Who Knows What When? -

The Information Content of Pre-IPO Market Prices*

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Abstract

To resolve the IPO underpricing puzzle it is essential to analyze who knows what when during the issuing process. In Germany, broker-dealers make a market in IPOs during the subscription period. We examine these pre-issue prices and find that they are highly informative. They are closer to the first price that is subsequently established on the exchange than either the midpoint of the bookbuilding range or the offer price. We further document that pre-issue prices are unbiased estimates of the subsequent first exchange price. They explain a large part of the underpricing that cannot be explained by other variables. The results imply that information asymmetries are much lower than the observed variance of underpricing suggests, a finding that is relevant for judging the validity of underpricing theories.

JEL classification: G10, G14, G24

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Introduction

The underpricing of initial public offerings has been the subject of intensive theoretical and empirical research and yet still represents a puzzle. At the heart of the puzzle is the question of who knows what, and when. Do informed investors know more about the firm value than the issuer and the underwriter (as is assumed by, e.g., Rock 1986, Benveniste / Spindt 1989)? Does the underwriter know more than the issuer (as in the principal agent models of Baron / Holmström 1980, Baron 1982)? Does the issuer have superior knowledge about the firm value but voluntarily chooses to underprice (as is assumed in the signaling models of Allen / Faulhaber 1989, Grinblatt / Hwang 1989, Welch 1989)? Or is underpricing a means of creating excess demand, which can be desirable even if information is symmetric (as in the optimal ownership structure models of Brennan / Franks 1997 and Stoughton / Zechner 1998)?

Finding an answer to these questions is complicated by the fact that there is usually no price history before an IPO. In Germany, by contrast, there is an active market for pre-issue trades in initial public offerings. In compliance with German financial regulation, broker-dealers offer OTC pre-issue trading for investors who want to buy or sell shares during the bookbuilding period. The price range is not bounded by the bookbuilding spread or any other limits. The pre-IPO prices represent an ideal opportunity for analyzing the quality of the information on firm value that is publicly available during the IPO process.

The information revealed through pre-IPO trades is potentially relevant for underwriters, investors and issuers. Underwriters learn about the market's assessment of the firm value and can set the final offer price accordingly. Investors can use the information contained in the pre-IPO prices to discriminate between overpriced and underpriced issues. To the extent that the prices are indeed informative, uninformed investors can make their subscription decision contingent on the pre-IPO prices. Issuers, finally, are provided with a benchmark for the pricing proposal of their investment bank. This is of importance as investment banks may intentionally underprice stocks to reap the benefits of lower marketing costs or of high commissions paid by investors who seek preferential allocations of shares.[1]

In the present paper we use pre-issue trading prices for more than 350 German IPOs to investigate what is known about the firm's value during the bookbuilding period. Our results can be summarized as follows. The pre-IPO prices are highly informative. They are closer to the

[1] Cf. Baron / Holmström (1980), Baron (1982) and Loughran / Ritter (2001).

prices subsequently established on the exchange than either the midpoint of the bookbuilding range or the offer price. Pre-IPO prices also appear to be largely unbiased estimates of the subsequent exchange prices. Finally, the pre-IPO return (defined as the difference between the midpoint of the bookbuilding spread and the midpoint of the pre-IPO quotes on the day prior to the first exchange listing) explains a large part of the underpricing left unexplained by other variables like issue size, post-IPO volatility, and market momentum. Taken together, informational asymmetries during the offer period appear to be relatively low. Our study thus provides empirical support to Welch / Ritter (2002), who argue that asymmetric information is not the main driver of underpricing.

We do not have knowledge of prior academic research on pre-IPO trading. In the U.S., when-issued trading is common in conjunction with stock splits (see Angel / Brooks / Mathew, 1997), but, as in many other countries, it is illegal for IPOs.[2] Our work is related to previous research analyzing the price formation for newly listed issues. Barry / Jennings (1992) and Schultz / Zaman (1994) report that the initial return is almost entirely reflected in the opening price on the first trading day. Aggarwal / Conroy (2000) analyze the quoting activity before the opening price on the first day of exchange trading is set and find that learning takes place in the pre-opening period. Benveniste / Fu / Seguin / Yu (2000) analyze equity carve-outs. They find that the initial returns of the carved-out subsidiaries are related to the returns on the parent companies in the pre-offer period. Due to the existence of pre-issue trading in Germany, we can extend this line of research. We can analyze prices set during the entire bookbuilding period rather than only in the pre-trading period on the first day of exchange trading, and our analysis is not confined to the special case of carve-outs.

The remainder of the paper is organized as follows. Section I provides an overview of the German market for pre-issue trading. In section II we present our data set and some descriptive statistics. Section III analyzes the accuracy of the pre-IPO prices and their relation to underpricing. In Section IV we summarize our findings and discuss their implications.

I. Institutional Aspects of Pre-IPO Trading

In Germany, special venues for trading new share issues before their first listing and, most importantly, during the subscription period, exist since the early 80s. This market segment is

[2] This does not necessarily mean that pre-IPO trades, at least among banks, do not take place. For example, the Economic Times (February 8, 2000) reports on large activities in the informal grey market for IPOs in India.

called *Handel per Erscheinen* and is one segment of the largely unregulated[3] „grey capital market". In the present paper we interchangeably use the terms *pre-IPO,* or *pre-issue trading*.

This market segment has, for a long time, been rather small and restricted to banks and has not received much attention. However, in the 1997-2000 hot IPO market the number of IPOs has reached unprecedented levels. Several large and well-marketed issues (like Deutsche Telekom AG and Infineon Technologies AG) and the success of the new market segment for growth companies (*Neuer Markt*) have contributed to this IPO wave. Private investors have become increasingly involved in the IPO market even though, as a consequence of high oversubscription rates, the odds of being allocated shares were not in favor of the average investor. This experience has brought the pre-IPO market to the attention of many investors. New trading platforms and the internet have also led to wider information dissemination and more price transparency. Bid and ask quotes are disseminated via the large information vendors (REUTERS, Bloomberg) and the Internet.[4] Daily newspapers (e.g. FAZ and Börsenzeitung) often report these prices when reporting about ongoing IPOs. In addition, the Börsenzeitung publishes summary post-trade information each day (daily high and low prices, trading volume and 4 p.m. quotes).[5] We now describe the institutional aspects of the pre-IPO market in more detail.

Trading „as if and when issued"

The trades in the pre-IPO market can be characterized as forward trades in shares that are in the process of going public. The transactions are contingent on the announced IPO taking place („if issued") and are settled on the first trading day of the stock in the secondary market („when issued"). In case the IPO is cancelled the pre-issue trades are undone. If the subscription period is extended by more than three days or if the bookbuilding price range is changed, all orders that have not yet been filled are cancelled. Otherwise all submitted orders are binding. Note that, contrary to other countries, a change of the bookbuilding range is very uncommon in Germany. Usually IPOs sold through the bookbuilding method have a binding upper bookbuilding price. Only recently did some offering prospecti allow for upward-adjustments

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[3] Recently there have been some proposals aiming at more stringent regulation (or even prohibition) of pre-issue trading.

[4] On the Internet this information is freely available on the websites of the broker-dealers themselves, the sites of the large online-brokers and on many IPO-forums including prominent sites like yahoo.de. Recently mobile communication devices like WAP mobile phones have been added to these information and ordering channels. In 2001 the brokerage firm Lang & Schwarz Wertpapierhandel AG has started a new trading platform in cooperation with a regional stock exchange (Düsseldorf) and an information vendor (VWD).

[5] Volume information is only available since June 2000.

of the bookbuilding range in response to changing overall market or specific demand conditions. There were, however, some cases where the final offer price was set below the lower bound of the bookbuilding range.

Market organization

Several broker-dealers organize competing markets in pre-issue trading. They are supervised by the German Federal Securities Supervisory Office (Bundesaufsichtsamt für den Wertpapierhandel). Until 1998 the pre-IPO market was a classical OTC market. Trading took place only via telephone, mainly between banks. Later, the quotes were made available to retail investors on the internet and through other information channels. Since summer 2000 the leading market participants have started – some in cooperation with large online-brokers – to implement online trading platforms, which give all investors fast and simple access to market information and order submission.

The two market leaders are the broker-dealers Börsenmakler Schnigge AG and Lang & Schwarz Wertpapierhandel AG (L&S).[6] Schnigge is the leading market maker for pre-issue trading. The company claims to have a market share of 80% (annual report 1999, p.14). Pre-IPO trading usually starts when the bookbuilding range and the exact timing of the issue (i.e., the subscription period and the day of the first exchange listing) are published. In Germany, this typically happens nine calendar days before the first listing.[7] First quotes are set after communication with market participants. Subsequently, quotes are adjusted in response to new information and demand and supply conditions. Pre-issue trading takes place from 8 a.m. to 11 p.m. The last trading day is the day before the first listing on the exchange.

Pre-IPO trading covers most issues that are subsequently listed on the various segments of the Frankfurt stock exchange. Brokers do not make a market in issues for which they or one of their cooperating partners act as underwriters. As an explanation for this abstinence, they mention potential conflicts of interest. Therefore, if our analysis reveals that the pre-IPO prices are informative, this is *not* because the underwriter is the market maker.

Market Participants and Trading Motives

Investors placing orders with the bookrunner may gain from underpricing when they are allocated shares. However, high oversubscription rates make this a rare event, especially when the

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[6] Both are themselves listed companies and mention pre-IPO trading as being their most important business in terms of volume and profitability. Schnigge reports 5 million monthly page impressions on their web sites.

issue is small. The pre-IPO market offers the opportunity to buy shares without bearing allocation uncertainty. This is one motive for buyers.

Investors who are confident to receive an allocation of shares may sell shares in the pre-IPO market in order to lock in profits. Similarly, investors who already own shares can sell them in the pre-IPO market as long as these shares are not subject to lockup restrictions. Finally, informed investors (and investors who believe that they are informed) may trade in the pre-IPO market in order to exploit their informational advantage.

II. Data

In our analysis we use quote and transaction data from the broker Börsenmakler Schnigge AG. Our raw data is from three different sources. First, Schnigge maintains a historical data base that contains the last bid and ask quotes from the day before the IPO (i.e., the day before the stock is first traded on the exchange). From this data base we collected all quotes in the period from 03/30/98 to 06/30/01. We refer to the resulting sample as the *full sample*. It covers 357 firms. Using quotation, rather than transaction, data is not an impediment to our analysis because our interest is in the information that is inferable from the pre-IPO market. None of our analyses assumes that trades have actually taken place at these prices.

Börsenzeitung, a leading financial newspaper, started publishing daily Schnigge quotes (from 4.00 p.m.) in April 2000. From June 2000 onwards, the published information was extended to include volume data. We collected this data from 04/17/00 through 06/30/2001. We refer to this sample as the *daily* sample. It covers 112 IPOs, for 86 of which we also have volume data. From 07/27/00 on we also recorded, at hourly intervals, the quotes published on Schnigge's website. The hourly data are used for illustrative purposes only. The main analyses are conducted separately for the full sample and the daily sample.

We restrict the analysis to stocks that went public on the Frankfurt Stock Exchange. We obtained data on these IPOs (offer price, IPO volume, bookbuilding spread, first trading price, market segment) from the exchange. Data on secondary market prices and trading volumes is from Datastream. Out of the 400 stocks that went public on the Frankfurt Stock Exchange from 03/30/98 through 06/30/01, Schnigge made a pre-IPO market in 357 issues.[8] 306 of

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[7] See Ljungqvist / Wilhelm (2001) fur further institutional details of the German IPO market.

[8] Schnigge does not make a market if it is involved in the underwriting. It also appears that Schnigge refrained from making a market in issues with little investor interest. Consistent with this interpretation, issues not cov-

these companies chose to list on the Neuer Markt, the growth segment of the Frankfurt Stock Exchange. Table I presents descriptive statistics for these offerings and the quotes from the last day before the IPO.

Insert Table 1 about here

The average size of an issue is € 117.3 million, the median is € 39.1 million. The underpricing in the sample period was substantial. The average underpricing was 42.7%, the median was 13.3%. Only 10.1% of the issues were *over*priced.

As discussed in section I, the pre-IPO market is a market maker market. The quoted bid-ask spreads are, as documented in Table 1, rather wide, averaging 10.5%. However, given the uncertainty about the true value of the stock and the potentially high degree of informational asymmetry in IPOs, there may be good economic reasons for these wide spreads. We regress the spread on a set of explanatory variables to check whether the determination of the spread is in accordance with established theories of the bid-ask spread. Our explanatory variables are the log of the IPO volume as a proxy for firm size, the inverse of the midpoint of the book-building range and the width of the bookbuilding range (defined as the difference between the maximum and the minimum of the range, divided by its midpoint). The results are as follows (n = 357, R^2 = 0.17, t-statistics in parentheses):

$$\underset{}{\text{Spread}_i} = \underset{(8.53)}{11.18} - \underset{(3.09)}{0.725}\ln(\text{Vol}_i) + \underset{(2.96)}{35.33}\left(1/\text{BB-Midpoint}_i\right) + \underset{(0.52)}{0.023}\text{BB-Range}_i$$

As one would expect, the spreads are wider for smaller firms and are inversely related to the price level. The width of the bookbuilding range, which serves as a proxy for information asymmetry, has the expected positive sign but is insignificant.[9]

Price discovery should be associated with changing bid and ask quotes. We use the hourly data to analyze the frequency of quote changes. In 43.4% of all recorded cases, either the bid or the ask price or both changed from one hour to the next. For the IPOs for which we have information on daily volume (86 IPOs from June 2000 onwards), the mean daily volume as a percentage of shares issued is 0.48%. For the same 86 stocks, we compute the mean secondary

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ered by Schnigge are smaller (the median issue volume is € 30.82 million vs. € 39.10 million for the full sample), less underpriced (22.25% vs. 42.71%), and very seldom listed on the growth segment Neuer Markt (1.8% vs. 85.7%).

[9] We used the standard deviations of the returns of the 20 trading days after the IPO as an alternative measure of uncertainty. The results were similar.

market volume – again as a percentage of shares issued – on the 30th day of exchange listing, which is 0.55%. The pre-IPO trading volume is thus of the same order of magnitude as the trading volume in the secondary market.

Figure 1 presents an example. It shows the evolution of the pre-IPO quotes for Linos AG, a company that went public on the Neuer Markt on September 1, 2000. The offer range was € 24 to € 27, the subscription period lasted from August 24 to August 30. Pre-IPO trading began on August 23 (the day on which the offer range was announced) and lasted until August 31 (the day before the first listing on the exchange). The first pre-IPO bid prices were more than 30% above the upper end of the offer range. In the course of the subscription period, the quotes rose steadily. The quotes on the last day of pre-IPO trading were above € 50. The daily average trading volume was 9,450 shares. This is equivalent to 0.68% of the issue volume. The offer price of € 27 was set at the upper end of the bookbuilding range. The first market price on September 1 was € 73. In this particular case, the pre-IPO quotes were thus considerably lower than the first market price, but they were also consistently closer to it than either the midpoint of the bookbuilding range or the offer price. In addition, the difference between the pre-IPO quotes and the subsequent first market price decreased in the course of the pre-issue trading period. This is evidence of price discovery and information aggregation through pre-issue trading. The next section will reveal whether this picture is representative.

Insert Figure 1 about here

III. Empirical Results

We present our empirical results in three subsections. In the first we examine the accuracy and efficiency of the prices set in the pre-issue period. We next analyze whether an (uninformed) investor can reduce winner's curse type of problems by conditioning his subscription decision on the pre-IPO quotes. The third subsection complements the analysis by modeling fundamental determinants of IPO underpricing and pricing errors.

III.1. Pricing Accuracy

A first indication of the accuracy of the pre-IPO prices is the frequency with which the first market price on the exchange falls within the last pre-IPO quotes. We find this to be the case

for 52.9% of the IPOs in our sample. In contrast, only 26.9% of the first exchange prices are inside the bookbuilding range.[10]

To assess the accuracy of the pre-IPO quotes in more detail we examine the percentage difference between the first market price and the prices set during pre-IPO trading. We define the pricing error as: [11]

$$\text{Pricing Error} = \frac{P_i - p_{i,j}}{p_{i,j}}$$

where P_i is the first exchange price of stock i, and $p_{i,j}$ is a pre-IPO price quoted for stock i at stage j of the offer period. We take the pre-IPO prices to be the average of the quoted bid and the quoted ask price. For the full sample, we only have quotes from the last day before the IPO. For the daily sample, we calculate variants of the pricing error based upon prices quoted on the day before the subscription period, on the first and last day of the subscription period, halfway through the subscription period, and on the day before trading on the exchange starts.[12] In 30 cases, pre-issue trading commenced only at the first day of the subscription period. For the quotes from the day before the subscription period the number of observations thus reduces from 112 to 82. In order to gauge the magnitude of the pre-IPO pricing error we use the pricing errors defined relative to, first, the midpoint of the bookbuilding range and, second, the offer price as benchmarks. For the offer price, the pricing error definition coincides with the usual definition of underpricing, i.e. (first exchange price / offer price – 1).

Insert Table 2 about here

Table 2 presents descriptive statistics on the pricing errors. The results for the full sample are shown in Panel A. The mean pricing errors are 49.4% for the midpoint of the bookbuilding range and 42.7% for the offer price. The first official price set on the exchange is thus more than 40% higher than the midpoint of the bookbuilding range and the offer price. By contrast, the last pre-IPO price is, on average, almost equal to the first price on the exchange. The mean pricing error is only 0.6%, which is not significantly different from zero (t-value 0.76, z-value for a Wilcoxon test 1.58). The standard deviations show that the pre-IPO prices are not only

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[10] In 86.9% of the cases the percentage bookbuilding range is *wider* than the last pre-IPO spread. The results reported in the text are thus not driven by excessively wide spreads.

[11] We also use logarithmic pricing errors. The results are similar and are, therefore, not discussed in the text. The appendix contains a table with descriptive statistics based on logarithmic pricing errors.

[12] If the subscription period extends over an even number of trading days, we take the midpoint to be the day that is closer to the beginning of the subscription period. Finally, there are some cases where the subscription

less biased, but also more efficient estimates of the first market price than either the midpoint of the bookbuilding range or the offer price. For the bookbuilding range midpoint and the offer price, the standard deviations of the pricing errors are 77.5% and 69.00%, respectively, more than four times larger than the corresponding figure for the pre-IPO quotes (15.74%). In the light of this, the gain in accuracy that the offer price achieves relative to the offer range midpoint appears to be small.

The results are not due to outliers. We reestimate the standard deviation using a winsorized sample. We replace the 5% largest and smallest observation with the 95% and 5% quantile of the distribution, respectively. After winsorization, the standard deviation of the pricing errors is 55.40% for the offer price, and 11.23% for the pre-IPO quotes.

The pricing error of the pre-IPO quotes is essentially an overnight return, namely, the return from the pre-IPO quote midpoint on the last day before exchange trading starts to the first transaction price established on the exchange. The reported values (11.23% and 15.74% with and without winsorization, respectively) appear to be high for the standard deviation of a cross-section of overnight returns. To put the results into perspective, we compute the cross-sectional standard deviation of close-to-close returns from the first trading day to the second. It is 13.20%, indicating that the standard deviation of the pricing error of pre-IPO quotes is similar to the volatility of post-IPO exchange prices.[13]

Insert Table 3 about here

So far, we described differences in accuracy without testing for their statistical significance. We conduct paired t-tests as well as Wilcoxon matched-pairs signed-rank tests to test the null hypothesis of no difference between absolute pricing errors of pre-IPO quotes on the one hand, and those of the offer range midpoint and the offer price on the other hand (cf. Table 3). In each test, the null hypothesis is rejected at the 0.1% level or better. To sum up, the results indicate that, first, pre-IPO quotes are significantly more informative than the bookbuilding

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period ended one day before the first official listing. In these cases the pre-issue prices from the last day of the subscription period and from the last day of pre-IPO trading are identical.

[13] The pricing errors of the offer price and the last pre-IPO price are correlated (the correlation coefficient is 0.4426). This finding may be explained by the arrival of new information after the end of pre-IPO trading. This is best seen by examining logarithmic pricing errors (See Table A1 in the appendix). Their correlation is 0.4379. Assume that the log difference between the first market price and the pre-IPO quote is solely due to overnight innovation. From Table A.1, the innovation would then have a standard deviation of 16.07%. If this innovation were the only source of correlation between the pricing errors, then the correlation would equal $0.1607^2 / (0.1607 \times 0.3761) = 0.4273$, little less than the observed correlation.

range and the offer price and, second, that pre-IPO quotes are good proxies for the prices set on the first trading day on the exchange.

Moving on to the daily sample, a similar picture emerges. As for the full sample, Table 2 contains the descriptive statistics, while Table 3 presents tests for differences in absolute pricing errors. The last pre-IPO quotes are, again, significantly more accurate than the offer price. Intriguingly, quotes set on the day before the start of the subscription period are significantly more accurate than the offer range midpoint, and as accurate as the offer price. During the bookbuilding period, the pricing accuracy steadily increases, that is, the quality of the information available to market participants rises over time. Further tests (not reported in Table 3) show that the absolute pricing errors from the last day of bookbuilding are significantly (0.1% or better) lower than the ones from the first day of the bookbuilding period.

If pre-IPO prices rationally incorporate available information they should be unbiased estimators of the true value of the stock. This can be tested by running the following regression:[14]

$$P_i = \alpha_j + \beta_j p_{i.j} + \varepsilon_{i,j}$$

P_i is the "true" price and $p_{i,j}$ is an estimate of the true price. Unbiasedness implies $\alpha_j = 0$ and $\beta_j = 1$. We take the first price set on the exchange to be a valid proxy for the true price.[15] In our alternative regressions, $p_{i,j}$ is taken to be pre-IPO quotes from various stages of the offer period, the midpoint of the bookbuilding range, and the offer price, respectively. Given the descriptive statistics discussed above we expect only pre-IPO quotes to be unbiased predictors of the true price.

Insert Table 4 about here

The results are shown in Table 4. For the full sample (see Panel A), they are fully consistent with our prior expectations. The final pre-IPO quotes are unbiased estimators of the true price (i.e., the joint null hypothesis $\alpha_j = 0$ and $\beta_j = 1$ is not rejected) whereas the midpoint of the bookbuilding range and the offer price are not. This also holds for the daily sample (see Panel B). Unbiasedness is rejected, however, until (and including) the midpoint of the subscription period. Pre-IPO prices appear to be unbiased estimates of the first price established on the exchange only in the second half of the subscription period.

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[14] To reduce the impact of heteroscedasticity on the efficiency of the coefficient estimates, we exclude one observation (the IPO of Deutsche Börse AG) from the regression because prices were much larger than those of the other IPOs. (The offer price was € 335 compared to € 54 for the IPO with the second highest offer price.)

III.2. Pre-IPO Quotes and the Winner's Curse

The daily sample also sheds some light on the usefulness of pre-IPO quotes for uninformed investors who are unsure whether to subscribe to an issue or not. These investors will be concerned about suffering from the winner's curse, i.e., being allocated overpriced shares. General statements on the magnitude of the winner's curse are difficult to derive as it depends on the allocation mechanism and the subscription strategy.

We examine the performance of the following feasible strategy: Subscribe to an IPO whenever the pre-IPO bid price on the first day of the offer period is strictly larger than the upper bound of the offer range. In the daily sample, the mean underpricing is 19.1%. 15.2% of all issues are *over*priced, i.e., the first market price is strictly smaller than the offer price. An investor following the strategy outlined above would have subscribed to 69 out of the 112 IPOs contained in the daily sample. The mean underpricing of these 69 IPOs is 30.4%, and only seven of them (10.1%) are overpriced. Thus, following the strategy substantially increases the average initial return and reduces the percentage of overpriced issues. The average underpricing of the 43 IPOs the investor would not have subscribed to is only 1.1%, and 23.3% of these issues are overpriced. We define two binary variables indicating whether an issue is overpriced or not, and whether an investor following the strategy would have subscribed to it or not. A chi-square test rejects the null hypothesis of independence at the 10% level (p-value 0.06).

These results suggest that winner's curse type of problems can be substantially reduced by conditioning the subscription decision on information available on the first day of the subscription period.

III.3. Multivariate Analysis

Most underpricing theories argue that underpricing is a rational answer to informational asymmetries. They also predict that the magnitude of the underpricing varies cross-sectionally. Hosts of empirical papers have uncovered variables that help to explain this variation (see Wasserfallen / Wittleder 1994 and Ljungqvist 1997 for research on the German IPO market). When comparing the pricing errors of offer prices and pre-IPO quotes, we should take into account the fact that a portion of the underpricing is explainable.

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[15] See, among others, Rock (1986) for a justification of this assumption.

Specifically, we wish to analyze whether the pre-IPO prices contain information that is not already contained in those variables that have proven to have explanatory power for the magnitude of the underpricing. We use the following variables:[16]

- the natural logarithm of the issue volume,
- the standard deviation of daily returns in the 20 trading days after completion of the IPO as a proxy for the uncertainty about the true value of the stock,[17]
- the return of an appropriate stock index in the 60 days prior to the subscription period. We include this variable because a strong positive relation between underpricing and the market return prior to the issue has been documented for Germany by Ljungqvist (1997). For firms that went public on the Neuer Markt we use the NEMAX All Share index, for firms listed on other segments of the Frankfurt Stock Exchange we use the CDAX index. Both indices are broad, value-weighted performance indices published by the exchange.
- the index return during the subscription period. We include this variable because the German practice of not adjusting the bookbuilding range limits the ability of underwriters to adjust the offer price to general market movements during the offer period.

The results of the cross-sectional regressions (based on the full sample) are shown in Table 5, starting with a regression in which underpricing is the dependent variable. First day returns appear to be lower for larger issues, and they are strongly positively related to the index returns prior to, and during, the subscription period. The coefficient on the secondary market volatility is positive and significant at the 1% level. The independent variables explain 32% of the variation in the underpricing. The standard error of the regression is 56.7%, which is still more than three times as large as the standard deviation of the pre-IPO quotes' pricing error (15.74%). This already indicates that the pre-IPO prices contain information beyond that contained in the variables that are usually included in underpricing regressions.

Insert Table 5 about here

This conclusion is strongly confirmed when we add the pre-IPO return as an additional explanatory variable. It is defined as

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[16] Our conclusions do not change when we also include the price revision, which we define as the percentage difference between the offer price and the offer range midpoint, or a dummy variable for listings on the growth segment Neuer Markt. Including these two variables in the underpricing regression (first row in Table 5) reduces the standard error of the regression only slightly from 56.7% to 56.1%.

[17] Using the percentage bookbuilding range as an alternative measure of the uncertainty leaves the conclusions unchanged.

$$\frac{\text{Midpoint of pre-IPO quotes}}{\text{Midpoint of Bookbuilding range}} - 1.$$

The pre-IPO quotes are from the day before the first day of exchange trading. Inclusion of the pre-IPO return changes the regression results dramatically. The R^2 jumps from 0.32 to 0.81. The return standard deviation and the index returns do no longer have explanatory power for the underpricing. Only the IPO volume retains its significance. Including *only* the pre-IPO return on the right-hand side yields an R^2 of 0.80. Again, the results are not driven by outliers. The robust Spearman rank correlation coefficient between underpricing and pre-IPO returns is 0.883, little less than the Pearson correlation (0.897). The predictive power of pre-IPO quotes is considerably larger than the one documented in Benveniste / Fu / Seguin / Yu (2000). In their study on equity carve-outs, the rank correlation between the market return of the parent company during the offer period and the subsequent underpricing of the subsidiary is 0.36.

A different, though related, question is whether those variables that are usually found to explain the underpricing do also have explanatory power for the pre-IPO pricing error. As before, this pricing error is defined as

$$\frac{\text{First exchange price}}{\text{Midpoint of pre-IPO quotes}} - 1.$$

The results, also shown in Table 5, reveal that the independent variables explain only a small fraction of the variation in the pre-IPO pricing error. The R^2 is 0.025. Only the return volatility in the secondary market has explanatory power. Pre-IPO quotes tend to be too low for IPOs with a high volatility.[18] The other explanatory variables are insignificant.

In a final step we analyze whether the absolute value of the pre-IPO pricing error is explained by the same set of independent variables. The two variables that enter the regression significantly are the secondary market volatility and the index return prior to the IPO. The pre-IPO quotes are less precise the higher the secondary market volatility To the extent that secondary market volatility is a valid proxy for uncertainty during the pre-IPO period, this is what one should expect to observe. The observation that absolute pricing errors increase with the market return prior to the IPO confirms the view that in a bull market, investor interest is expected but hard to predict (cf. Derrien / Womack, 2000).

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[18] Note that this does not entail a violation of market efficiency for two reasons. First, transaction costs are substantial (the average spread is, as shown in Table 1, 10.5%). Second, the standard deviation is calculated from returns in the secondary market and is, therefore, not observable during the subscription period.

IV. Summary and conclusions

In the present paper we exploit a special feature of the German capital market, namely, the existence of an active market for pre-issue trades in IPOs. This allows us to observe market prices for IPOs already during the subscription period. The information impounded in these prices is potentially relevant for underwriters, issuers, and investors. Both the underwriter and the issuer can make use of that knowledge when negotiating the offer price. Private investors can use the information in the pre-IPO prices to condition their subscription decision, and thereby avoid subscribing to overpriced issues.

Our analysis yields the conclusion that the pre-IPO prices are indeed highly informative. They are, on average, very close to the price subsequently established on the exchange, much closer than either the midpoint of the bookbuilding range or the offer price. Since the final pre-IPO prices are largely unbiased estimates of the subsequent exchange prices, there is little indication that they are affected by investor irrationality or price manipulation. Finally, the pre-IPO return (defined as the "return" between the midpoint of the bookbuilding spread and the midpoint of the IPO quotes on the day prior to the first exchange listing) explains a large part of the underpricing that is left unexplained by market momentum and other observable variables.

The results imply that information asymmetries and valuation uncertainty are much lower than the observed variance of underpricing suggests. This provides empirical support for the conjecture of Welch / Ritter (2002) that asymmetric information cannot explain the recently observed high levels of underpricing. Any informational disadvantage of uninformed investors, for instance, is largely reduced because they can monitor the pre-IPO prices and condition their subscription decision on that information. They can thereby alleviate, or even eliminate, the winner's curse problem. In the presence of a pre-IPO market that efficiently aggregates private information, the winner's curse does not provide a valid explanation for underpricing.

In information acquisition models (Benveniste / Spindt, 1989), underpricing rewards informed investors for revealing their information during the bookbuilding process. Previous empirical studies (e.g. Hanley, 1993, Ljungqvist / Wilhelm, 2001, and Cornelli / Goldreich, 2001) find support for this hypothesis. They show that investors who provide information benefit from underpricing. They do, however, not quantify the extent to which the underpricing can be explained through the Benveniste-Spindt argument. Qualitatively, our results also appear to be consistent with the information production hypothesis. Information production could, together with information leakages, explain the finding that pricing errors of pre-IPO quotes decrease in the course of the bookbuilding. However, if the goal of the bookbuilding is to elicit as much

information as possible and, subject to incentive constraints, incorporate it into the offer price, one should expect offer prices to be more accurate than pre-IPO quotes observed early during the subscription period. As our empirical evidence suggests otherwise, it appears that either the value of information produced through bookbuilding is small, or underwriters are inflexible in responding to this information. The Benveniste-Spindt argument thus does not seem to provide a sufficient explanation for the observed magnitude of underpricing.

The signaling explanation for underpricing is consistent with the evidence. In a separating equilibrium, investors infer the firm value from the issuer's behavior, such that pre-IPO prices should be good predictors of the first market prices. The signaling theory has, however, not received much support in previous empirical studies (e.g. Jegadeesh / Weinstein / Welch, 1993, and Michaely / Shaw, 1994).

Finally, if underpricing is used as a means of creating excess demand, be it to achieve a preferred ownership structure or to serve the banks' interests, issuers and underwriters should welcome an efficient pre-IPO market. With risk averse investors, the less uncertain investors are about the true price, the less underpricing is needed to create a given excess demand. Taken together, our evidence thus corroborates the recommendation of Welch / Ritter (2002) that underpricing research should concentrate on agency conflicts and allocation issues.

Another set of implications pertains to the design of the selling procedure. Our evidence suggests that the offer price does not incorporate all available information. There are several ways in which the bookbuilding procedure could be adapted in order to make better use of available information. The bookbuilding range could be set based on observed pre-IPO prices, and changes of the range could be made in response to the development of these prices. In addition, underwriters could increase the width of the range to increase pricing flexibility. Practitioners sometimes argue that a narrow offer range is necessary to prevent winner's curse type of problems.[19] As shown in this paper, however, pre-IPO trading can drastically reduce investor uncertainty so that this argument loses appeal.

These suggestions presuppose the existence of an efficient market for pre-IPO trading. The German example shows that such a market is feasible. Of course, if the pre-IPO market were to influence the setting of the offer price more directly, the incentive to manipulate prices

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[19] The argument is as follows. Private investors (who are supposed to be uninformed) usually submit unlimted orders. They thus run the risk of being allocated shares at a price equaling the upper bound of the bookbuilding range even if that price is above the "true" price. If the bookbuilding spread is wide, this risk is aggravated.

would be increased. However, even in the present form in which pre-IPO trading is not directly linked to the selling and underwriting process, the advantages that a pre-IPO market entails for investors, issuers and underwriters appear to be substantial.

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Table 1: Descriptive Statistics for the Full Sample (357 IPOs from 03/30/98 to 06/30/01)

Underpricing is defined as (first price on the exchange / offer price – 1). The width of the bookbuilding range is defined as 2 × (upper bound – lower bound) / (upper bound + lower bound). Similarly, the width of the pre-IPO quotes is defined as 2 × (ask – bid) / (ask + bid).

	Mean	Median	Standard deviation
IPO volume (million €)	117.32	39.10	465.96
Underpricing (%)	42.71	13.33	69.00
Width of bookbuilding range (%)	17.75	16.99	5.58
Width of last pre-IPO spread (%)	10.45	10.00	4.24

Table 2: Descriptive Statistics for Pricing Errors (in %)

The pricing error is defined as

$$\text{Pricing Error} = \frac{P_i - p_{i,j}}{p_{i,j}}$$

where P_i is the first trading price and $p_{i,j}$ is as defined in the first column. The t-value in the third column is for a test of the null hypothesis of a zero mean. In the winsorization, extreme observations are pulled to the variable's 5% and 95% quantiles, respectively.

For the quotes from the last day before the subscription period the number of observations reduces to 82 as trading did not commence at this stage in some cases. For this sample of 82 IPOs, the standard deviation of the pricing errors based on offer range midpoints and offer prices is 48.3 and 39.9, respectively.

	Mean	t-value	Std. Dev	Std. dev. (after winsorization)	Quantiles 25%	50%	75%
Panel A: Full Sample (NOB=357)							
Midpoint of offer range	49.44	12.05	77.52	64.21	0.00	20.69	73.68
Offer price	42.71	11.70	69.00	55.40	1.09	13.33	60.26
Last pre-IPO quotes	0.64	0.76	15.74	11.23	-6.47	-1.58	4.58
Panel B: Daily Sample (NOB=112)							
Midpoint of offer range	19.34	4.46	45.90	39.08	-10.28	10.73	32.8
Offer price	19.15	5.48	36.95	30.23	0.00	5.00	22.7
Pre-IPO quotes from							
Day before subscription period	-5.13	-1.67	27.83	23.25	-23.50	-8.25	5.2
First day of subscription period	-9.48	-4.06	24.72	20.38	-24.42	-12.41	0.3
Midpoint of subscription period	-7.80	-4.06	20.37	18.46	-20.00	-8.10	1.5
Last day of subscription period	-4.26	-2.50	18.07	14.78	-15.18	-5.15	1.1
Last day of pre-IPO trading	-2.54	-2.00	13.48	8.96	-8.76	-4.84	0.0

Table 3: Testing Differences between Absolute Pricing Errors (in %)

Using paired t-tests and Wilcoxon matched-pairs signed-rank test, we test the significance of mean differences between absolute pricing errors. These are defined as

$$\text{Absolute Pricing Error} = \left| \frac{P_i - p_{i,j}}{p_{i,j}} \right|$$

where P_i is the first trading price and $p_{i,j}$ is a price indication available prior to the exchange listing. Table entries are test statistics for the null hypothesis of zero difference between the absolute pricing errors of the prices defined in the column and row headers, respectively. p-values are in parentheses. For the quotes from the day before the subscription period the number of observations reduces to 82.

	Midpoint of offer range		Offer price	
	t-test	Wilcoxon	t-test	Wilcoxon
Panel A: Full Sample (NOB=357)				
Last pre-IPO quotes	12.34 (0.000)	14.86 (0.000)	10.46 (0.000)	10.87 (0.000)
Panel B: Daily Sample (NOB=112)				
Pre-IPO quotes from				
Day before subscription period	3.57 (0.001)	2.42 (0.016)	-0.51 (0.613)	1.03 (0.306)
First day of subscription period	3.51 (0.001)	2.11 (0.035)	-0.97 (0.330)	0.67 (0.505)
Midpoint of subscription period	4.78 (0.000)	3.62 (0.000)	0.09 (0.938)	1.87 (0.064)
Last day of subscription period	5.94 (0.000)	6.18 (0.000)	1.50 (0.133)	3.15 (0.002)
Last day of pre-IPO trading	7.37 (0.000)	8.04 (0.000)	3.25 (0.001)	4.63 (0.000)

Table 4: Unbiasedness

The Table shows the results of the regression

$$P_i = \alpha_j + \beta_j p_{i,j} + \varepsilon_{i,j}$$

where P_i is the first price set on the exchange and $p_{i,j}$ is as defined in the first column. t-statistics (in parentheses) are calculated using heteroscedasticity-consistent standard errors. The last column shows the p-value for a Wald test of the joint null hypothesis $\alpha_j = 0; \beta_j = 1$.

In both panels one observation (the IPO of Deutsche Börse AG) has been excluded. The prices were much larger than those of the other IPOs (offer price € 335 and first price on the exchange € 362, compared to € 54 and € 73, respectively, for the IPO with the second highest offer price). For the quotes from the last day before the subscription period the number of observations is reduced to 81 as trading in some IPOs did not commence at this early stage.

	α_j	β_j	R^2	p-value for H_0: $\alpha_j = 0; \beta_j = 1$
Panel A: Full Sample (NOB=356)				
midpoint of offer range	-1.753 (-0.33)	1.678 (7.37)	0.666	0.000
offer price	-1.410 (-0.26)	1.591 (7.24)	0.683	0.000
last pre-IPO price	-0.786 (-1.08)	1.035 (43.75)	0.968	0.290
Panel B: Daily Sample (NOB=111)				
midpoint of offer range	-2.36 (-1.20)	1.38 (14.35)	0.651	0.000
offer price	-2.13 (-1.28)	1.36 (17.05)	0.725	0.000
Pre-IPO quotes from				
Day before subscription period	-3.78 (-2.11)	1.16 (12.01)	0.806	0.059
First day of subscription period	-1.40 (-0.88)	0.99 (11.79)	0.781	0.008
Midpoint of subscription period	-1.72 (-1.34)	1.02 (14.46)	0.852	0.002
Last day of subscription period	-0.661 (-0.67)	1.00 (17.39)	0.880	0.140
Last day of pre-IPO trading	-1.26 (-1.50)	1.05 (21.56)	0.933	0.125

Table 5: Pre-IPO trading and underpricing

The Table shows the results of regressions of a measure of underpricing and the pricing errors in the pre-IPO trading on variables that, based on previous research, are considered to have explanatory power for the magnitude of the underpricing. We include the natural logarithm of the issue volume, the secondary market volatility in the 20 days following the IPO, and the return on an appropriate stock index, computed separately for the 60 days prior to the offer period and for the offer period.

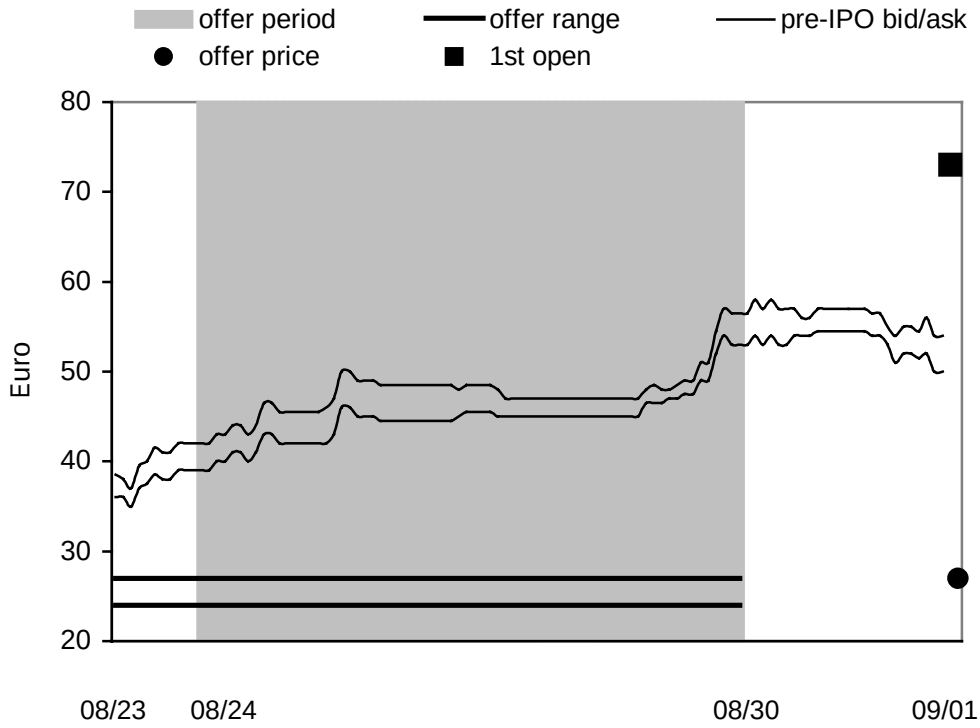
Underpricing is defined as (first price on the exchange / offer price – 1). The pre-IPO return is defined as (midpoint of the last pre-IPO quotes / midpoint of the bookbuilding range – 1). The pricing error of the last pre-IPO price is (first price on the exchange / midpoint of the last pre-IPO quotes – 1).

T-statistics (in parentheses) are calculated using heteroscedasticity-consistent standard errors.

Dependent variable	constant	log(volume)	secondary market volatility	index return prior to offer period	index return during offer period	pre-IPO return	adj. R^2
underpricing	0.231 (1.97)	-0.028 (-1.16)	4.537 (5.34)	1.051 (6.12)	2.216 (4.68)		0.324
underpricing	0.097 (1.66)	-0.033 (2.55)	0.713 (1.46)	-0.059 (-0.72)	0.302 (0.94)	0.883 (16.32)	0.807
underpricing	0.003 (0.16)					0.886 (18.80)	0.804
pricing error last pre-IPO price	0.013 (0.48)	-0.009 (-1.46)	0.580 (3.02)	-0.034 (-0.86)	0.282 (1.51)		0.025
| pricing error last pre-IPO price |	0.074 (3.83)	-0.001 (-0.23)	0.425 (2.71)	0.077 (-2.79)	0.158 (1.05)		0.052

Figure 1: Pre-issue trading of LINOS AG

Linos AG went public on September 1, 2000 at an offer price of € 27. The first price established on the exchange was € 73. The offer range was € 24 to € 27, the subscription period lasted from August 24 to August 30. Pre-IPO trading began on the day of the announcement of the offer range (August 23) and lasted until August 31. The shown pre-IPO bid and ask prices were recorded at full hours.



APPENDIX

Table A1: Descriptive Statistics for Logarithmic Pricing Errors (in %)

The pricing error is defined as

$$\text{Pricing Error} = \ln\left(\frac{P_i}{p_{i,j}}\right)$$

where P_i is the first trading price and $p_{i,j}$ is as defined in the first column. The t-value in the third column is for a test of the null hypothesis of a zero mean. In the winsorization, extreme observations are pulled to the variable's 5% and 95% quantiles, respectively.

For the quotes from the last day before the subscription period the number of observations reduces to 82 as trading did not commence at this stage in some cases. For this sample of 82 IPOs, the standard deviation of the pricing errors based on offer range midpoints and offer prices is 34.40 and 26.68, respectively.

	Mean	t-value	Std. Dev	Std. dev. (after winsorization)	Quantiles 25%	50%	75%
Panel A: Full Sample (NOB=357)							
Midpoint of offer range	30.31	13.69	41.83	38.28	0.00	18.81	55.21
Offer price	27.37	13.75	37.61	33.74	1.08	12.52	47.16
Last pre-IPO quotes	-0.59	-0.69	16.07	10.79	-6.69	-1.59	4.47
Panel B: Daily Sample (NOB=112)							
Midpoint of offer range	11.65	3.66	33.68	30.35	-10.85	10.19	28.4
Offer price	13.94	5.85	25.22	22.36	0.00	4.88	20.5
Pre-IPO quotes from							
Day before subscription period	-9.08	-3.01	27.31	24.18	-26.79	-8.62	5.1
First day of subscription period	-13.15	-5.62	24.77	21.97	-28.00	-13.26	0.3
Midpoint of subscription period	-10.42	-5.15	21.41	19.66	-22.31	-8.44	1.5
Last day of subscription period	-5.94	-3.58	17.58	14.89	-16.47	-5.29	1.1
Last day of pre-IPO trading	-3.38	-2.91	12.27	9.13	-9.17	-4.96	0.0