The issue of underpricing in Initial Public Offerings

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Final Year Project

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ABSTRACT

Motivated by the prevalent volatile economic conditions and uncertainty surrounding the global capital markets, we study the recent development of the theories of underpricing in the IPO market. We expand the previous literature by combining the asymmetric information theory with cross-country and market cycle analysis. Using recent data from the American and German IPO markets during 2000-2008, we prove that on average stocks are underpriced. We test for multi-country differences in the underpricing and find that they vary with the different institutional characteristics. Further to that, we prove the existence of hot and cold markets and show that the underpricing varies with changes in investment optimism. Finding evidence of asymmetric information, we support a relatively new theory explaining the positive relationship between offer price setting and underpricing. Finally, we find that underpricing is a seasonal phenomenon.

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1. Introduction

The process of going public is a milestone for every private company. It presents a vast amount of opportunities for a company to raise public capital, obtain lower-cost funding or attract external investors. However, what often raises questions among researchers is the phenomenon of new stock valuation. It is often perceived as a market anomaly that new issues underperform the market, because their offer price is lower than the market price, which brings substantial high returns on the first trading day for investors.

Therefore, the pervasive underpricing puzzle is considered as a signal for market inefficiency, which has interested economists for many decades. Since the early 1970s, when the phenomenon was first described, there has been a wave of research aiming to explain this widely documented discrepancy. Underpricing is shown to fluctuate from 21% in the 1960s, to 12% in 1970s, 16% in 1980s, 21% in 1990s, 40% in the 2000 and 15% in 2006.[3] The evidence of abnormal returns brought to the development of four major groups of theories- asymmetric information, control and ownership, procedural and behavioural, which have been well documented during the history of the underpricing puzzle. Nevertheless, the mixed empirical results of these theories and volatile economic conditions in the recent years have

[3] Averages based on Jay Ritter statistical data available on http://bear.warrington.ufl.edu/ritter/ipodata.htm

shifted the research on the underpricing into a new direction.[4] While the majority of previous literature investigates single theories within a country, the new wave of empirical research is aimed at multi-country analysis combining two or more theories.

The economic events in the last decade, starting from the Internet bubble in the late nineties to the credit crisis in 2007, represent a period of high volatility and uncertainty regarding new issues volume and underpricing.[5] This attracts our interest allowing us to build up on the well-developed asymmetric information theory by accounting for market cycle volatility and cross-country differences.

Motivated by the theoretical comparison between American and European markets presented by Ritter (2003), we have adopted a similar approach when investigating the level of underpricing on American and German IPO markets and build on it by empirical analysis. In contrast to the US IPO market, the German has not attracted much attention and its importance has been underestimated. During the Internet boom, the Frankfurt Stock Exchange in Germany has become the most important market in terms of market capitalization and issue activity in Europe (Ritter, 2003). After the credit crisis in the late 2007, Germany has distinguished itself by having one

[4] For more detailed analysis of these theories please refer to: Ljungqvist (2006), Ritter (1998), Ibbotson (1975), Benveniste and Spindt (1989), Rock (1989)
[5] A comprehensive analysis of market cycles is present in Ritter (1984), Gregoriou (2008), Helwege and Liang (2004)

of the largest GDP[6] in Europe and one of the strongest economies in the world. Therefore, the importance of its impact and the growing volume of its capital markets provide a motivation for us to examine more in-depth the German IPO market and provide a comparison with the well-developed US market.

We hypothesize that the level of underpricing differs significantly across both countries due to institutional differences and varying firm characteristics such as age and offering size. The hypothesis is motivated by the contrasting IPO requirements in the American and German markets. Therefore, we use a sample of 656 companies from both markets that went public during the period 2000-2008. In line with the investigation of Benerjee, Dai, Shrestha (2010), our analysis proves that the initial returns vary across countries and there are different determinants of underpricing in both markets. Further, similarly to Ritter (1980) and Gregoriou (2008) we analyse whether market fluctuations affect the level of underpricing and prove that during hot periods with high IPO activity the level of underpricing is significantly higher than during cold markets.

We also back up the asymmetric information theory[7] by proving that uncertainty regarding the company raises the level of underpricing; nevertheless, we find that a single industry sector is not a determinant of

[6] The OECD Statistical database online library
http://stats.oecd.org/Index.aspx?datasetcode=SNA_TABLE4
[7] See Rock (1986), Allen and Faulhaber (1989), Welch (1989)

abnormal returns, probably due to the increasing influence of Internet on all other sectors, which blurs the clear distinction among industries.

We also build up on the analysis of underpricing demonstrating seasonality in initial returns by showing that companies, which tend to go public in the first months of the year are on average more underpriced. Similarly, due to the influence of the Internet bubble, companies, which went public after 2000 were on average less underpriced on a yearly basis. Finally, we back up a recent new finding, which proves that, as the offer price of an issue increases, the initial returns also increase, in line with the analysis of Spindt and Fernando (2002).

This paper is structured as follows. Section 2 discusses the concept of IPO and the underpricing phenomenon. Section 3 reviews the institutional characteristics of American and German IPO markets. Section 4 provides a detailed description of market cycles. Section 5 reviews relevant literature on the IPO puzzle. In Section 6 we discuss the economic model. In Section 7 we present our sample and present preliminary analysis of the data. Section 8 uses cross-sectional regression for underpricing and illustrates the results. Finally, in Section 9 we run robustness test and in Section 10 we summarize.

2. The process of IPO and Underpricing

A firm, which decides to go public, is running an Initial Public Offering (IPO). While it is beneficial for companies to go public in order to better

access capital, diversify its investments and increase its reputation, it is often an expensive process, which increases the exposure of private information to the shareholders, thus reducing the level of control.

After the company starts trading, empirical evidence shows that investors experience abnormal returns on their investments. Thus, the underpricing of the stock has been calculated as the difference between first day closing price and the offer price of the stock, divided by the offer price:

$$\boldsymbol{Underpricing = \frac{P_{1i} - P_{0i}}{P_{i0}}}$$

Here P_{1i} is the first day closing price and P_{0i} is the offer price. This is also the notation for underpricing, which we will be using throughout this paper.

This apparent phenomenon inspires large theoretical and empirical research, which is often based on the theories, discussed in the following sections.

3. Institutional Differences among Countries

The IPO market is often considered to experience economy-wide fluctuations with varying initial returns across countries. Chowdhry and Sherman (1996), Ritter (2003), Boulton, Smart and Zutter (2009), Loughran, Ritter and Rydqvist (1994) report that institutional differences arise from contractual mechanisms, regulatory interference and issuer characteristics.

As shown in Table 1, there is a high variation in the initial returns across 47 countries. While underpricing has been documented in almost every market, we focus at factors, which cause the different levels of underpricing across countries.

Ritter, Loughran and Rydqvist (1994) provide a detailed analysis of 25 major markets in terms of regulations and contractual mechanisms.

We adopt similar approach in the following subsection to present the characteristics of the German and American IPO markets in terms of procedural differences and firm characteristics.

Table 1 Initial returns for 47 countries

Table 1
Equally weighted average initial returns for 48 countries

Country	Source	Sample Size	Time Period	Avg. Initial Return
Argentina	Eijgenhuijsen & van der Valk	20	1991-1994	4.4%
Australia	Lee, Taylor & Walter; Woo; Pham; Ritter	1,103	1976-2006	19.8%
Austria	Aussenegg	96	1971-2006	6.5%
Belgium	Rogiers, Manigart & Ooghe; Manigart DuMortier; Ritter	114	1984-2006	13.5%
Brazil	Aggarwal, Leal & Hernandez; Saito; Ushisima	253	1979-2009	35.8%
Bulgaria	Nikolov	9	2004-2007	36.5%
Canada	Jog & Riding; Jog & Srivastava; Kryzanowski, Lazrak & Rakita; Ritter	635	1971-2006	7.1%
Chile	Aggarwal, Leal & Hernandez; Celis & Maturana; Ritter	65	1982-2006	8.4%
China	Chen, Choi, & Jiang; Jia & Zhang	1,762	1990-2009	156.1%
Cyprus	Gounopoulos, Nounis, and Stylianides	51	1999-2002	23.7%
Denmark	Jakobsen & Sorensen; Ritter	145	1984-2006	8.1%
Egypt	Omran	53	1990-2000	8.4%
Finland	Keloharju	162	1971-2006	17.2%
France	Husson & Jacquillat; Leleux & Muzyka; Paliard & Belletante; Derrien & Womack; Chahine; Ritter; Vismara	686	1983-2009	10.6%
Germany	Ljungqvist; Rocholl: Ritter; Vismara	704	1978-2009	25.2%
Greece	Nounis, Kazantzis & Thomas; Thomadakis, Gounopoulos & Nounis	373	1976-2009	50.8%
Hong Kong	McGuinness; Zhao & Wu; Ljungqvist & Yu; Fung, Gul, and Radhakrishnan; Ritter	1,008	1980-2006	15.9%
India	Marisetty and Subrahmanyam	2,811	1990-2007	92.7%
Indonesia	Hanafi; Danny; Suherman	339	1989-2008	21.5%
Iran	Bagherzadeh	279	1991-2004	22.4%
Ireland	Ritter	31	1999-2006	23.7%
Israel	Kandel, Sarig & Wohl; Amihud & Hauser; Ritter	348	1990-2006	13.8%
Italy	Arosio, Giudici & Paleari; Cassia, Paleari & Redondi; Vismara	273	1985-2009	16.4%
Japan	Fukuda; Dawson & Hiraki; Hebner & Hiraki; Pettway & Kaneko; Hamao, Packer, & Ritter; Kaneko & Pettway	3,078	1970-2009	40.5%
Jordan	Marmar	53	1999-2008	149.0%
Korea	Dhatt, Kim & Lim; Ihm; Choi & Heo; Mosharian & Ng; Cho; Joh	1,521	1980-2009	63.5%
Malaysia	Isa; Isa & Yong; Yong	350	1980-2006	69.6%

Country	Source	Sample Size	Time Period	Avg. Initial Return
Netherlands	Wessels; Eijgenhuijsen & Buijs; Jenkinson, Ljungqvist, & Wilhelm; Ritter	181	1982-2006	10.2%
New Zealand	Vos & Cheung; Camp & Munro; Ritter	214	1979-2006	20.3%
Nigeria	Ikoku; Achua	114	1989-2006	12.7%
Norway	Emilsen, Pedersen & Saettem; Liden; Ritter	153	1984-2006	9.6%
Philippines	Sullivan & Unite; Ritter	123	1987-2006	21.2%
Poland	Jelic & Briston; Ritter	224	1991-2006	22.9%
Portugal	Almeida & Duque; Ritter	28	1992-2006	11.6%
Russia	Ritter	40	1999-2006	4.2%
Singapore	Lee, Taylor & Walter; Dawson; Ritter	519	1973-2008	27.4%
South Africa	Page & Reyneke; Ali, Subrahmanyam & Gleason; Ritter	285	1980-2007	18.0%
Spain	Ansotegui & Fabregat; Alvarez Otera	128	1986-2006	10.9%
Sri Lanka	Samarakoon	115	1987-2007	48.9%
Sweden	Rydqvist; Schuster; Simonov; Ritter	406	1980-2006	27.3%
Switzerland	Kunz,Drobetz, Kammermann & Walchli; Ritter	159	1983-2008	28.0%
Taiwan	Chen	1,312	1980-2006	37.2%
Thailand	Wethyavivorn & Koo-smith; Lonkani & Tirapat; Ekkayokkaya and Pengniti	459	1987-2007	36.6%
Turkey	Kiymaz; Durukan; Ince; Kucukkocaoglu	315	1990-2008	10.6%
United Kingdom	Dimson; Levis	4,198	1959-2008	16.3%
United States	Ibbotson, Sindelar & Ritter; Ritter	12,028	1960-2008	16.9%

Source: Ritter, Loughran and Rydqvist (2010)

3.1. Comparison between the American and German markets

The great amount of research papers investigating the US IPO performance has shifted the attention away from one of the major world and European markets- the German one. Ritter (2003) reports that during the boom in 2000, the European IPO market exceeded the US market, with the German market, being one of the most important in terms of issue volume and market capitalization. However, the US market is considered as one of the largest capital markets worldwide.

Gregoriou (2008) contributes to the detailed description of the German and the US IPO market characteristics. The IPO market in Germany has been

dominated by the Frankfurt Stock Exchange (Frankfurter Wertpapierbörse). The NASDAQ market, on the other hand, is the largest electronic trading market in the US and the second largest in the world in terms of market capitalisation.

Nevertheless, the consequences of the boom in 2000 imposed restructuring of both markets. The Deutsche Börse established General and Prime Standard markets, while the volatile NASDAQ market experienced serious fluctuations in terms of trading volume after the Internet bubble.

The pricing mechanism in the US is mainly bookbuilding[8], which has also almost substituted the fixed-price mechanism in Germany. The price range of the American IPOs is usually set approximately $2 and can fluctuate between 20% from the maximum and minimum value in the range. In Germany (usually more than 2 Euros) varies from 10% to 20% to the midpoint. Ritter (2003) shows that both markets also differ in terms of the timing of price setting. In Germany it is typically set between 8 and 10 days before the first trading day, while in the US it is set a day before and it is open to amendments (Table 3). Furthermore, overallotment[9] option is usually allowed in the US and varies between 10% and 15%, while it does not exist in Germany.

[8] During the bookbuilding procedure the underwriter records interest of investors, who are bidding for a price within a price range.
[9] Overallotment (Greenshoe option) is the right of the issuer to sell more shares that originally available if there is excess demand for the offerings.

In terms of firm characteristics, as described by Loughran, Ritter and Rydqvist (1994) the majority of the companies listed on the German IPO market are mature, with a median age of 55.

Table 2 Average elapsed time on a country basis.

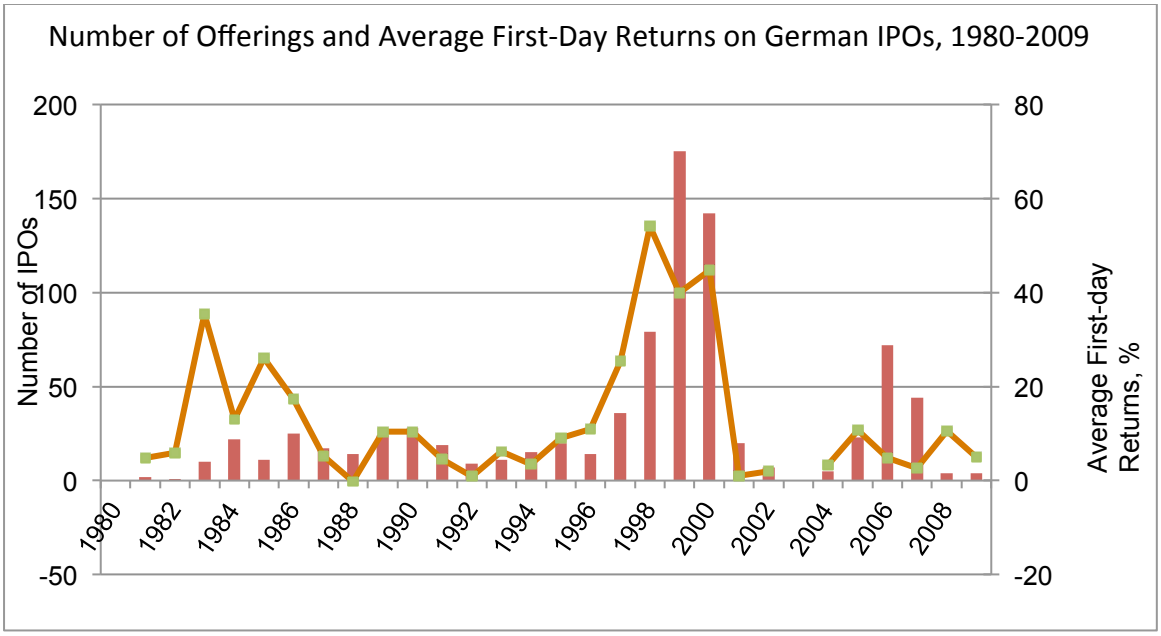
Elapsed time [a]	Discretionary allocation		Non-discretionary allocation	
	Underpricing	Country	Underpricing	Country
0 days	16%	Chile		
1 day	12%	US (firm commitment)	4%	France
			4%	Netherlands (tender)
			29%	Portugal (auctions)
			2%	UK (offer by tender)
2 days	8%	Belgium	11%	Belgium (tender)
5 days	15%	UK (placing)		
10 days	9%	Canada		
2 weeks	11%	Germany	11%	UK (offer for sale)
	15%	Japan (post-April 1, 1989)		
	42%	Japan (pre-April 1, 1989)		
1 month	12%	Australia	18%	Hong Kong
	78%	Brazil	27%	Singapore
	60%	Korea (post-June 1988)	45%	Taiwan
	36%	Switzerland		
2 months	36%	Sweden	135%	Portugal
	42%	US (best efforts)	58%	Thailand
3 months	55%	Finland	12%	Finland
	28%	Italy		

[a] 'Elapsed time' refers to the typical time period from the setting of the offer price to the issue date.
Source: Loughran et al. (1994, Table 2).

Table 2. Source Loughran et al (1994, Table 2)

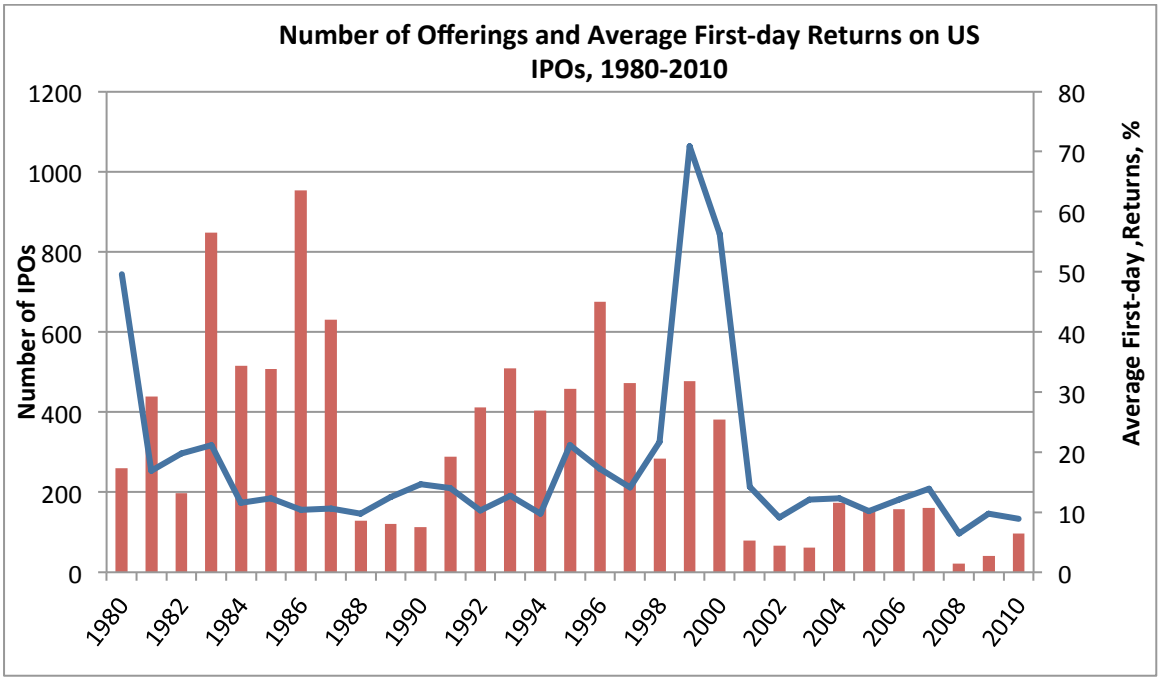
Graphs 1 & 2 show how the volume of the IPO markets changes throughout the years. In Germany, the period in the late 1990s associated as Internet boom is met with a very large increase in the number of offerings, while it has decreased in the post-boom periods. Further, the level of underpricing shows positive correlation with the IPO activity. Even though characterised by higher volume and underpricing, similar pattern is observed during 2000-2008 by the US IPO market as shown by Graph 2.

Graph 1. Number of offerings and level of underpricing on the German IPO market



Source: http://bear.warrington.ufl.edu/ritter/ipodata.html

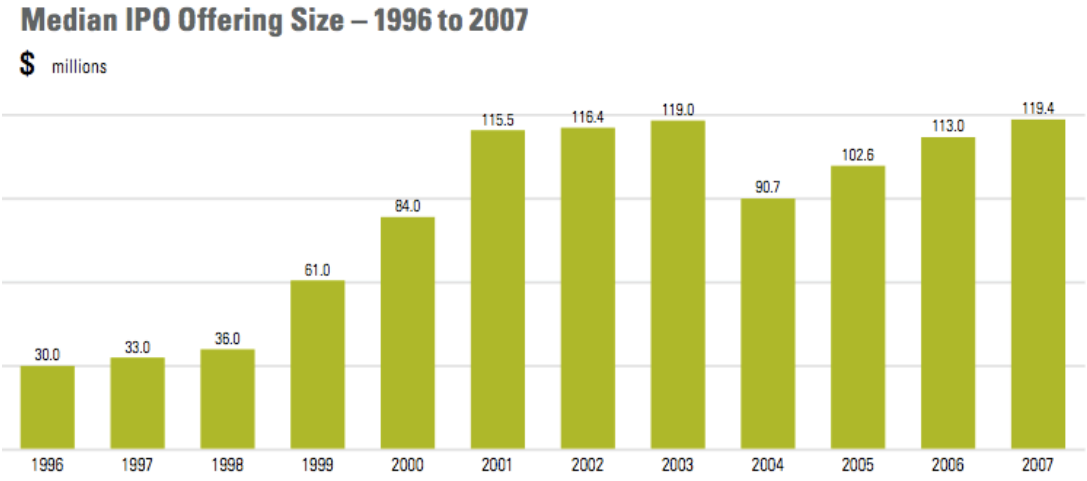
Graph 2 Number of companies and level of underpricing on the US IPO market



Source: Official website of Ritter http://bear.warrington.ufl.edu/ritter/ipodata.htm

In terms of firm characteristics, the US market in the beginning of the new century has been characterised by relative young companies. Another characteristic is the offer size of the IPOs, which is shown on Graph 3. The average deal has been increasing since the boom period in the end of nineties from 60 to 119 million $ on average.

Graph 3 Average offer size in the US 1996-2007



Source: SEC fillings

These apparent differences in both markets imply that the level of underpricing is likely to be affected by the varying characteristics the markets.

4. Hot and Cold Markets Fluctuations

Apart from market features, widely discussed determinants of underpricing are the market cycles. Hot and Cold IPO markets are used as definitions of markets, which experience high volume and initial returns swings. Hot

markets have been characterized as bull markets in which there is untypical high volume of offerings, greater amount of underpricing and oversubscription[10]. Cold markets, on the other hand, have been associated with bear markets, where the issuing volume is much less and the amount of underpricing and oversubscription is smaller (Helwege and Liang, 2004). Ibbotson and Jaffe (1975) documented that the underpricing behaviour is cyclical, with monthly differences in the level of underpricing. Ritter (1984) reported unusual high volume of offerings and higher abnormal returns in the U.S. in the 1980.

According to Gregoriou (2008), there are two reasons for the cyclical features of IPO markets. On one hand, there are periods in which larger firms undertake sizable projects for execution, thus require greater amount of funding. On the other hand, when there is an increase in the absolute value of wealth of investors they are over-optimistic in their investments. (Loughran and Ritter, 1995)

Cornelli, Goldreich and Ljungqvist (2006) explore the investor sentiment as a cause for IPO fluctuations. They present the hot markets as a "window of opportunity" for smaller and riskier firms, due to the over-optimistic investor behaviour.

[10] Oversubscription is when the demand for the offerings exceeds the number of shares offered

More recent theories explain hot markets as an event of clustering of companies from specific industries, which are associated with recent technological innovation. Therefore, during a hot period, if the first company the goes public is successful, there is a wave of IPOs from the same industry (Benveniste, Busaba and Wilhelm, 2002).

Graph 1 and 2 show the number of IPOs in the time period of 1980-2010 in the US and Germany. The volume of IPOs tend to exhibit the same cycles and to be highly correlated during the period 2000-2008. In 2000 there is above average volume of offerings due to the Internet-boom. During 2001-2003 there is a sharp decrease in the amount of IPOs following from the consequences of the bubble-burst in both the US and Germany, which is usually associated with a cold market. This is also backed up by the higher decrease in the initial returns from almost 65% in 2000 to 14% in 2001 in the US and from nearly 50% (2000) to 5% (2001) in Germany (Gregoriou, 2008).

On the contrary, 2004 has shown different IPO behaviour across Europe and the US. As it can be seen on Graph 1 and 2, 2004 is a year of rapid development in initial public offerings in the US market, while the German market shows low level of IPO activity. As reviewed in the IPO Watch Report by PriceWaterhouseCoopers, in 2004 the Deutsche Börse experienced 5 IPOs, which raised 1.8bn Euro. These results significantly differ from the IPO boom in the US during 2004, where an expansion of the IPO activity

amounting to a threefold increase in the offerings from 2003 occurred. The IPO climate in 2005 did not manage to preserve the momentum of 2004 and showed an 8% decrease due to mixed economic factors. (Hale and Dorr LLP[11]). In Germany the Deutsche Börse was the third most active exchange by volume of IPOs during 2005 and this trend continued in 2006. Ernst & Young reported a global IPO market increase during 2006-2007. PwC[12] IPO Report 2007 outlined 279 IPOs, which went public in the US. The Credit crisis in the last quarter of 2007 had a tremendous impact on the IPO activity in 2008, in both the US and Germany. Nevertheless, in terms of new money raised, the US IPO market outperformed the European during 2008 for the first time since 2005.

5. Literature Review

Several theoretical models have been built and often challenged with data. These theories can be broadly classified into 4 groups - asymmetric information, control and ownerships, procedural and behavioural. This section builds on our analysis by reviewing previous literature on the first three theories, excluding the behavioural concept, as a relatively new and not supported by data theory.

[11] Hale and Dorr LLP IPO Report 2005
[12] PriceWaterhouseCoopers IPO Watch in Europe 2004,2005,2006,2007,2008

5.1. Asymmetric Information Theory

The best-established and supported theory is the Asymmetric information theory, in which the market participants are considered to have varying information about the issuing process, which consequently creates an adverse selection problem. Ibbotson (1975) is one of the first researchers to present evidence for underpricing using a sample of IPO offerings. He hypothesises that the new issues are on average underpriced in order to "leave a good taste in investors' mouth".

5.1.1. Firm's Quality

Benveniste and Spindt (1989) study two market frictions determining the underpricing. On one hand, the issuing firm is likely to present itself as having higher quality than in reality in order to attract more investors to the deal. Allen and Faulhaber (1989), Grinblatt and Hwang (1989) and Welch (1989) present models, in which high-quality firms distinguish themselves from low-quality ones by underpricing their issues. Thus they find it beneficial to signal their advantage of being able to carry the costs resulting from it. On the other hand, low quality firms mislead investors by trying to appear as high quality firms. Michaely and Shaw (1994) test this preposition, but do not find empirical results to support it.

5.1.2. Informed and uninformed investors

Investor sentiment plays a significant role on the level of underpricing. Rock (1986) presents a model explaining asymmetric information between different types of investors. The informed investors obtain costly information for the true value of the company, while uninformed investors invest unselectively in order to break even. Therefore, Rock (1986) considers that underpricing compensates the informed investors for their incurred costs, while punishing free riding. This is referred to as "the winner's curse" theorem. It implies that while informed investors can properly evaluate when a stock is mispriced and bid for it while crowding out uninformed demand, uninformed investors receive full allocation only to unattractive offerings. However, the presence of the uninformed investors is necessary for the success of the offering, since the demand of the informed investors is not sufficient for the full allocation of issues. In order to attract the free riders in the market, he assumes that the issues should be underpriced as a compensation for their probability of misallocation. The process of prioritising informed investors over uninformed ones by the underwriter is called rationing. Rock (1986) studies the degree of rationing on the offer date, however evidence is not supported due to the underwriters' sensitivity to fair allocation. He identifies the benefit of underpricing, because full allocation leads to achieving the capital targets of the firm, even though the associated costs decrease the value of the deal.

5.1.3. Underwriter reputation and uncertainty of investors

Ritter and Beatty (1985) further develop the asymmetric information theory by examining two determinants - the uncertainty of investors, which increases the expected underpricing and the reputation of the underwriter. In reality, not all public offerings are successful - some have a rapid increase in first day price, while others a decrease. This creates uncertainty among investors, which are faced with the choice of whether to enter the market and the amount of shares they want to bid for in advance and among underwriters, who have to determine the price of the offering. The authors use an empirical model, for IPOs during 1960-1982, supporting the hypothesis that greater ex ante uncertainty of the issue value is associated with greater expected underpricing. As the issue valuation is uncertain, informed investors benefit from their information acquisition. Moreover, they examine the proposition that underpricing benefits underwriters, by ensuring that they will preserve their reputation. Ritter and Beatty (1985) assume that experienced underwriters can use economies of scale to determine the offer price. However, if the issue is mispriced, this represents a potential risk of loss of market share for the underwriter, which reduces the return it earns on its reputation and determines the failure of the issuing. Therefore, if the issue is underpriced too much, i.e. there is a lot of money "left on the table", the issuing company sustains losses, while if not underpriced enough, investors will not be interested in participating, as their returns will not be sufficient. Ritter and Beatty (1985) establish a negative relationship between underpricing and reputation of the

underwriter, which has also been supported by more recent studies as Booth and Chua (1996).

Ritter (1984,2003) examines the relationship between the riskiness of the assets and the degree of underpricing. If a firm going public is considered riskier, the degree of underpricing is higher in order to compensate investors for the costs they are likely to occur.

Therefore, many issuing companies consider hiring a prestigious underwriter as a way of reducing underpricing. Carter and Manaster (1990) and Carter (1998) consider the relationship between the reputation of the underwriter and underpricing. According to them, underpricing, although considered beneficial, is a costly procedure. Thus, less risky companies distinguish themselves by hiring a prestigious underwriter as a signal of reduced risk for investors. The results of the model prove that greater underwriters' reputation is associated with lower risk issues. They also account for the deal size of the IPO as a determinant of underpricing. Usually, mature companies with available public financial information and better performance offer larger IPOs.

Loughran and Ritter (2002), on the other hand, point out a positive relationship between the reputation and the level of underpricing. They argue that high reputation investors are likely to underprice more due to the increasing financial analyst coverage of IPOs.

5.1.4. Book building process

Another determinant of the valuation process is the book building lead by underwriters. It is also classified as asymmetric information, as

underwriters use their information advantage to identify important price information and allocate the shares. Cornelli and Goldreich (2001) relate this process empirically with underpricing. They examine a sample of 39 international equity issues in order to determine how the underwriters receive information about the demand of the investors, before setting a price. In the same way as Benveniste and Spindt (1989), they argue that underpricing is a compensation for investors who reveal information and therefore, receive higher allocation. Moreover, having allocation discretion, the underwriter can allocate shares to regular investors, who act as insurance against low demand allocations. Furthermore, Cornelli and Goldreich (2001) prove that underwriters prefer limit price bids, which reveal the maximum price investor is willing to pay, as this enables underwriters to determine how demand changes with price range. Additionally, underwriters award with a better allocation local and informed regular investors, compared to international and uninformed. The reason for that is that the former reveal information, useful for the underwriter to determine the offer price. Furthermore, large bids are favourable for underwriters as they reduce the liquidity problem.

5.1.5. Offer price

The setting of the offer price might also carry an explanation of the underpricing phenomenon. Daily et al (2003) argue that a higher offer price set by the underwriter implies less uncertainty regarding the post-IPO development of the company. Furthermore, a theory regarding the investors

at which the IPO is aimed is developed by Benveniste and Spindt (1989). They assume that a higher set price will attract more institutional investors as a compensation for their support with information during the marketing of the IPO.

5.1.6. Age of firm

The age of the firm has been assumed to have a negative effect on underpricing. This is so because newly established firms lack historical financial data and carry more uncertainty to investors, while the availability of information regarded with mature firms reduces the principle-agent problem as assumed by Ritter (1984).

5.2. Control and Ownership theory

Another theory explaining the underpricing phenomenon is the Control and Ownership theory, which implies the conflicting interests of the three parties of the underwriting process.

5.2.1. Ownership dispersion

Brennan and Franks (1997) explain the underpricing as a way to ensure the necessary investors demand is met and to strategically allocate the shares in order to verify ownership dispersion and decrease monitoring by outsiders. They build a model predicting that directors would like to retain control over the company by reducing the possibility of acquisition of large bidders. The issue of discriminating large against small investors might cause the large investors to withdraw their bids, causing the ineffectiveness of the issuing.

In contrast, Benveniste and Spindt (1989) show that underwriters aim to allocate the shares among large and informed investors to reduce liquidity and winner's curse problem. Therefore, the directors of the issuing firms trade off the cost of underpricing and the benefits of reduced monitoring. There is a negative relationship between the degree of underpricing and the amount of large shareholders. The results determine the willingness of issuing firm to discriminate against large investors, and via underpricing, to ensure dispersed ownership.

Furthermore, Booth and Chua (1996) indicate underpricing as a way of achieving dispersed ownership to ensure liquidity of the secondary market for issues. They empirically prove that the liquidity increases underpricing to compensate investors for increased information costs, and decreases the expected rate of return for investors.

5.3. Procedural explanations

The third theory is the Procedural theory. It is consistent with the assumptions that many companies are subject to legal liability and lawsuits by shareholders in the post-IPO markets. Ibbotson (1975) and Ritter (1998) consider as a determinant of underpricing the likelihood that shareholders, who are not satisfied with the after-IPO performance or allocation, will sue the company. Ritter and Beatty (1985) mention underpricing as a way of reducing tax liability since SEC requires detailed numerical explanation of proceeds' uses. Furthermore, Rydqvist (1997) shows the relationship between tax liability and underpricing, using sample of Swedish IPOs. As

the government established a law taxing the proceeds of the underpricing, it significantly decreased from 41% in 1980-1989 to 8% in 1990-1994.

5.3.1. Contract type

Another factor of underpricing is related to the procedure of contract choice between the underwriter and the issuing firm. Firm commitment contract is the most secure, but expensive contract, as the underwriter undertakes the risk to sell all the issued shares at the offer price. Therefore, according to Benveniste and Spindt (1989) the underwriter has the incentive to sell the stock in the pre-IPO market in order to secure the full allocation of issues, which due to higher uncertainty increases underpricing. The other type of contract is best-effort contract, in which the underwriter tries to sell as many issues as it can, but it is not obliged to buy any unsold shares at the end of the offering. The choice of the contract is determined by risk-aversion of the issuing firm, financial needs, riskiness and uncertainty of the issuing. Risky and risk-averse companies are likely to choose firm commitment contracts, where underpricing is greater, but the issuing is more secure, while those underpriced a lot prefer best-efforts contract. However, there is contradictory empirical evidence for the latter.

6. Economic model

In order to build a model of underpricing and analyse how these theories are applied with date, we first need to outline the economic concept of initial returns.

The short-run performance of newly issued companies is estimated using various asset-pricing models. The most famous among them include CAPM, Fama-French three-factor model and APT. To measure the abnormal return of new issues, the traditional CAPM model, even though overly simplistic, provides a good approximation of the relationship between the risk and return in capital markets. The CAPM idea is represented by the following equation:

$$\boldsymbol{E(R_i) = R_f + [E(R_m) - R_f]\beta_i}$$

where $\boldsymbol{\beta_i}$ is the market beta, which is $\boldsymbol{\beta i = \frac{COVim}{VARm}}$, R_f is the risk-free rate of return, $E(R_m)$-R_f is the market risk premium and $E(R_i)$ is the expected return on a given stock. The CAPM highlights that the expected return is a linear function of the risk-free rate and the risk premium depending on the normalized covariance between the return on the asset and total return on the market portfolio. The yield of the Treasury bill is used as a proxy for the risk-free rate and the market is usually measured by a stock price index. In our paper will be using the NASDAQ Composite index and DAX index for the period between 2000-2008.

Some of the predictions of the CAPM often appear incompatible with real-life phenomena. Due to the assets' risk-return relationship, they are expected to lie on the Security Market Line (SML). The prediction of the SML is useful when determining whether the stock is correctly priced, which

has a good application in the analysis of IPO valuation. In our analysis we expect the majority of the companies to be underpriced, thus to appear above the SML, because the expected return of the stock is higher than the predicted by CAPM. Nevertheless, an empirical analysis of CAPM shows evidence that the model is not a true representation of the real world. Fama and French (2004) analyse the difference between the early and later tests. Besides, some of the tests determined that other types of risks affect return and beta is not stable, therefore it creates bias when measuring risk. The necessity to use a market proxy for the market portfolio also produces varying results depending on whether it is an equally–weighted or a value-weighted portfolio.

For these reasons, some researchers employ the market adjusted return model, which implies that the systematic risk of the IPOs is 1 for all assets. Results of this model, as reported by Brown and Warner (1980), are shown to be more consistent with the true model. Nevertheless, Ibbotson (1975) shows that the average beta of stocks is usually higher than the market systematic risk, which results in upward bias. It has also been reported by Brown (1999) that the large difference in the size of IPOs, would cause imprecise estimation of the size of any market index if the deal size is a determinant of the level of underpricing.

We have estimated the average daily market return during 2000-2008 of the NASDAQ composite index and DAX. They show an average return of 0,006%

and 0,003% respectively, while the average initial return of selected companies during the same period was 19,67%. Therefore, adjusting for the market return will have a minor effect on our results.

As a result, due to the deviations of the CAPM and issues with market-adjusted return, this paper will analyse the abnormal return based on initial raw data returns as described in Section 2[13]:

$$\boldsymbol{Underpricing} = \frac{\boldsymbol{P_{close}} - \boldsymbol{P_{offer}}}{\boldsymbol{P_{offer}}}$$

7. Empirical Model

The following sections describe the approach we have adopted when building up a model of underpricing. We will describe the sample and data selection, variables and summary of data.

7.1. Data

A sample of IPOs from January 2000 to December 2008 has been selected from the American and German IPO Markets. The majority of the published papers have access to corporate data. The access to such information is often limited; therefore this paper uses data collected mainly from public sources. The data has been obtained from the NASDAQ stock exchange in the US and The Frankfurt Stock Exchange in Germany. The reason for the choice

[13] We use similar notation as, for example, Banerjee, Dai and Shrestha (2010), Gregoriou (2008), Beatty and Ritter (1985)

of these markets is that the American and European markets have been two of the global markets with highest IPO activity in the sample period 2000-2008. The majority of the sample data for the NASDAQ IPOs was obtained from MSN IPO Centre, which included a sample of NYSE and NASDAQ and has been filtered to account for the NASDAQ market only. It provided data regarding the companies such as issue date, industry, underwriter, offer price and closing price. Shares offered and deal size have been hand-collected from the same website or individual prospectuses if not available in the website. The information has been double checked with the official NASDAQ website (www.nasdaq.com). For Germany, the major source of information was obtained from the official website of Deutsche Börse, which operates The Frankfurt stock exchange (deutsche-boerse.com). This included date of issue, industry, deal size, offer price and placement volume. The rest of the information regarding closing price and age of companies has been hand-collected from financial websites such as Yahoo[14] and Bloomberg[15] and individual companies' websites. Individual prospectuses are available from the PI navigator database. To estimate the model, due to the difference in the currency between the US (US dollar) and Germany (Euro), the opening and closing price and the deal size have been changed to US dollars using annual PPP exchange rate.[16] The PPP exchange rates have been obtained from the OECD statistical database. The sample of 656 companies contains 474 US companies, which are 40% of all the companies listed in US in the

[14] www.yahoo.com
[15] www.bloomberg.com
[16] US dollar per 1 Euro varied between 0,8948 and 1,4648 during the sample period

time period 2000-2008 and 182 German companies, representing 56% of the German IPOs during the same period. Issues that have missing data regarding the level of underpricing or delisted companies have been excluded from the model. Closed-end funds, REITs and Investment and Unit trusts have also been excluded from the sample.[17]

7.2. Hypotheses

To obtain the determinants of the short-run underpricing puzzle we set the following hypotheses:

***H_1**: IPOs listed on the NASDAQ stock exchange and Frankfurt stock exchange are underpriced*

***H_2**: There is a difference in the level of underpricing between the US and Germany*

***H_3**: There is a negative relationship between age of company and level of underpricing[18]*

***H_4**: The level of underpricing differs with deal size*[18]

***H_5**: The level of underpricing varies among different industries[19]*

***H_6**: The level of underpricing varies with different market cycles[20]*

***H_7**: There is a relationship between the underwriter reputation and the level of underpricing[21]*

[17] Investment trusts are closed-end funds, while unit trusts are open-end trusts. They have been excluded due to their large deal size and low risk, which might introduce biased results in our empirical analysis.
[18] Gregoriou (2008) and Islam, Ali,Ahmad (2010) use similar hypotheses
[19] See, for example, Lowry and Schwert (2002)
[20] Ritter (1984), Liang and Helwege (2004)

***H_8**: There is a difference in the level of underpricing depending on the offer price* [22]

7.3. Regression Variables

To test the hypotheses in the previous section we use Ordinary Least Squares (OLS) regressions with a t-statistics controlled for heteroskedasticity, using White's (1980) approach. The cross-sectional data has been utilized to account for the **UNDERPRICING** as a dependent variable. The explanatory variables, which have been employed, are: **YEAR** and **MONTH** to account for underpricing, varying with the year and month of issue. **Ln_AGE** is the natural logarithm of the difference in years between the date of incorporation and the date of issue. **TYPE** are dummy variables for the type of industries, in which the companies operate. There are 5 dummy variables for the 5 categories. **TYPE_IT** includes companies whose activity is related to IT, Internet, Chips, Software and Network systems. **TYPE_MANU** is a dummy taking 1 if the company's activity is manufacturing (Pharmacy & Healthcare, Automobile, Equipment, Industrial and etc.). **TYPE_SERV** takes a value of 1 if company is in the field of services- Retail, Media, Transportation & Logistics, Hospitals and Schools. **TYPE_FIN** is a dummy variable, which takes a value of 1 if a company provides financial services such as bank, hedge funds, mutual funds, consulting. **TYPE_MISC** takes a value of 1 if it is a company, whose activity has not been accounted for in the previous dummy variables- e.g.

[21] Carter and Manaster (1990)
[22] Fernando and Spindt (2002)

Construction, Basic Resources, Storage and etc. **TYPE_MISC** has been used as a control group in order to avoid multicollinearity among explanatory variables. The **REPUT**[23] variable is a binary variable, used as a proxy for the underwriter reputation. To correctly estimate the reputation of the Investment Bank, we use the Carter and Manaster (1980) approach and the reputation rankings. They assign a ranking between 0-9 as 9 is used for the highest reputable underwriters. To obtain the ranking Carter and Manaster (1980) have estimated, whether a company appears in a high position in the underwriter syndicate section and have underwritten greater amount of shares compared to other members of the syndicate. For the German underwriters, which have not been included in the ranking, a ranking has been created using the same method depending on the number of issues during the sample period. The **US** variable is a dummy variable taking 1 if the company has been listed on the NASDAQ stock exchange and 0 if on the Frankfurt Stock Exchange. **HOT** is also a dummy variable denoting a hot period of 1 and 0 otherwise. The hot periods have been indicated during the years 2000 and 2004-2007 for US and 2000, 2005-2007 for Germany. The **DEAL_SIZE** is given by the number of shares issued multiplied by the offer price.[24] The deal size of the German companies has been turned into US dollars using annual PPP exchange rate. We take the natural logarithm of the offer price **ln_OP** due to the assumption of non-linear relationship with underpricing.

[23] We assigned 1 for companies ranked 7 or higher and 0 otherwise
[24] In million US dollars

Table 3 List of explanatory variables

Variables	Symbol	Explanation	Expected Sign
Underpricing	**UNDERPRICING**	The % change between the first day closing price and the offer price	**Dependent Variable**
Year of issue	**YEAR**	The year, in which the offering has been executed. Takes value from 2000-2008	-
Month of Issue	**MONTH**	The month, in which the offering has been executed. Take value from 1-12 respectively of the months	-
Firm age	**Ln_AGE**	Age of company calculated as the natural logarithm of the difference between the date of issue and the date of incorporation	-
IT & Internet industry	**TYPE_IT**	Type of industry: Dummy variable taking 1 if Internet and IT company and 0 otherwise	+
Manufactu-ring industry	**TYPE_MANU**	Type of industry: Dummy variable taking 1 if Manufacturing company and 0 otherwise	+
Services industry	**TYPE_SERV**	Type of industry: Dummy variable taking 1 if Services company and 0 otherwise	+/-
Financial services industry	**TYPE_FIN**	Type of industry: Dummy variable taking 1 if Financial services company and 0 otherwise	+/-
Miscellaneous industries	**TYPE_MISC**	Type of industry: Dummy variable taking 1 if Construction, y and 0 otherwise	+/-
Underwriter reputation	**REPRUT**	Dummy Variable for the reputation of the underwriter, taking 1 if High reputation and 0 otherwise	-
Country	**US**	Dummy Variable for the country, taking 1 if the US and 0 if Germany	+
Market cycle	**HOT**	Dummy Variable for the market cycle, taking 1 if hot period and 0 otherwise	+
Offer size	**DEAL_SIZE**	The dollar value of the number of share multiplied by the offer price	-
Offer price	**Ln_OP**	The natural logarithm of the offer price	-

7.4. Data Analysis

The estimated model is:

$$UNDERPRICING=\alpha_0 + \alpha_1 YEAR + \alpha_2 MONTH + \alpha_3 Ln\_AGE + \alpha_4 TYPE\_IT + \alpha_5 TYPE\_MANU + \alpha_6 TYPE\_SERV + \alpha_7 TYPE\_FIN + \alpha_8 REPUT + \alpha_9 HOT + \alpha_{10} US + \alpha_{11} DEAL\_SIZE + \alpha_{12} LN\_OP + \varepsilon_{it}$$

where $E(\varepsilon_{it})=0$; $Cov(X_{it}, \varepsilon_{it})=0$, $i=1,\ldots,k$, $t=1,\ldots,T$;.

Table 4 shows that in the combined model of the US and Germany, the majority (67%) of the companies as expected are underpriced. The average underpricing is 34% with a standard deviation of 56,7%. A maximum value of 471% underpricing has been observed during the Internet-bubble period of 2000. A minimum value of 0,077% has occurred in the post-bubble period of 2001.

The 186 companies that were overpriced represent 28% of the companies in our sample. On average they have been overpriced by 12%, with a maximum value of 0,024% and minimum of 80%. Its variability is approximately 15%. Finally, 28 companies do not show variation between the offer price and the first closing price. The level of underpricing is highly significant at 1% level. (t-statistics=9,7184)

Table 4 Underpriced, overpriced and correctly priced stocks 'characteristics

	Number of Companies	Mean	Maximum	Minimum	Standard Deviation
Overpriced	186	-12,022	-0,024	-80	15,100
Underpriced	443	34,224	471,429	0,077	56,711
Correctly	28	0	0	0	0

We allocate the companies into 5 industries to examine how the number of companies changes depending on the time period and industry. Table 5 presents the number of companies that went public each year from 2000-2008 within the 5 industry types. During this period the majority of the companies that went public have been from the Manufacturing industry- 282 companies of which more than 68 were during 2000. The second most active industry sector during 2000 has been the Internet & IT, where approximately 57 companies that went public. The third largest sector was Services with 38 during 2000 and 151 during the sample period. The lowest number of companies has been from the Financial sector and Miscellaneous.

Table 5. Number of companies issued on an industry basis

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Internet &IT	57	8	5	1	15	11	18	28	1
Manufacturing	68	19	3	5	34	25	48	45	5
Services	38	10	10	7	15	20	15	16	4
Financial services	8	5	4	5	9	10	14	7	0
Miscellaneous	8	2	4	4	7	15	17	12	2

Each of the industries is characterized with different initial returns based on factors such as new or mature, inventory, riskiness and availability of financial information. Table 6 shows that the IT sector is associated with the highest underpricing- 29% due to the relatively young technological companies listed during the Internet boom.

Table 6 Underpricing on an industry basis

INDUSTRY	Mean Underpricing %
IT	29,21
Manufacturing	18,35
Services	20,06
Fin Services	1,23
Miscellaneous	18,45

IT companies are also associated with higher risk due to inventory clustering and restricted amount of available financial data due to their short history. The other three sectors that are severely underpriced are Services, Manufacturing and Miscellaneous. Financial services industry is the industry experiencing the lowest initial returns of 1% on average.

An important characteristic of the companies in our sample and crucial distinction between the American and German companies is the age. Table 7 shows the age features of the companies in our sample, which ran an IPO from 2000-2008. For the combined model, we observe that the average age of companies decreases during the hot periods.

An apparent difference arises between the US and Germany. On average, the companies that went public on the Frankfurt stock exchange during 2000-2008 appear to be older than the companies on NASDAQ.

Table 7. Age characteristics of the companies

YEAR	MEAN AGE COMBINED	MEAN AGE US	MEAN AGE GERMANY
2000	11,3	9,4	13,5
2001	21,0	14,4	27,3
2002	24,2	22,4	33,5
2003	22,2	15,5	0,0
2004	15,9	46,2	50,8
2005	20,0	46,2	31,8
2006	20,1	16,2	29,7
2007	14,5	9,3	34,8
2008	13,6	11,8	22,5

Only during 2005, the companies in the US have been recorded to be functioning for approximately 46 years compared to the ones in Germany for 32 years. In the combined model the oldest companies have been recorded during the cold period of 2002-2003, while approximately 10 years younger have gone public during the hot periods in 2000 and 2004-2007. This is compatible with the results found by Loughran, Ritter and Rydqvist (1994).

Table 8 combines our analysis to show the level of underpricing accounting for market and time differences. The greatest amount of underpricing occurred during the internet-boom with the record value of 57,6%(Standard

deviation 82,1%) for the US and 31,2% for Germany (Standard deviation 81,2%). During 2000 have also been recorded the highest maximum level of underpricing during the sample period. In Germany the maximum amount is 471,4% and similarly in the US - 370,8%. This supports the hypothesis that hot periods have been a "window of opportunity" for riskier companies due to the highly optimistic behaviour of investors. (Cornelli, Goldreich and Ljungqvist, 2006).

In the year after the bubble burst there was a sharp decrease in underpricing to 16,2% in the US and resulted in 7,2% overpricing in Germany. The trend in both countries shows a decrease in the level of underpricing in the following years. In the US, the highest underpricing occurred in 2003, 2005 and 2007. These years have also been associated with a higher volume of IPO activity. The maximum level of underpricing has been recorded during 2004 (88,6%), 2006 (353,9%) and 2008 (110,5%).

In Germany, the underpricing in the years following 2000 shows a very sharp decrease and even some years associated with overpricing. 2001 and 2004 have experienced very low level of IPO activity with 18 and only 5 companies respectively. In 2001, 2004 and 2006 the IPO offerings have been on average overpriced. The maximum level of underpricing in Germany occurred in 2001 and 2007- 85,7% and 125,2% respectively.

Table 8 Underpricing characteristics on a country and yearly basis

		2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of Companies	US	97	17	20	20	75	67	80	82	9
	Germany	86	18	4	0	5	11	31	21	2
	Combined	183	35	24	20	80	78	111	103	11
Mean Underpricing	US	57,6	16,2	6,8	20,7	9,2	12,4	10,2	16,3	13,5
	Germany	31,2	31,2	31,2	31,2	31,2	31,2	31,2	31,2	31,2
	Combined	46,2	4,0	7,3	20,7	8,3	11,3	4,9	14,2	12,4
Standard Deviation	US	82,1	16,2	15,7	21,4	14,6	43,6	16,2	23,7	37,1
	Germany	81,2	31,7	18,5	0,0	7,8	15,2	26,0	28,9	10,4
	Combined	83,3	27,8	15,8	21,4	14,7	40,6	21,2	25,0	33,8
Maximum	US	370,8	46,1	66,7	88,6	59,0	353,9	63,0	97,2	110,5
	Germany	471,4	85,7	37,7	0,0	3,7	25,0	40,6	125,2	14,2
	Combined	471,4	85,7	66,7	88,6	59,0	353,9	63,0	125,2	110,5
Minimum	US	-20,0	-13,6	-9,4	-5,4	-11,0	-16,4	-29,5	-20,3	-12,0
	Germany	-74,8	-75,5	0,0	0,0	-16,7	-21,5	-80,0	-16,0	-0,5
	Combined	-74,8	-75,5	-9,4	-5,4	-16,7	-21,5	-80,0	-20,3	-12,0

Table 8 Descriptive Statistics of the OLS variables.

OLS Variables	Number of Obs.	Mean	Standard Deviation	Min	Max
YEAR	656	2003,642	2,74	2000	2008
MONTH	656	6,878	3,28	1	12
AGE	656	16,39	25,36	0	288
LN_AGE	642	2,242	1,034	0	7,58
TYPE_IT	656	0,2195	0,414	0	1
TYPE_MANU	656	0,3719	0,483	0	1
TYPE_SERV	656	0,2027	0,4023	0	1
TYPE_FIN	656	0,0945	0,2927	0	1
TYPE_MISC	656	0,1036	0,305	0	1
US	656	0,724	0,4472	0	1
HOT	656	0,847	0,3597	0	1
REPUT	656	0,721	0,4488	0	1
DEAL_SIZE	655	151,56	364,0997	1,15	5382,5
OP	656	16,86	15,26	1,93	299,77
LN_OP	656	2,66	0,5234	0,657	5,7

Min=Minimum, Max=Maximum

Table 9 presents the summary statistics of the independent variables that take part in our empirical model. The variables year and month take values between 2000-2008 and 1-12 respectively. The average age of the companies that went public during the sample period has been 16 years. The minimum age of a company has been less than a year and the maximum is 288 years. The deal size is estimated to be 151 million US dollars on average, with a minimum of 1,15 million US dollars and maximum of 5, 4 billion US dollars. The offer price has been estimated approximately 16,9 US dollars, with a minimum value of 1,9 and maximum of 300 US dollars.

The rest of the variables are binary variables, which take value of 0 and 1.

8. Results

$$UNDERPRICING=\alpha_0 + \alpha_1 YEAR + \alpha_2 MONTH + \alpha_3 Ln\_AGE + \alpha 4 TYPE\_IT + \alpha_5 TYPE\_MANU + \alpha_6 TYPE\_SERV + \alpha_7 TYPE\_FIN + \alpha_8 REPUT + \alpha_9 HOT + \alpha_{10} US + \alpha_{11} DEAL\_SIZE + \alpha_{12} LN\_OP + \varepsilon_{it}$$

where $E(\varepsilon_{it})=0$; $Cov(X_{it}, \varepsilon_{it})=0$, $i=1,\ldots,k$, $t=1,\ldots,T$;.

To test the hypotheses, the OLS multivariate regression with a t-statistics adjusted for heteroskedasticity[25] has to be consistent with the assumptions in Appendix 1. In our analysis we adopt a level-log model, which following Woodridge (2006) after several empirical trials for functional form, it produced the highest goodness-of-fit and the vast majority of significant variables.

The results from the OLS regressions are presented in Table 10. Robust standard errors are reported in parenthesis.

The results of model (1) show that seven variables have a significant impact on the level of underpricing. After testing for multicollinearity it turned out that all of the variables except the industry dummies have a relatively mild collinearity[26]. The dummy variables show VIF of extreme levels around 30. This implies serious multicollinearity between the industry dummy

[25] For a reference and more detailed explanation of the procedure please refer to White (1980)

[26] We use the method used by Marquardt (1970), which uses VIF of 10 or more as a guidance for serious multicollinearity.

variables, which might arise since many businesses operate in two or more industries.

Table 9 OLS Regression Model: IPO Underpricing

Underpricing	OLS Coefficients (1)	Robust St. Error (1)[27]	OLS Coefficients (2)	Robust St. Error (2)[9]
YEAR	-0,05401***	(0,008807)	-0,05391***	(0,00880)
MONTH	-0,0217***	(0,005699)	-0,02169***	(0,0056)
Ln_AGE	-0,0321**	(0,014175)	-0,0325**	(0,0141)
TYPE_IT	0,1338	(0,127217)	0,0347	(0,0678)
TYPE_MANU	0,05421	(0,125334)	-0,0399	(0,0571)
TYPE_SERV	0,0591	(0,127673)	-0,0447	(0,0658)
TYPE_FIN	-0,0539	(0,125975)	-0,1524**	(0,0633)
TYPE_MISC	0,1071	(0,136923)	----------	
REPUT	-0,0858*	(0,044863)	-0,0854*	(0,04475)
US	0,2574***	(0,056649)	0,2612***	(0,0548)
HOT	0,1498***	(0,042106)	0,1507***	(0,0421)
DEAL_SIZE	-0,0000469	(0,000058)	-0,0000464	(0,00006)
Ln_OP	0,2327***	(0,050238)	0,2341***	(0,0499)
Constant	107,705***	(17,6039)	107,705***	(17,5949)
Observations	641		641	
R^2	17,46%		17,43%	
Note:[28] ***p<0.01 , **p<0.05 , *p<0.1				

Therefore, we exclude the variable TYPE_MISC and re-estimate the model with the Misc. industry dummy as a control group. The new model now predicts that one more variable - the financial services industry, has a significant impact on the level of underpricing and all the variables

[27] Robust standard errors have been adjusted using White (1980) heteroscedastic-consistent covariance matrix

[28] The significance of the variables has been determined based on a two-tailed test

experience low collinearity. Therefore, for the rest of the paper we will analyse the results of model (2).

The time variables of YEAR and MONTH are highly significant at 1%. They appear to be negatively correlated with the level of underpricing, which is consistent with our expectations. This implies that as years increase the underpricing decreases. Our formal analysis backs up these results showing that after 2000 there has been a steady decrease in the level of underpricing, fluctuating only in certain years related with hot market cycles.

The interpretation of the MONTH variable is similar. It shows an interesting result, which has not been widely investigated in the related literature. The monthly variable is highly significant at 1% significance level. The negative correlation with underpricing implies that companies, which went public towards the end of the year, have been less severely underpriced than those, which went public during the first months of the year. Showing time-dependence of initial public offerings, Gregoriou (2008), finds similar results for high initial returns in the first months of the year and decreasing towards the end of the year, which signals seasonality.

The asymmetric information theory is widely considered to give explanation about the level of underpricing. The uncertainty regarding the performance of IPOs results in a higher level of underpricing (Beatty and Ritter, 1984). Therefore, greater risk is associated with greater initial return to

compensate investors. The age of the issuer is used as a proxy for the uncertainty regarding the IPO. The significance of the variable at 5% implies that investors use the indicator of the maturity of the company to decrease the asymmetric information and the uncertainty of the issue. The negative correlation is compatible with our prediction that mature companies imply more public financial data available, which allows investors to evaluate the issue. Therefore, prospectuses carry useful information influencing the decision of the investors.

Another proxy for uncertainty is the offer size of the offering. The deal size estimator has the predicted negative effect on underpricing. It is assumed that the larger offerings are usually associated with companies, which have been operating for a longer time and have better performance. Similar results have been reported also by Carter et al (1998) and Carter and Manaster (1990). These results also show evidence against the "partial adjustment phenomenon"[29] analysed by Ibbotson, Sinelar and Ritter (1988). The negative relationship implies that there is no offer size revision, which is also backed up by the insignificance of the variable on the level of underpricing.

Another way for the issuer to decrease the level of underpricing is by hiring a prestigious underwriter. Highly reputable investment banks are associated with higher quality companies and relatively lower level of underpricing

[29] After the underwriter is selected and the prospectus is prepared, higher demand, which is associated with higher underpricing, implies that the offer price and the number of shares are amended upward.

(Michaely and Shaw, 1994). In our model the underwriter reputation has a negative significant effect on underpricing at 10% significance level. The effect of the reputation has shown mixed results in the previous research. Loughran and Ritter (2002) suggest positive relationship during the bubble. In contrast, Ritter and Beatty (1985), Carter and Manaster (1990) show negative relationship between reputation and underpricing. Therefore, the reputation of the underwriter is a valuable asset of an investment bank, which can be easily lost. For this reason, the correct pricing of an issue is an advantage of reputable underwriters and is essential in order for the investment bankers to attract enough investors to ensure the success of the offering. This implies that in order to attract more investors, underpricing is a way of offering greater initial returns, thus increase the demand for the IPO. However, the underpricing option is available to most reputable underwriters, who can exhibit economies of scale.

The effect of the offer price on the underpricing is highly significant at 1%. Nevertheless, the expected sign has not been confirmed by our results. Previous literature suggests diverse theories regarding the negative relationship between the two variables. Ibbotson, Sindelar and Ritter (1994), Ibbotson (1975), report an opposite relationship between offer price and underpricing showing that low-priced IPOs are more underpriced, because they are associated with higher risk, thus higher level of underpricing. Our result of a positive relationship is a new finding and has been confirmed only in the recent literature. We show, similarly to Spindt and Fernando (2002),

that underpricing increases with higher offer price. They show that higher price is associated with higher quality firm; therefore, the offer prices are informative for investors. This result is also confirmed by Benvenieste and Spindt (1989) who show that the offer price is not a decision of the underwriter, but is mostly based on investors' preferences. Lipman (2000) supports the hypothesis that high-priced stocks carry information regarding the quality of the issue, thus they attract more institutional investors, who possess valuable information for price setting. Therefore, our results are compatible with the theory that institutional investors, who share information about their preferences of the offer price are being compensated by higher underpricing.

The industry dummies show mixed results. Only the financial services industry has a negative and significant (at 5% level) effect on underpricing. Nevertheless, we test the joint hypothesis of significance of the industry dummies and find it significant at 5% (F-test= 2,99). The positive sign of IT industry is consistent with Lowry and Schwert (2002), who report that high-technology companies are on-average more underpriced, than low-technology companies. This result can be explained by the higher risk of the technological companies, which is related with inventory clustering and a relatively young industry. The financial services sector, on the other hand, shows 15% less underpricing than Misc. The mixed results may arise due to rising technological progress in the years of our sample period, which creates a vague distinction between different industries. An increasing number of

companies use Internet services, Financial services, thus it is hard to allocate them only to a certain group. Therefore, this creates bias in our results and prevents us to analyse the industrial sector as a determinant of underpricing.

HOT variable is an important determinant for abnormal initial returns. It shows highly significant effect at 1%, showing that hot periods are associated with 15% more underpricing. This is compatible with our analysis regarding the hot and cold periods difference in underpricing and similar to the ones found by Ritter (1984). Therefore, for the hot period during 2000 we can assume that arose due to younger Internet companies going public, as Gregoriou (2008) reports. This supports the hypothesis that during boom periods, many younger and riskier companies take a "window of opportunity", thus facing higher underpricing to compensate for their uncertain performance.

Our model also finds support to hypothesis H_2.The high significance of the country variable is also backed up by the positive expected relationship. The relatively younger companies, which went public in the US market during the sample period, tend to be more underpriced, than the more mature companies in Germany by 26%. These results have been backed up theoretically by Ritter (2003), nevertheless, previous empirical analysis, which provides comparison of the underpricing in both countries is not common. Therefore, we run separate models to account for the causes of

institutional distinction in the two markets. The results are shown on Table 11:

Model (3)

$$\text{Underpricing US} = \varphi_0 + \varphi_1 \text{YEAR} + \varphi_2 \text{MONTH} + \varphi_3 \text{Ln\_AGE} + \varphi_4 \text{TYPE\_IT} + \varphi_5 \text{TYPE\_MANU} + \varphi_6 \text{TYPE\_SERV} + \varphi_7 \text{TYPE\_FIN} + \varphi_8 \text{TYPE\_MISC} + \varphi_9 \text{HOT} + \varphi_{10} \text{US} + \varphi_{11} \text{DEAL\_SIZE} + \varphi_{12} \text{LN\_OP} + \upsilon_{it}$$

where $E(\upsilon_{it})=0$; $\text{Cov}(X_{it}, \upsilon_{it})=0$, $i=1,\ldots,k$, $t=1,\ldots,T$;.

Model (4)

$$\text{Underpricing Germany} = \delta_0 + \delta_1 \text{YEAR} + \delta_2 \text{MONTH} + \delta_3 \text{Ln\_AGE} + \delta_4 \text{TYPE\_IT} + \delta_5 \text{TYPE\_MANU} + \delta_6 \text{TYPE\_SERV} + \delta_7 \text{TYPE\_FIN} + \delta_8 \text{TYPE\_MISC} + \delta_9 \text{HOT} + \delta_{10} \text{US} + \delta_{11} \text{DEAL\_SIZE} + \delta_{12} \text{LN\_OP} + \xi_{it}$$

where $E(\xi_{it})=0$; $\text{Cov}(X_{it}, \xi_{it})=0$, $i=1,\ldots,k$, $t=1,\ldots,T$;.

It can be seen that there are few institutional differences, when running a regression for both the US and Germany. The US model shows similar results as our combined model. All of the variables supporting the asymmetric information hypotheses are significant: LN_AGE, HOT, DEAL_SIZE, LN_OP, except the reputation of the underwriter.

It can also be concluded that due to the higher R^2, asymmetric information theory has better implication in the US IPO market, than in Germany.

Table 10 Country OLS regressions

Underpricing	OLS Residuals US (3)	Robust St. Errors US	OLS Residuals Germany (4)	Robust St. Errors Germany
YEAR	-0,0508***	(0,0102)	-0,0323**	(0,0127)
MONTH	-0,0149***	(0,0055)	-0,0540***	(0,0169)
Ln_AGE	-0,0375***	(0,014)	-0,0431	(0,0322)
TYPE_IT	0,0866	(0,0787)	-0,1283	(0,1612)
TYPE_MANU	-0,0306	(0,0654)	-0,0356	(0,1551)
TYPE_SERV	-0,0383	(0,0735)	-0,1082	(0,1593)
TYPE_FIN	-0,0994	(0,0654)	-0,3006*	(0,1567)
REPUT	-0,0249	(0,0386)	-0,2270**	(0,1034)
HOT	0,1363***	(0,0509)	0,3030***	(0,1075)
DEAL_SIZE	-0,0004***	(0,0001)	0,0000	(0,00006)
Ln_OP	0,4629***	(0,014)	0,0589	(0,0616)
Constant	101,08***	(20,54)	65,0540**	(25,463)
Observations	464		177	
R^2	23,89%		19,86%	

Note: ***p<0,01 , **p<0,05 , *p<0,1

Further to that, due to the higher volume of IPOs in US, the combined model might be biased, resulting from the higher number of observations in US. This arises due to the relatively smaller IPO market in Germany, as we observed earlier.

The Germany model shows only minor differences in the predicted signs of industrial dummies, which are insignificant to explain underpricing. The reputation of the underwriter is used from investors to make judgments about the IPO, contrary to the US, where it is insignificant. On the other hand, the DEAL_SIZE is not a determinant for the level of underpricing. Nevertheless, we can conclude that the asymmetric information theory has

less implication on the German market; therefore, further analysis of the other theories is advised.

The relatively low R^2 in the three models is not unexpected. As pointed out by Ritter and Beatty (1985) this is normal, especially in the application of theories such as asymmetric information, country differences and IPO time-dependence. If the R^2 was higher, it would imply that investors would be able to correctly predict the IPO performance, thus the level of underpricing. Hence, risky IPOs are hard to predict, which explains the presence of the underpricing puzzle on the capital markets.

9. Robustness

Our previous OLS models present the underwriter reputation as exogenous. Nevertheless, Habib and Ljungqvist (2001) and Ljungqvist and Welch (2002) argue that it should be treated as endogenous, because the rank of the underwriter is correlated with the firm characteristics. They show that due to the asymmetric information between investors, issuers incur promotion costs in order to signal their quality, thus reducing underpricing of their offering. Hence, hiring a prestigious underwriter is a way of reducing these costs, as well as the initial returns of the issue. They argue that regressing underpricing on reputation results in an endogeneity bias, because the choice is based on the expected level of underpricing, which is likely to occur. Therefore, both the choice of underwriter and the choice of the issuer by the underwriter are not random. Ignoring this issue would lead to biased OLS estimators. To control for the endogeneity bias we run a Two-stage least

squares regression (2SLS) similar to the approach of Habib and Ljungqvist (2001). In the first stage we run a regression on the variable Rank, which is created based on the Carter-Manaster rankings and takes a value from 0-9, while the second stage estimates the underpricing using Rank as an instrument variable. The IV needs to satisfy assumptions for relevance $Cov(REPUT, Rank) \neq 0$ and validity $Cov(Rank, \varsigma) = 0$, where ς is the error term. The instrument is relevant with t_{Rank}=6,14. The results are shown on Table 12.

Table 11 2SLS regression results for underpricing

	OLS (5) Rank	OLS Rob. Std. Error	2SLS (6) Underpricin	2SLS Rob. Std. Error
YEAR	-0,0203	(0,024)	-0,0539***	(0,0087)
MONTH	0,0087	(0,0216)	-0,0212***	(0,0059)
Ln_AGE	----------	----------	-0,0333**	
TYPE_IT	0,2651	(0,264)	0,0496	(0,0792)
TYPE_MANU	0,4698*	(0,247)	-0,0308	(0,0654)
TYPE_SERV	0,0885	(0,279)	-0,042	(0,0687)
TYPE_FIN	0,4051	(0,3525)	-0,1531**	(0,0637)
REPUT	----------	----------	-0,1529	(0,2178)
US	0,7909***	(0,1527)	0,2826***	(0,08477)
HOT	0,1548	(0,1933)	0,1574***	(0,0455)
DEAL_SIZE	0,00014	(0,0014)	-0,00003	(0,00006)
Ln_OP	0,3748**	(0,1508)	0,2509**	(0,0772)
Constant	46,28	(48,29)	107,6024	(17,41)
F-test	4,15			
R^2	4,47%		17,15%	
Observations	655		641	

Note: ***p<0,01 , **p<0,05 , *p<0,1

A comparison of the result of OLS model (2) and 2SLS (6) does not show substantially different results. The Rank variable is insignificant, however, preserves its negative sign, which is compatible with the results of Habib and Ljungqvist (2001). Therefore, we conclude that, due to the small difference in the results, our previous OLS estimators are robust.

It is also conceivable that a possible omitted variable bias might have been present in the OLS models. Nevertheless, based on previous studies firm characteristics appear to be adequately covered. Therefore, extending the model is unlikely to cause significant changes.

10. Conclusion

The question of the present contribution addresses the causes of the IPO underpricing puzzle. Examining the period of high volatility and uncertainty of 2000-2008, we also investigated what introduces differences in the level of underpricing in two major markets- American and German. While abnormal returns have been documented in almost every market, we know little about what causes them to fluctuate globally. Ritter (2003) and Loughran, Ritter and Rydqvist (1994) provide insights about country-level characteristics. We built on their analysis empirically by not only verifying the robustness of their findings, but also studying why they produce varying initial returns. We also accounted for the market cycles as a factor of abnormal returns. We based our model on asymmetric information as a tool to explain whether information frictions in the markets boost the underpricing.

Based on recent IPO data, we showed that the underpricing is influenced by the market cycles. Hot periods are associated with higher investor participation due to their overly optimistic behaviour to undertake more uncertain investments. Furthermore, we find support for the asymmetric information theory, implying that underpricing is a way of signalling the quality of the company. Therefore, age, underwriter reputation and offer price setting are informative for investors' behaviour. Nevertheless, we do not find support for the deal size and the single industry as a determinant of underpricing.

Having proven the variations in underpricing on the American and German markets, we built two models, one for each country. We find proof of the time-dependence of IPOs in both markets. An important distinction is that information frictions carry important role on the underpricing in the US market, while it finds little support in the German one.

Therefore, while this analysis will be of help for financial managers and investors to evaluate an IPO, it does not imply that the ex-ante uncertainty and asymmetric information are the main driving force for underpricing. Instead, following similar pattern, this study can be extended to incorporate analysis of behavioural factors shedding light on the other theories to explain the fluctuations of underpricing.

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Appendix 1

A. Assumptions for the OLS Underpricing Model

Assumption UP.1 The population model is:

$$\boldsymbol{y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + u}$$

where $\beta_0, \beta_1, \beta_2 \ldots \beta_k$ are unknown parameters for estimation and $\boldsymbol{u}$ is an unobservable error term.

Assumption UP.2 There is random sampling in the cross section data.

Assumption UP.3 The expected value of the error term given the independent variables is zero:

$$\boldsymbol{E(u|x_1, x_2 \ldots x_k) = 0}$$

Assumption UP.4 In the model, the variables change over time and there is no perfect linear relationship among the explanatory variables.

Assumption UP.5 The variance of the idiosyncratic error term given the independent variables is constant.

$$\boldsymbol{Var(u|x_1, x_2 \ldots x_k) = \sigma^2}$$

Assumption UP.6 The error term $\boldsymbol{u}$ is independent of $\boldsymbol{x_1, x_2 \ldots x_k}$ and identically distributed with $\boldsymbol{u \sim N(0; \sigma^2)}$