It is not possible to reject the hypothesis $H_0 : \beta_4 = 0$ at any reasonable significance level. The reason might be the fact that the German IPO market, although one of the most liquid ones in Europe, is still not liquid enough to measure the effect of the IPO volume properly. Most of the papers focusing on investigating the relationships including the IPO volume use the sample from USA IPO markets, where the volume is at least two times higher. According to the information from Deutsche Börse website, and PwC Reports Focarino and Wu (2007) with Gehsmann (2011), in Germany for the period 2000-2010, the highest IPO volume was in 2000 and reached 173 new listed companies. In USA, the IPO volume was about 2.5 times higher, 429 companies. The problematic years for the thesis investigation are especially the recent ones, in 2010 there were only 13 IPOs in Germany, whereas in USA 168 companies went public. In 2009 in Germany 3 IPOs are recorded, in USA the number is 69. The other possible explanation for the insignificance of the variable might be the fact that, in spite of the reasoning why period of 6 months has been chosen, the time frame is too short for capturing the reaction of firms which would exploit the investor sentiment.

6.2.4. Hypotheses 4 and 5

The results show very little evidence to support the last two hypotheses. The null hypotheses $H_0 : \beta_5 = 0$ and $H_0 : \alpha_5 = 0$ cannot be rejected at any reasonable significance level. The source of the problems might be too broad reference portfolio chosen for the buy-and-hold abnormal returns calculation. The German broad market index DAX has been used because of practical reasons. The best possibility for the

reference portfolio would be returns on the matching peers. The procedure requires finding the non-listed company as similar to the firm from dataset as possible. The peer company should be matched from many points of view, especially industry, operating performance, book value or market value. In USA the data are easy to find via Compustat, however, the service provides the information only on American firms. The other possibility is to use an industry index as a reference portfolio. Deutsche Börse Group is offering a new range of sector indices, but the data older than 2008 is not available. The use of DAX index as a reference portfolio does not have to cover all important factors influencing the long-run performance as the different conditions in various industries and among firms of different size and profitability.

Chapter 7

Conclusion

The aim of the thesis was to investigate whether sentiment of investors can be a possible source for most popular IPO anomalies - IPO underpricing, long-run underperformance of IPOs and cycles in IPO volume. Traditional theories explaining IPO underpricing, assuming rationality of all market players, have troubles to serve as a source for all three IPO puzzles. Moreover, the observations of unprecedentedly extreme values of IPO underpricing, for instance during a period of the dot-com bubble in USA, represent an evidence against the traditional theories. On the other hand, the investor sentiment theory, based on the fact that in some periods of time investors become irrationally optimistic, seems as an intuitive explanation for the aforementioned empirical patterns.

Although other papers have already investigated investor sentiment as a reason for some of the anomalies, most of the times they focused only on either IPO underpricing with a long-term performance, or IPO underpricing and IPO volume cycles. Therefore, the original contribution of this thesis is mainly the investigation of all the anomalies together and connecting them in a proposed theoretical model. Moreover, the use of grey market prices as a proxy for the investor sentiment and an updated dataset reaching to the year 2010 are another factors contributing to the originality of the study.

Concretely, the study attempted to find an evidence for a positive relationship between the grey market prices and IPO underpricing, and between grey market prices and long-term underperformance of IPOs issued at time the grey market prices were gathered from. Such conclusions would serve as grounds for investor sentiment being a source of IPO underpricing. Also, the relationship between the grey market prices and consequent IPO volume, between grey market prices and offer prices, and also between grey market prices and long-run underperformance of IPOs relative to

the offer price was investigated. The positive relationships would be an evidence that issuing firms exploit the favourable conditions of irrational high demand for IPOs by the way of an increased number of companies going public and setting the offer prices higher, above the fair value. In the study, there has been a positive relationship between grey market prices and IPO underpricing, and also between grey market prices and offer prices found. However, the other three hypotheses have not been confirmed. The reason of the insignificance might be a liquidity of German IPO market and the method used for calculating the long-run performance.

The recommendation for a future research is to continue using grey market prices as a proxy for investor sentiment, since, according to many studies including Cornelli et al. (2006), it serves as a proxy well. Additionally, it is easier to work with than other proxies used for instance in Baker and Wurgler (2007). Moreover, the more thorough investigation of all notable IPO anomalies together and looking for a common source is left for a future research. Probably, the USA market data would be most suitable for such research due to its very high liquidity, which would likely prevent troubles this thesis had with a German sample.

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Appendix A

Tables

Table A.1.: Correlation matrix for Regression 1

	<i>pg/mid</i>	<i>po/mid</i>	<i>pa/mid</i>	<i>dax</i>	<i>abhar</i>	<i>vol6</i>
<i>pg/mid</i>	1					
<i>po/mid</i>	0.6843	1				
<i>pa/mid</i>	0.6715	0.6916	1			
<i>dax</i>	0.2172	0.1276	0.3109	1		
<i>abhar</i>	−0.1715	−0.1452	−0.2905	−0.2161	1	
<i>vol6</i>	0.2880	0.2166	0.5258	0.5776	−0.2522	1

Table A.2.: Correlation matrix for Regression 2

	<i>pg/mid</i>	<i>po/mid</i>	<i>pa/mid</i>	<i>dax</i>	<i>abhar</i>	<i>vol6</i>
<i>pg/mid</i>	1					
<i>po/mid</i>	0.6843	1				
<i>pa/mid</i>	0.6715	0.6916	1			
<i>dax</i>	0.2172	0.1276	0.3109	1		
<i>abhar</i>	−0.1052	−0.1538	−0.1470	−0.1132	1	
<i>vol6</i>	0.2880	0.2166	0.5258	0.5776	−0.1608	1

Table A.3.: Heteroskedasticity testing

	Prob > F	F(5, 122)
<i>Breusch – Pagan test for Regression 1</i>	0.4172	1.01
<i>Breusch – Pagan test for Regression 2</i>	0.4429	0.96

Table A.4.: Normality testing

	W	V	z	Prob>z
<i>Shapiro – Wilk test for Regression 1</i>	0.98584	1.439	0.819	0.20646
<i>Shapiro – Wilk test for Regression 2</i>	0.98608	1.415	0.781	0.21750
	W'	V'	z	Prob>z
<i>Shapiro Francia test for Regression 1</i>	0.98685	1.456	0.774	0.21933
<i>Shapiro Francia test for Regression 2</i>	0.98713	1.425	0.731	0.23230

Table A.5.: Estimated Regression 1

variable	coefficient	t-statistic	standard error	p-value
<i>pa/mid</i>	1.217685	3.79	0.321427	0.000
<i>po/mid</i>	3.020739	4.83	0.6255304	0.000
<i>abhar</i>	−0.0022845	−0.52	0.0043551	0.601
<i>vol6</i>	0.0157472	0.08	0.2003499	0.937
R^2		0.5470		

Table A.6.: Estimated Regression 2

variable	coefficient	t-statistic	standard error	p-value
<i>pa/mid</i>	1.211841	3.83	.3164381	0.000
<i>po/mid</i>	3.040749	4.84	.6276314	0.000
<i>abhar</i>	−.0021898	−0.50	.0043673	0.617
<i>vol6</i>	.0565361	0.28	.2043179	0.782
R^2		0.5472		

Table A.7.: Summary statistics

number of observations			128		
variable	mean	median	variance	skewness	kurtosis
<i>pg</i>	61.86	44.56	6293.29	5.67	45.50
<i>pg/mid</i>	2.71	2.57	2.95	2.86	19.74
<i>pa</i>	27.75	18.93	1380.62	6.75	60.40
<i>pa/mid</i>	1.17	1.02	0.29	2.56	12.70
<i>po</i>	23.45	18.50	946.47	8.30	83.66
<i>po/mid</i>	1.00	1.00	0.06	6.00	72.60
<i>abhar</i>	−0.23	−0.36	0.31	2.22	9.53
<i>obhar</i>	−0.23	−0.35	0.27	2.09	9.18
<i>vol6</i>	39.73	23.50	1132.70	0.82	2.12
<i>dax</i>	6602.73	6736.73	855947.9	−0.76	3.35

Figure A.1.: Monthly IPO volume

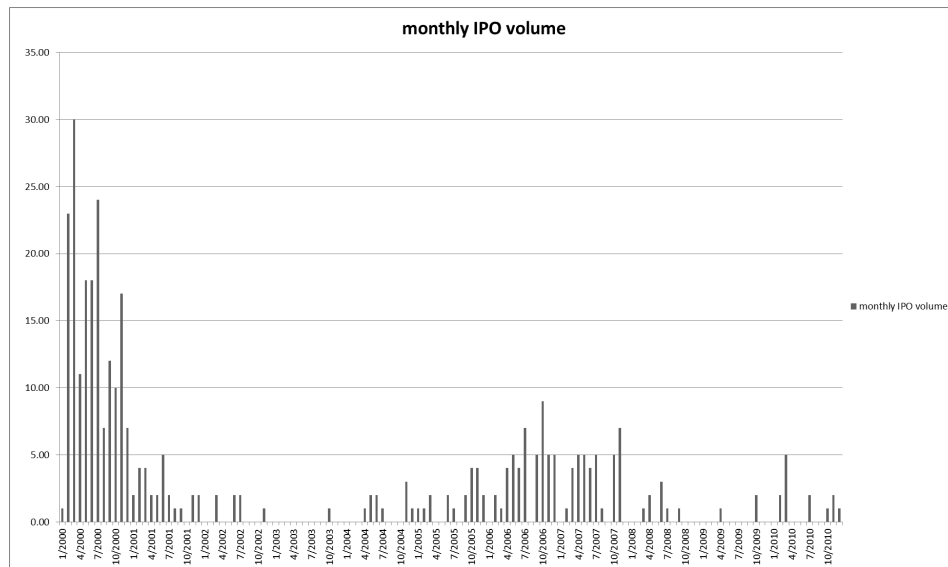


Figure A.2.: Histogram-residuals from Regression 1

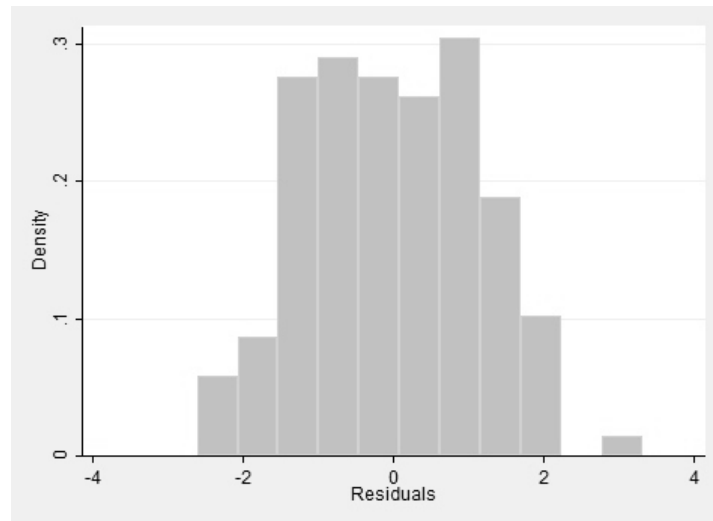


Figure A.3.: Histogram-residuals from Regression 2

