IPO Pricing with Bookbuilding and a When-Issued Market

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NOTA DI LAVORO 8.2004

JANUARY 2004

PRA – Privatisation, Regulation, Antitrust

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Summary

This paper examines the German IPO pricing process which combines bookbuilding with a liquid pre-IPO when-issued market. We find no partial adjustment phenomenon, as has been documented for U.S. IPOs. We thus find no evidence that bookbuilding provides information for IPO pricing, beyond the information that is required to set preliminary price ranges. Once price ranges are set, when-issued trading commences and indicates how IPOs should be priced in the primary market. However, the evidence suggests that such trading does not *fully* supplant information gathering through bookbuilding.

Keywords: Initial public offerings, Bookbuilding, When-issued trading

JEL Classification: G32

This paper has been presented at the EuroConference on "Auctions and Market Design: Theory, Evidence and Applications" organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003.

Many of the results of this paper were first presented in the papers "The First Prices in a New Market: Nasdaq vs. Neuer Markt" and "Sticky Prices: IPO Pricing on Nasdaq and the Neuer Markt". We thank Gary Beechener, Ekkehart Boehmer, Jim Booth, Cyprian Bruck, Wayne Ferson, Zsuzsanna Fluck, Simon Gervais, Edie Hotchkiss, Tim Jenkinson, Ed Kane, Katharina Lewellen, Alexander Ljungqvist, Gunter Loffler, Jay Ritter, Kristian Rydqvist, Phil strahan, Peter swan, Terry Walter, Josef Zechner and Christine Zelehner for helpful comments. We are also grateful to participants of seminars at Boston College, the University of Bergen, the University of Birmingham, the University of Frankfurt, the University of Innsbruck, the University of Oxford and Gerzensee, as well as the Western Finance Association Meeting (2003), the German Finance Association Annual Meeting (2001), the European Finance ssociation annual Meeting (2002), the Symposium of Finance, Banking and Insurance (2002) and the Australian Finance and Banking Conference (2002) for their helpful comments. We are grateful to Nikolay Hovhannisyan and Alexandra Wolfram for their valuable research assistance.

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1 Introduction

In an initial public offering of shares (IPO) the issuer sells securities for which there does not yet exist a secondary market price. The issuer must thus not only market and distribute the shares, but also determine a price at which the securities can be sold. Various types of mechanisms have been used to do this. In auctions, investors submit bids, and then securities are priced and allocated according to explicit rules. In bookbuilt offerings, underwriters collect investors' indications of interest, and then exercise discretion in the pricing and allocation of the securities. Apart from this difference, both mechanisms have in common that pricing-relevant information is obtained directly from potential buyers in the primary market.

Alternatively, information that is needed for setting primary market prices may be revealed through trading in related securities. For some securities, there may even be active forward trading *before* the securities are offered in the primary market. This is the case for auctions of U.S. Treasury securities, in which investors buy and sell the securities in a pre-auction, "when-issued" market. This when-issued market can allow the release of information that may affect investors' bidding strategies in the auction and thus the price(s) at which the securities are sold. In the U.S., IPOs differ from Treasury issues in that there is no market for when-issued trading of IPO shares. Such trading is effectively prohibited by a U.S. securities regulation that restricts the covering of short sales.[1] The stated reason for the short sale restriction is: "Such short sales could result in a lower offering price and reduce an issuer's proceeds."[2]

In contrast to the U.S., a number of countries in Europe do permit when-issued trading before the IPO. Germany, in particular, stands out as a country with a very active when-issued market for IPO shares. The prices in this market are publicly available and so may act as indications of how an IPO should be priced at the offer. In fact, to quote one of the largest market makers in the German when-issued market: "By observing when-issued

[1] Regulation M, Rule 105 prohibits the covering of short positions in IPO shares that were created within the last five days before pricing, with allocations received in the IPO. In addition to this rule, there are also restrictions on trading in unregistered shares.

[2] See Paragraph II.F. of the Securities Exchange Act Release No. 38067(December 20, 1996) on Regulation M, found at the webaddress, http://www.sec.gov/rules/final/34-38067.txt. Regulation M became effective on March 4, 1997.

trading, the underwriter can gauge the market's interest in an IPO."[3]

The German when-issued market operates concurrently with a bookbuilding process in which underwriters collect indications of interest directly from investors. Bookbuilding has been recognized as a source of information for IPO pricing. The theory of Benveniste and Spindt (1989) explains how underwriters can elicit information directly from investors. Hanley (1993) provides evidence consistent with this theory. It is possible, however, that in the presence of when-issued trading, bookbuilding does not play this informational role. According to Benveniste and Spindt, gathering information through bookbuilding may be costly. Prices of when-issued trading, on the other hand, are publicly and freely available. For this reason, it may be that underwriters in a market with when-issued trading will not gather information through bookbuilding. They may instead use bookbuilding only as a means for distributing shares.

The purpose of this paper is to determine whether when-issued trading does provide information that is useful for IPO pricing, and whether when-issued trading supplants bookbuilding as a source of such information. To answer these questions, we study IPO pricing in the German market. We find that when-issued trading does reveal information that is relevant for IPO pricing. We also find that, once when-issued trading begins, bookbuilding is not a source of costly information for underwriters. Despite these results, however, we cannot conclude that bookbuilding is fully supplanted by when-issued trading as a source of information for IPO pricing. We instead find evidence consistent with bookbuilding being used to gather information *prior* to the onset of when-issued trading.

When-issued trading commences soon after the underwriter posts a preliminary range for the price at which IPO shares will be offered in the primary market. This trading continues up to the first day of secondary market trading of the shares. In our empirical analysis, we distinguish between bookbuilding before and after the opening of the when-issued market, that is before and after the range has been set. In order to determine the role of bookbuilding after range setting, we test for a "partial adjustment phenomenon", as documented by Hanley

[3]This quote was taken from the website of Schnigge AG, http://www.schnigge.de/info/service/pre-ipo-trading.html. The orginal quote was in German: "Der Emissionsführer kann auf Grund der Handelstätigkeit im Handel per Erscheinen das Interesse des Marktes an der Neuemission messen."

(1993) for U.S. IPOs. Hanley found that there is a significant positive relation between IPO initial returns and the revision of IPO offer prices from price ranges set some time before IPO pricing. This finding is consistent with the theory of bookbuilding that has been posited by Benveniste and Spindt (1989). According to this theory investors are loath to reveal positive information about an issue because this will increase the price they must pay for shares. To encourage investors to truthfully reveal positive information, underwriters only partially adjust the IPO offer price with respect to such information, and then allocate underpriced shares to those investors who provided the information. The investors thus receive rents in exchange for their information. The partial adjustment phenomenon found by Hanley (1993) has been documented in the U.S. also by other researchers and with more recent data.[4]

We do not find a partial adjustment phenomenon in the German IPO market. We thus find no evidence, of the sort found in the U.S., that investors are rewarded for providing information in bookbuilding after price ranges have been posted. This finding suggests that underwriters either do not gather information after when-issued trading begins, or they obtain the information for free through the prices of when-issued trading.

The lack of a partial adjustment phenomenon, together with our finding that when-issued trading reveals pricing-relevant information, may imply that when-issued trading supplants bookbuilding as a source of such information. Before concluding this, however, we test one more hypothesis: if underwriters can indeed obtain all relevant information for free, then investors should not receive rents for any information, including information impounded in the prices of when-issued trading. However, we reject this hypothesis: we find that, in pricing IPOs, underwriters systematically underreact to information contained in the prices of recent trades in the when-issued market. Hence, investors in the primary market realize returns that could be informational rents. According to the theory described above, the investors should only receive such rents for providing underwriters with positive *private* information. Prices in the when-issued market are *publicly* available. Hence, our findings raise the question of why informational rents may be paid for information that is available for free.

We suggest a simple answer to this question: prior to the onset of when-issued trading, the underwriter collects information directly from investors in order to set the price range.

[4]See, for example, Bradley and Jordan (2002) and Lowry and Schwert (2001).

The setting of this range is important, in that underwriters in this market do not set the offer price above the range.[5] In order to obtain information prior to when-issued trading, the underwriter may underprice the IPO to reward investors for providing the information. If some of this information gets impounded into the prices of when-issued trading, IPOs will be underpriced relative to these prices.[6]

To summarize, we provide evidence of the coexistence of two rather different sources of information for determining the offer prices for IPOs in Germany. Underwriters gather information from potential investors *before* posting a price range. When-issued trading commences after the range has been posted. This trading indicates to the underwriter where the IPO should be priced, within or below the price range. There is no partial adjustment phenomenon, indicating that investors are *not* rewarded for providing information *after* when-issued trading commences. However, investors may be rewarded for providing information to underwriters prior to the onset of when-issued trading.

Our findings are consistent with other recent contributions to the literature. Jenkinson and Jones (2002) examine data from order books of European IPOs. By looking at books built after the posting of price ranges, they find that while institutional bidders are favored in the allocation of IPO shares, this favorable treatment is not necessarily a reward for information contained in their orders. Jenkinson, Morrison, and Wilhelm (2003) argue that underwriters' commitments to binding price ranges may assist in information gathering, through bookbuilding prior to setting the ranges. They also discuss institutional details that are consistent with our evidence of information gathering prior to the range setting. Pichler and Stomper (2003) develop a model that shows how information gathering through bookbuilding can enable informative when-issued trading. They also argue that, due to the interdependence of bookbuilding and when-issued trading, the presence of an active when-issued market should not interfere with the process of gathering information directly from

[5] In the U.S. underwriters can price 20% above the range and often amend ranges so as to price even higher. This does not happen in Europe. Ljungqvist, Jenkinson and Wilhelm (2003) in their investigation of French, German and UK IPOs pointed out that IPOs in these countries are almost never priced above the posted ranges. None of the IPOs in our study are priced above the posted range.

[6] It has been documented for U.S. IPOs that initial returns are positively related to publicly available information. See Lowry and Schwert (2002), Loughran and Ritter (2002a) and Bradley and Jordan (2002). We provide an explanation why this may occur with respect to when-issued prices.

investors.

Our paper extends the existing literature on IPO pricing, and underpricing, by investigating information gathering in a market with a different institutional framework than that in the United States. Other recent papers have examined the connection between share allocations and pricing in European IPO markets. Cornelli and Goldreich (2001) examine bookbuilding by one European investment bank and find that investors who post more informative bids do on average earn higher profits since they receive more favorable allocations of IPO shares. Ljungqvist and Wilhelm (2003) address the link between information gathering and allocations to institutional investors, using data from France, Germany, the United Kingdom and the United States. They find a linkage between these allocations, price revisions and underpricing that is consistent with the theory of Benveniste and Spindt (1989).

This paper is also related to the literature on when-issued markets. Bikchandani and Huang (1993) describe the when-issued market for U.S. Treasury securities, and discuss the concern that traders who plan to bid in Treasury auctions will be loath to reveal positive information in when-issued trading. Bikchandani and Huang (1992) and Nyborg and Sundaresan (1996) provide evidence consistent with this concern, although Nyborg and Sundaresan show that this is less of a concern for uniform price auctions, as compared to discriminatory price auctions. Löffler, Panther and Theissen (2002) examine the when-issued market for German IPOs and find that the final prices in this market are unbiased predictors of opening prices in the secondary market. Our study differs from theirs in that we focus on the pricing of IPOs, and on the interaction of bookbuilding and when-issued trading.[7]

The paper is organized as follows. The following section provides a description of key institutional aspects of the German IPO market. In the third section we describe our data. In the fourth section we provide, through the use of summary statistics, an overview of IPO pricing relative to price ranges and when-issued trading prices. In the fifth section we develop a number of hypotheses on IPO pricing in the presence of bookbuilding and when-issued trading. It is in this section that we also present a methodology to test for a

[7]There is also when-issued trading of shares prior to stock splits and spinoffs. This when-issued trading occurs in parallel with secondary market trading of similar, and possibly even identical securities. See, for example, Ezzel, Miles and Mulherin (2002).

partial adjustment phenomenon (as defined by Hanley (1993)), in the presence of binding price ranges. In the sixth section we present the regression model and discuss the regression results. The final section concludes.

2 Institutional Characteristics of the German IPO Market

In March 1997 the Frankfurt Stock Exchange created the Neuer Markt (New Market) in order to facilitate the financing of young companies.[8] In 1999 more companies went public on the Frankfurt Stock Exchange than on any other European exchange. (See Table 1.) Worldwide, only Nasdaq saw more IPO activity. In September 2002, the Frankfurt Stock Exchange announced the closure of the Neuer Markt as part of a reorganization of the exchange's market segments. This reorganization has no direct consequences for the topic of our study, IPO pricing with bookbuilding and when-issued trading. The generic institutional framework that we study here continues to exist in Germany and other European countries.

The Neuer Markt is similar to U.S. equity markets in its disclosure requirements for listing firms and is similar to Nasdaq in the types of firms that go public and list there.[9] As in the U.S., most companies are taken public using bookbuilding methods. However, the bookbuilding process on the Neuer Markt may differ from that in the U.S. due to the existence of an active market for when-issued trading of IPO shares. This market is referred to as the "grey market". As we expect that many readers are familiar with the Nasdaq IPO market we will describe the Neuer Markt largely by contrasting it with Nasdaq. In doing so, we do not want to suggest that the Neuer Markt is unique. It is rather the prime example for an institutional framework that is shared by other European markets. Among these markets, the Neuer Markt stands out as the most active IPO market with liquid and complete when-issued trading of IPO shares.[10]

[8]The Frankfurt Stock Exchange is part of a larger organization, the Deutsche Börse, or German Stock Exchange. We use the name Frankfurt Stock Exchange because we expect that this is a more familiar term for readers.

[9]Kukies (2000) states that firms that go public on the Neuer Markt are "small, young and belong to industries in which future growth opportunities rather than fixed assets determine market valuation".

[10]In terms of IPO activity, the Neuer Markt is comparable in Europe only to the London Stock Exchange. However, few of the IPOs in the U.K. feature when-issued trading. According to information from Tullett & Tokyo Liberty (securities) Ltd., one of the biggest brokers in the when-issued market of IPOs in Europe, when-issued trading takes place in only 8% of the U.K. IPOs. We are grateful to Gary Beechener from Tullett & Tokyo Liberty (securities) Ltd. for providing this information.

Listing and disclosure requirements: Table 2 states criteria for issuers seeking a listing on the Neuer Markt and on Nasdaq. While these criteria suggest that Neuer Markt IPOs may be smaller than Nasdaq IPOs, there are few other differences. Firms listing on the Neuer Markt must satisfy stricter disclosure requirements than firms listing on the main market segment of the Frankfurt stock exchange.[11]

IPO pricing through bookbuilding: Bookbuilding is the dominant method for selling IPO shares on the Neuer Markt. As is done in the U.S., underwriters post price ranges some time before the final pricing of issues. However, there are a number of differences: 1) For Neuer Markt IPOs, there is much less variation than in the U.S. in when price ranges are posted. The initial range for a Neuer Markt IPO is typically posted one week prior to pricing.[12] While bookbuilding "officially" occurs only after the filing of the ranges, during the so-called "subscription period", underwriters may conduct discussions with prospective investors before setting the price ranges. Thus, the kind of information gathering that happens through U.S.-style bookbuilding may already begin prior to the filing of the price ranges.[13] 2) Underwriters on the Neuer Markt almost never amend posted ranges, whereas in the U.S. range amendments are quite common. 3) While U.S. issues are frequently priced outside the final price ranges, this is rare for Neuer Markt IPOs. We find that during 1999 and 2000, some Neuer Markt issues were priced below the range, but none were priced above. While no explicit legal restriction keeps underwriters from pricing IPOs above the ranges, bankers told us that this is never done due to concerns of legal action. Thus, an effective ceiling is placed on the IPO offer price.

When-issued trading: Virtually all firms that went public on the Neuer Markt during 1999 and 2000 had an active when-issued, forward market for IPO shares, also known as "Handel

[11] In fact, the Neuer Markt even requires issuers to draw up financial statements according to US-Generally Accepted Accounting Principles (GAAP) or International Accounting Standards (IAS).

[12] For the years 1999 and 2000, the mean (median) time between the posting of the range and the pricing date is 7.02 (7.00) calendar days; the minimum (maximum) is 2 (18) calendar days. Aussenegg, Pichler and Stomper (2002) examine a sample of Nasdaq IPOs for the same time period. They find that the time of first posting a price range varies from 140 days before pricing to 11 days before.

[13] Jenkinson, Morrison, and Wilhelm (2003) argue that this constitutes a difference between IPO pricing in Europe and the U.S. In the U.S., the 1933 Securities Act discourages underwriters from contacting investors prior to the filing of a registration statement.

per Erscheinen" but more commonly called the "grey market".[14] Grey market trading starts after the filing of the price range, but before the setting of the IPO offer price. The last grey market trading day is the day before the first secondary market trading day. Grey market trading is off-exchange over-the-counter trading. Several banks and brokers act as market makers, but they do not make the market in IPOs for which they act as underwriters. Bid and ask quotes are published in newspapers, the internet and by large information vendors, such as Reuters or Bloomberg. All grey market transactions are contingent on whether an IPO takes place and are settled on the IPO's first trading day. Selling IPO shares in this market is (by definition) short-selling, and is restricted to institutions and large investors.[15] In spite of this restriction, grey market trading seems to be fairly liquid: while not much data is available, a major market maker (Schnigge AG) reports to have handled a trading volume ranging from 5 to 35 million Euros per month in trading shares of IPOs between June 2000 and March 2001. Furthermore, Löffler, Panther and Theissen (2002) report that the average grey market trading volume is comparable to secondary market trading volume.[16]

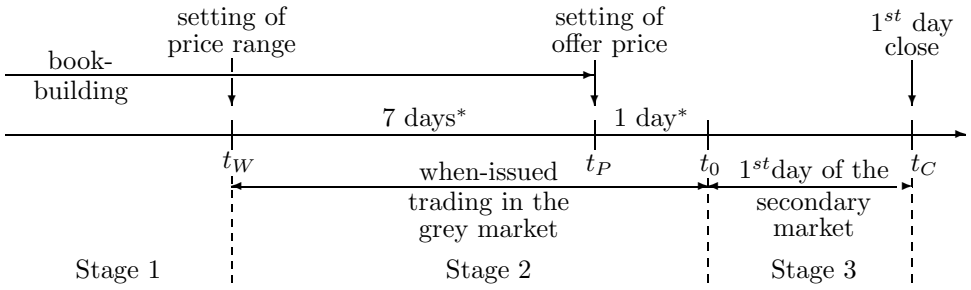
Timeline: The timeline, presented in Figure 1, has three stages. In Stage 1, underwriters can gather information to use in setting the price ranges prior to the opening of when-issued trading at time t_W. After time t_W there follows Stage 2, the period of when-issued trading in the grey market. Grey market trading starts *after* price ranges are posted, and continues beyond time t_P, which is when the underwriter sets the IPO offer price. The grey market closes on the evening before the first day of trading in the secondary market. The opening of the secondary market at time t_0 marks the beginning of Stage 3. The closing price of the first day of secondary market trading is realized at time t_C.

On the Neuer Markt the term bookbuilding is used to refer specifically to the process of underwriters collecting investors' orders during the subscription period. By this definition,

[14]The exceptions were six firms that went public simultaneously on other exchanges. In the analysis that follows we exclude these firms.

[15]See the website of Schnigge, http://www.schnigge.de/index.html. Similarly to the U.S., insiders who owned shares prior to the IPO are restricted in their ability to sell these shares.

[16]For a sample of 86 Neuer Markt IPOs Löffler, Panther and Theissen (2002) report an average daily grey market trading volume of 0.48% of the issue volume. This equals roughly the average secondary market trading volume on the 30th trading day.



* median number of trading days during the years 1999 and 2000

Figure 1: The Neuer Markt IPO Pricing Process

bookbuilding does not start until after time t_W.[17] Throughout this article, we will use the term bookbuilding more as a generic term for how underwriters gather information directly from investors, even if this information gathering happens before time t_W. However, in our analysis we will differentiate between bookbuilding that occurs prior to the opening of the grey market, and bookbuilding that occurs concurrently with grey market trading.

3 Data

We have collected data for all IPOs that began trading on the Neuer Markt between January 1999 and December 2000. These are the two years in which the Neuer Markt IPO market was most active. As shown in Table 1, 131 firms went public on the Neuer Markt in the year 1999 and 132 firms in 2000. In 2001 only 11 IPOs took place on the Neuer Markt. The years 1999 and 2000 are unquestionably regarded as a hot market period for IPOs. Ljungqvist and Wilhelm (2003) and Loughran and Ritter (2002b) find that even after controlling for many firm-specific characteristics, such as firm age and whether the firm is in a high-technology industry, initial returns are significantly positively related to whether a firm went public during the 1999-2000 period. While some of our quantitative results may be affected by this, we do not expect that it affects our qualitative results regarding the roles of bookbuilding and grey market trading in IPO pricing.

[17] The subscription period starts usually on the day after time t_W and continues typically for four days.

Exclusions: Six IPOs were dual listings that went public simultaneously on the Neuer Markt and another exchange. We exclude these observations from our sample, because the pricing may involve information gathering in markets for which we have no data. In addition, we use the data for IPOs in January 1999 solely to measure primary market conditions prior to the IPOs in February. We exclude the four IPOs in January 1999 from our regression sample because we do not have data for primary market conditions prior to these IPOs. With the exclusion of these ten IPOs, we obtain a final sample of 253 IPOs.

Data sources: Data was obtained from Deutsche Börse AG (primary market data), Reuters, Thomson Financial – Datastream, and Karlsruher Kapitalmarktdatenbank (secondary market data), as well as from one of the two most important market makers in the grey market, the German Schnigge AG (prices of grey market trading). In the regressions involving data on when-issued trading, we use the price of the last *transaction* before the pricing date t_P of each IPO. To obtain these data, we asked Schnigge AG to search their archive of transaction records. For 14 IPOs we could not obtain such price data. For these IPOs, we use the last mid-quotes (mean of the bid and ask quotes) posted before the pricing date. As discussed in Section 2, when-issued trading usually continues for at least one day *after* the setting of the IPO offer price. Thus, the closing prices on the final day of when-issued trading may contain information that was not available when the IPO offer price was set. For this reason we do not use the final grey market closing prices in our analysis.

To our knowledge, our data set is the only one that includes prices of grey market transactions just before IPO pricing for such a large sample of IPOs. Unfortunately, we lack corresponding volume data, as would be needed in order to detect price effects of large transactions. However, we can check whether there is a systematic difference between the grey market prices and the prices at which trading opens in the secondary market. To this end, we regressed these opening prices on the grey market prices. We found that the latter prices are unbiased predictors of the former prices.[18]

For the industry classification of Neuer Markt IPOs we draw on the industry description in the prospectus and on the NEMAX (Neuer-Markt-Index) industry classifications. We

[18]The results of this regression are not reported here, but may be obtained from the authors.

split our sample into groups of IPOs by high-technology and nonhigh-technology issuers, as well as internet and noninternet issuers. These industry groups overlap, in that each IPO is assigned to two groups. For example, IPOs of internet retailers are classified both as nonhigh-technology and as internet. To identify high-technology issuers, we use the high-technology industry description in Appendix 4 of Loughran and Ritter (2002b). (High-technology issuers are in the businesses of computer hardware, communications equipment, electronics, navigation equipment, measuring and controlling devices, medical instruments, telephone equipment, communications services, and software). IPOs are classified as internet IPOs if the NEMAX industry classification is "internet".

Descriptive statistics on the size of issues and issuers: Summary statistics on the size of IPO issues and issuers are presented in Table 3. For comparison, we include data on the Nasdaq IPO market for the same time period.[19] In the years 1999 and 2000, the Neuer Markt IPO market was more dominated by high-technology issuers than was the Nasdaq IPO market, but the Neuer Markt IPO market saw significantly less activity by internet firms. High-technology issuers account for 68% of IPO volume on the Neuer Markt and 51% on Nasdaq; internet issuers account for 34.5% of the volume on the Neuer Markt and 49% on Nasdaq. In absolute numbers of IPOs, 72% (61%) of Neuer Markt (Nasdaq) IPO firms were high-technology firms. Only 21% of Neuer Markt IPO firms were internet firms, as compared to 50% on Nasdaq.

The market capitalization of the issuers as well as the IPO proceeds are smaller on the Neuer Markt than on Nasdaq; this difference is significant at the 5% level and is somewhat more pronounced for high-technology and noninternet IPOs.[20] In terms of the fraction of issuers' stock sold at the IPO, firms listing on the Neuer Markt on average sell a significantly larger fraction than those on Nasdaq. This is true across all four industry classifications. The markets are similar in that, in both markets, internet firms sell a smaller fraction of

[19]Numbers for the Nasdaq IPO market are based on data obtained directly from the U.S. SEC Edgar database. Unit offerings, REITs (real estate investment trusts), closed-end funds, banks and savings and loans, ADRs (American Depository Receipts) and preferred stock offerings are excluded. Nasdaq high-technology issuers were identified using the SIC codes as described in Appendix 4 of Loughran and Ritter (2002b). To identify internet IPOs we use the list of internet IPOs provided by Jay Ritter, http://bear.cba.ufl.edu/ritter/ipodata.htm.

[20]For Nasdaq IPOs the currency of denomination is US$; for Neuer Markt IPOs it is the Euro. The average value of one Euro during the years 1999 and 2000 was close to one, at US$1.012.

their equity than do noninternet firms.

4 IPO Pricing Relative to Ranges and Grey Market Trading

In this section we discuss observed patterns in the pricing of IPOs relative to price ranges and grey market prices. Price ranges for Neuer Markt IPOs exhibit more variation than for IPOs on Nasdaq. For our sample of Neuer Markt IPOs, the mean value of the range center (midpoint between the range minimum and maximum) is Euro 22.10 and the standard deviation is Euro 11.60. Most Nasdaq IPOs during 1999 and 2000 had initial price ranges of \$10 to \$12.[21]

Table 4 presents data on the distribution of IPO offer prices and grey market prices relative to the price ranges. No IPO in our sample is priced above the range maximum.[22] More than half of the IPOs are priced exactly at the range maximum. Thus, the range appears to be effectively binding at the upper end. IPOs are priced below the range minimum. The ranges do seem to define some focal points for IPO pricing. About 10% of the IPOs are priced precisely at the lower end of the range, and a quarter of the IPOs priced within the range have an offer price equal to the range center.

Panel B of Table 4 presents data on IPO offer prices, relative to both the range and the prices paid for IPO shares in the grey market. More than 90% of the IPOs with a grey market price above the price range are priced, at the IPO, exactly at the range maximum. The majority of IPOs with grey market prices within the range also have IPO offer prices within the range. Of those IPOs with grey market prices below the range, half have IPO offer prices that are also below the range. Thus, it appears that the grey market provides an indication of how an IPO should be priced relative to the range, with the constraint that the IPO will not be priced above the range.

In Table 5 we examine IPO pricing further. Panel A of Table 5 presents statistics on the percentage by which underwriters deviate in IPO pricing from the grey market price.

[21] U.S. firms often undergo stock splits prior to going public, so as to manage the stock price.

[22] This observation is consistent with earlier observations in European IPO markets. Ljungqvist and Wilhelm (2002) in their investigation of French, German and UK IPOs pointed out that IPOs in these countries are almost never priced above the posted price ranges. Derrien and Womack (2003) also point this out for French IPOs. In contrast, Ljungqvist and Wilhelm (2003) document for the year 1999 (2000) that 47% (39%) of U.S. IPOs were priced above the range.

"Constrained" IPOs in this table are those that had a grey market price above the range and an offer price exactly at the top of the range. On average, IPO offer prices are about 22% below the grey market price. This is perhaps not very surprising, given the underwriters' policy of not pricing above posted price ranges. However, we find that underwriters on average price below the grey market prices, even if the price ranges do not constrain their pricing decisions. Across the 79 IPOs with unconstrained offer prices, the offer prices are on average 4.5% below the grey market prices. A t-test reveals that this deviation is statistically significant at the 1% level ($t = -4.1006$).

Panel B of Table 5 provides statistics on the initial returns of our sample of IPOs, defined as the percentage return between the offer price and the first day closing price. Across all IPOs in our sample, the mean initial return is 46.7%; the median is 19.6%. In comparison, Loughran and Ritter (2002b) report for the years 1999 and 2000 a mean (median) initial return of 65.0% (32.3%) for IPOs in the U.S.[23] For the subset of IPOs with constrained offer prices the average initial return is 67.1%. For IPOs with unconstrained offer prices, the average initial return is only 1.7%; not significantly different from zero.

5 The Model and Hypotheses

5.1 Economic arguments

We start by outlining the economic arguments behind the model. There are a number of differences between obtaining information through bookbuilding and obtaining information from trading. These differences may cause one or the other source of information to be more effective. The key characteristic of bookbuilding is that underwriters gather information directly from investors. As described in the Introduction, doing so may require the issuer to pay rents for the information. In addition to the cost of paying investors informational rents, bookbuilding also requires underwriters to incur the cost of building and maintaining relationships with investors. Due to this cost, the number of relationships is limited, and underwriters may miss important pieces of information that reside with investors who do

[23] If we include the 10 excluded IPOs, then in the sample of 263 IPOs the mean (median) initial returns are slightly higher, i.e. 48.2% (20.0%).

not participate in bookbuilding. But, if such investors trade in the grey market, then their information can be revealed through the prices in this market. The grey market therefore represents a potentially important source of free information for IPO pricing. This does not necessarily imply, however, that the grey market can supplant bookbuilding as an indicator of how IPOs should be priced.

For effective information aggregation, the grey market must be sufficiently liquid so that informed traders are willing and able to participate. The market microstructure literature and the literature on when-issued trading of U.S. Treasury securities suggest reasons why such liquidity cannot be taken for granted. First, prospective sellers may stay out of the market because of the possibility of a "squeeze". In Treasury markets, a squeeze can occur if short-sellers in the when-issued market are not awarded securities in the auction.[24] If bookbuilding precedes grey market trading, however, then some investors may already be confident that they will be allocated IPO shares, thus lessening the fear of squeezes.[25] Second, prospective buyers may be loath to trade too aggressively prior to IPO pricing, because such trading may lead to a higher offer price. Bikhchandani and Huang (1992) and Nyborg and Sundaresan (1996) provide evidence consistent with this for when-issued trading prior to U.S. Treasury auctions. As discussed, however, grey market trading of IPO shares commences only after the posting of a price range which places an effective ceiling on the offer price.

Finally, as modeled by Glosten and Milgrom (1985), a market may fail to open if there are severe informational asymmetries across potential traders. In the presence of such asymmetries, agents who would normally supply liquidity (market makers) quote spreads that are so wide that no trading occurs. Relative to the valuation of Treasury bonds, the valuation of IPO shares is apt to involve more "private" information that is held only by a subset of potential investors.[26] Thus, this problem is potentially much more severe in when-issued

[24] See Bikhchandani and Huang (1993), Nyborg and Sundaresan (1996), and Chatterjea and Jarrow (1998).

[25] The following quote is from the website of Schnigge AG, one of the larger market makers in the grey market: "Sellers in the when-issued market are also foreign banks who can count on receiving a certain number of shares in the primary market." The orginal quote was in German: "Auch haben ausländische Banken Festzusagen über eine gewisse Aktienanzahl, die sie gerne schon vorbörslich mit entsprechender Marge verkaufen." This quote was taken from: http://www.schnigge.de/info/service/pre-ipo-trading.html.

[26] For example, Treasury securities can typically be priced relative to similar securities that are already trading. While there may be asymmetries of information about demand in a Treasury auction, there are unlikely to be significant asymmetries of information about other fundamentals.

trading of IPO shares, as compared to when-issued trading of Treasury securities. The posting of price ranges at time t_W, however, may mitigate this problem. Price ranges are not merely "cheap talk" because the underwriters do not set offer prices above the ranges. As such, the ranges can reveal some information that the underwriter has gathered directly from informed investors.[27] The revelation of such information can mitigate informational asymmetries between traders in the when-issued market, and hence enable this market to open.

To summarize, we argue that when-issued trading in the grey market may not supplant bookbuilding as a source of information for IPO pricing. Instead, effective information aggregation in grey market prices may even depend upon the gathering of information through bookbuilding and the (partial) release of this information, prior to the opening of grey market trading. Hence, grey market trading may not be able to supplant bookbuilding, even if grey market prices subsequently reveal all information that can be obtained before setting the IPO offer price. This is not, of course, to suggest that underwriters *deliberately* promote when-issued trading of IPO shares. Rather, it may simply be the case that bookbuilding generates externalities that enable the opening of informative when-issued trading.

5.2 Hypotheses: IPO pricing relative to grey market prices

In developing our hypotheses, we first address the question of whether grey market trading reveals information of relevance for setting the IPO offer price. Such information would affect how the underwriter revises the IPO offer price relative to the price range that is set just before grey market trading commences. We define the price revision as the difference between the IPO offer price and the center of the price range. We use the symbol $PREV^*$ to represent the "latent" price revision, which is the revision that would occur if the offer price were not constrained by the upper end of the price range. We define the "grey market return" as the difference between the price of the last transaction in the grey market *before* IPO pricing at time t_P, and the center of the price range. We thus define $PREV^*$ and grey

[27] Consistent with this view, Jenkinson, Morrision and Wilhelm (2003) argue that underwriters set the price ranges after they obtain some information from investors. Pichler and Stomper (2003) demonstrate how engaging in direct information gathering, prior to when-issued trading, can enable informative when-issued trading, as a positive externality of bookbuilding.

market return in similar ways. As such, any relation between these variables is due to a relation between the IPO offer prices and the prices in the grey market, not returns.[28]

If grey market trading reveals information that is of relevance for setting the offer price, then we should be able to reject the following hypothesis:

> **$\mathbf{H^{Inf}_{GREY}}$:** After controlling for other public information, the grey market return has a coefficient of zero in a regression explaining the latent price revision, $PREV^*$.

The alternative hypothesis is that the coefficient is greater than zero. If we reject $\mathbf{H^{Inf}_{GREY}}$ in favor of the alternative, then there is evidence that the grey market reveals information of relevance for setting the offer price.

We next test whether underwriters fully revise the offer prices of IPOs relative to information contained in the grey market prices:

> **$\mathbf{H^{Adj}_{GREY}}$:** In a regression explaining the *latent* price revision $PREV^*$, the grey market return has a coefficient of one.

The alternative to hypothesis $\mathbf{H^{Adj}_{GREY}}$ is that the coefficient is less than one. That is, underwriters revise the pricing of IPO shares only partially with respect to the grey market prices. If IPO offer prices are "under-revised" relative to information revealed by the grey market, then investors who receive share allocations at the offer price earn a return that is related to positive information impounded in grey market prices. As discussed in the Introduction, if we reject $\mathbf{H^{Adj}_{GREY}}$ in favor of the alternative, then it would appear as if rents are paid for information that is made publicly available through grey market trading.[29] However, a natural explanation for this is simply that grey market trading reveals some information that underwriters gather *prior* to the onset of grey market trading in order to set the price ranges. If such information is obtained directly from investors through bookbuilding, then according to the theories described, we would expect to observe an "under-revision" in the pricing of IPOs, with respect to this information.[30]

[28] We define our variables as returns in this section so that we can use the same variables in the empirical tests in the following section.

[29] We want to emphasize that hypothesis $\mathbf{H^{Adj}_{GREY}}$ regards the *latent* price revision; if we reject this hypothesis, it is not due to the pricing constraint.

[30] We use the term "under-revision" in order to distinguish this phenomenon from the "partial adjustment" phenomenon described in the Introduction and modeled in the following section.

5.3 Price revisions with a pricing constraint

Before writing our next set of hypotheses, we must develop a model of IPO pricing and underpricing that explicitly allows for a pricing constraint. As discussed above, IPO pricing in this market is constrained by the upper ends of the posted ranges, but there is no compelling evidence of a constraint at the lower end. Thus, the price revision from the midpoint of the price range to the offer price can be expressed as:

$$PREV = \min[PREV^*, MAXREV], \tag{1}$$

where $PREV$ denotes the *actual* price revision from the midpoint to the offer price (in Euros), $MAXREV$ is the maximum possible price revision (the difference between the top and the midpoint of the price range), and $PREV^*$ is the *latent* price revision that would result if the underwriter were able to set the offer price above the top of the price range.

The latent price revision may be due to both public information, and private information that the underwriter obtains in the course of bookbuilding *after* setting the price range. However, Benveniste and Spindt's (1989) theory of bookbuilding relates only to private information. We therefore wish to control for any partial adjustment that may be explained by public information.[31] In everything that follows, we will distinguish between the latent price revision that is due to public information and that due to private information:

$$PREV^* = PREV_0 \ + \ \beta \times i, \tag{2}$$

where $PREV_0$ is that part of the latent price revision that is induced by publicly available information, i is information about the value of IPO shares that the underwriter obtains from investors who participate in bookbuilding, and β is a coefficient that will equal one if the underwriter fully adjusts the offer price in response to the information i.

We assume that the first day closing price reveals the true share value (or, alternatively, that the information gathered by underwriters is about the first day closing price). The

[31] Lowry and Schwert (2002), Loughran and Ritter (2002a) and Bradley and Jordan (2002) all provide evidence for U.S. IPOs that initial returns are positively related to publicly available information, such as market returns prior to setting the IPO offer price.

(Euro) initial return can be expressed as:

$$IR = IR_0 + \begin{cases} (1-\beta) \times i & \text{if } PREV^* \leq MAXREV, \\ (1-\beta) \times i \ + \ (PREV^* - MAXREV) & \text{if } PREV^* > MAXREV, \end{cases} \tag{3}$$

where IR denotes the Euro-return between the first day closing price and the offer price of an IPO.[32] IR_0 is the initial return if $i = 0$ (that is, if after setting the price range, the underwriter receives no private information), and if the offer price is not constrained by the top of the price range ($PREV^* \leq MAXREV$). The term $(1-\beta) \times i$ represents per share informational rents that are paid to investors in the form of initial returns.

Next, we derive the relation between the price revision and the initial return. From equation (2): $i = (PREV^* - PREV_0)/\beta$. Upon substituting for i in equation (3), we obtain the following:

$$IR = IR_0 + \begin{cases} \gamma_U \times (PREV^* - PREV_0) & \text{if } PREV^* \leq MAXREV, \\ \gamma_C \times (PREV^* - PREV_0) & \\ \qquad + \ \delta \times (PREV_0 - MAXREV) & \text{if } PREV^* > MAXREV, \end{cases} \tag{4}$$

where $\gamma_U = (1-\beta)/\beta$, $\gamma_C = 1/\beta$, and $\delta = 1$. In interpreting the above equation, $PREV^* - PREV_0$ is that part of the latent price revision which cannot be explained by public information. For IPOs subject to constrained pricing ($PREV^* > MAXREV$), the initial returns equation contains an additional term: $PREV_0 - MAXREV$ is the extent to which the price range constrains the price revision.[33] If rents are paid for information, in the form of partial adjustment, then $\beta < 1$, so that $\gamma_U > 0$ and $\gamma_C > 1$.

From this point onward we will refer to IPOs subject to constrained pricing as "constrained" IPOs (C), and all others as "unconstrained" IPOs (U). In the following section, consistent with equation (4), we will form different hypotheses for IPOs that are constrained and those that are unconstrained.

[32] In the empirical analysis, we will translate this Euro-return into a rate of return.

[33] Note that $PREV_0$ is the latent price revision, given only public information. Thus, $PREV_0 - MAXREV$ measures the extent of the pricing constraint relative only to public information.

5.4 Hypotheses: Bookbuilding during grey market trading

The next hypotheses address the question of whether underwriters conduct bookbuilding to obtain costly information for IPO pricing *after* the grey market opens. In answering this question we will conduct a test of the partial adjustment phenomenon that is similar to that of Hanley (1993). A key aspect of this test is that we proxy for private information gathering by measuring the adjustment from the posted price range to the offer price. This is appropriate for the analysis of information gathering *during* grey market trading, because the opening of the grey market immediately follows the posting of the price range. Our analysis in this section is also similar to Hanley's in that we use initial returns as a measure of informational rents paid to investors. Our analysis differs from hers in that we need to adjust the model, as described in the previous section, to account for constrained IPO pricing.

If no informational rents are paid to investors who participate in bookbuilding after the setting of the range, then the underwriters will fully adjust the offer prices of IPOs in response to any information i that they receive. In this case, β of equation (2) will equal one, γ_U of equation (4) will equal zero, and γ_C will equal one. We thus obtain the following two hypotheses:

> **$\mathbf{H^U_{REV}}$:** When regressing the initial returns of *unconstrained* IPOs on that part of the latent price revision that cannot be explained with public information, the coefficient (γ_U) is equal to zero.
>
> **$\mathbf{H^C_{REV}}$:** When regressing the initial returns of *constrained* IPOs on that part of the latent price revision that cannot be explained with public information, the coefficient (γ_C) is equal to one.

If instead, there is an informational role of bookbuilding after grey market trading starts (after time t_W), then the theory of Benveniste and Spindt (1989) suggests that $\beta < 1$. In this case, we should reject the hypotheses $\mathbf{H^U_{REV}}$ and $\mathbf{H^C_{REV}}$ in favor of the alternative hypotheses that $\gamma_U > 0$ and $\gamma_C > 1$.

We should point out that the hypotheses $\mathbf{H^U_{REV}}$ and $\mathbf{H^C_{REV}}$ are really joint hypotheses. Whether or not we can reject these hypotheses depends on both (i) whether underwriters receive information from investors who participate in bookbuilding after time t_W, and (ii)

whether the investors receive informational rents. It is possible that underwriters receive informative orders from investors after time t_W, but no informational rents must be paid to the investors since the information is simultaneously revealed through grey market trading.[34]

5.5 Initial Returns and Pricing "Constraints"

Equation (4) also provides predictions as to how initial returns are related to the fact that underwriters do not price IPOs above the price ranges. For constrained IPOs, this equation has a second term, $PREV_0 - MAXREV$, which indicates the extent to which the range constrains the offer price. Initial returns represent money left on the table by the issuer. The extent to which the offer price is constrained, $PREV_0 - MAXREV$, thus represents the per share amount of money left on the table due to the pricing constraint. We will check whether this amount is significantly different from zero and will then calculate a cost of constrained pricing for those IPOs that are priced at the top of the range.[35]

6 Regression Analysis

Our regression analysis consists of two parts. We first examine the setting of the IPO offer price and test the hypotheses $\mathbf{H^{Inf}_{GREY}}$ and $\mathbf{H^{Adj}_{GREY}}$. We next examine the relation between initial returns, grey market trading and IPO pricing, and test the hypotheses $\mathbf{H^{U}_{REV}}$ and $\mathbf{H^{C}_{REV}}$.

6.1 IPO Pricing

In the regression analysis we normalize the variables introduced in Section 5 by the range center. Our dependent variable in this part of the analysis is thus the *percentage* latent price revision:

$$PREV^* = 100 \times \frac{\textit{offer price}^* - \textit{range center}}{\textit{range center}} \tag{5}$$

[34] We thank Michel Habib for pointing this out.

[35] The term $PREV_0 - MAXREV$ actually captures only that part of the constraint that is due to public information. That part of the constratint that is due to private information is included in the first term and we are unable to isolate it. Thus, we actually calculate a lower bound on the amount of money left on the table due to the constraint.

where *offer price** is the offer price that would be set if underwriters did not restrict themselves from pricing above the top of the price range.

Our first objective is to understand the role that publicly available information plays in the setting of IPO offer prices in this market. To do so, we estimate the following model:

$$\begin{aligned} PREV^* = \; & f(\textit{underwriter reputation}, \;\; \textit{IPO pricing process up to} \\ & \textit{range setting}, \;\; \textit{issuer characteristics}, \;\; \textit{primary \&} \\ & \textit{secondary market conditions}, \;\; \textit{IPO activity}) + \varepsilon_1 \end{aligned} \tag{6}$$

Panel A of Table 6 presents the exact definitions of all of the explanatory variables included in each of the broad categories in equation (6). This model is based on findings of a number of previous studies of IPO pricing; the development of the model and the related literature are discussed in Appendix A. There are three endogenous explanatory variables, written with a "hat" ($\hat{\cdot}$) in Panel A of Table 6. These variables are (i) the proxy for underwriter reputation, (ii) the center of the price range, and (iii) the fraction of issuer's stock sold in an IPO. Panel B of Table 6 presents the instruments that we use in the first-stage regressions. To obtain an (over-)identified model, we impose several exclusion restrictions. The identifying variables are denoted in bold face in Panel B of Table 6; each of these variables is included in one of the first stage regressions and excluded from the model in any other way.[36]

In order to test the hypotheses $\mathbf{H^{Inf}_{GREY}}$ and $\mathbf{H^{Adj}_{GREY}}$, we expand the model of equation (6) to include the grey market return:

$$\begin{aligned} PREV^* = \; & g(\textit{underwriter reputation}, \;\; \textit{IPO pricing process up to} \\ & \textit{range setting}, \;\; \textit{issuer characteristics}, \;\; \textit{primary \&} \\ & \textit{secondary market conditions}, \;\; \textit{IPO activity}, \\ & \textit{grey market return}) + \varepsilon_2 \end{aligned} \tag{7}$$

where the grey market return is defined as 100(%)×(last grey market price before t_P – $RCENTER$)÷ $RCENTER$.

In estimating models (6) and (7), we must take into account the fact that none of the IPOs are priced above the upper bounds of the price ranges. As a further complication,

[36]Since the model is overidentified, we can test the validity of these variables as instruments by testing the exclusion restrictions. (There are three endogenous variables and more than three identifying variables. Thus, the model satisfies the "order condition" for identification, stated for example in Davidson and MacKinnon (1993), page 633.)

the sizes of these price ranges differ somewhat across IPOs. Thus, the price revision is a right-censored variable, but censoring occurs at different levels of the latent price revision $PREV^*$. An ordinary TOBIT model is not suited to estimate these models. Instead, we must use a generalized TOBIT model, allowing for the censoring points to vary. We estimate this model using a routine for "interval regressions" that is available from the Stata Corporation.[37] In the estimation, we also allow for heteroscedasticity. Such heteroscedasticity could arise because IPOs may differ in the extent to which underwriters receive non-public information of relevance for IPO pricing. We use the issuers' industry affiliations as proxies for heteroscedasticity.

In order to run the interval regression, we must first categorize each IPO as either constrained or unconstrained. We use two criteria for identifying constrained IPOs. First, the offer price of an IPO must equal the upper bound of the price range. Second, a price higher than this upper bound must have been paid for shares in the last grey market transaction prior to the pricing date t_P. While 177 IPOs satisfy the first criterion, three of these fail to meet the second. We categorize these three IPOs as unconstrained.[38]

Table 7 presents the results. Panel A reports estimates for the first stage regressions. Panel B presents the results from estimating models (6) and (7). For both models, the test discussed by Smith and Blundell (1986) rejects exogeneity of the three variables treated as endogenous, with a p-value of 0.018 for column (1) and a p-value of 0.036 for column (2).[39] Furthermore, we test the validity of the set of identifying variables denoted in bold face in Panel A of Table 7 as instruments. A test of the overidentifying restrictions shows that these six instruments are indeed neither individually significantly related to the price revision, nor jointly so, with a p-value of 0.84 for column (1) and of 0.25 for column (2). Thus, it is valid to exclude these variables from the models in Panel B.

The estimates in Table 7 are consistent with findings of prior studies of IPO pricing. Column (1) of Panel A reports estimates for the first stage regression explaining under-

[37]This routine, INTREG2, can handle not only interval data but also "point data" (such as the price revision of the unconstrained IPOs) and censored data (such as the price revision of the constrained IPOs, where the latent variable $PREV^*$ is in the interval $[MAXREV, \infty)$). The estimation method is maximum likelihood, based on a log likelihood function summing up logs of probabilities of censoring (for the censored observations) and logs of densities (for the uncensored observations).

[38]Our results are robust to changing the classification of these three IPOs.

[39]See also page 541 of Davidson and MacKinnon (1993) on how to use artificial regressions to compute the test statistics.

writer choice. We use the market shares of underwriters as a proxy for their reputation.[40] The results in Panel A column (1) show that the choice of underwriter depends on the size of the issue and the issuer, as suggested by Habib and Ljungqvist (2001) and Beatty and Welch (1996). We obtain positive coefficients for the variables $I_{EPROC>MEDIAN}$ and $I_{EMCAP>MEDIAN}$ that indicate IPOs with above-median expected issue proceeds and market capitalization. Also, the coefficients of the log of issuers' sales and the issuers' total assets are significantly positive.

Columns (2) and (3) of Panel A present estimates for the other first stage regressions. The range center is positively related to the issuer's earnings per share (EPS), the issuer's size ($I_{EMCAP>MEDIAN}$) and to proxies for recent primary market returns ($\bar{IR}^{NM}_{t_W-2m}$) and IPO activity ($N^{NM}_{t_W-2m}$). Issuer size ($I_{EMCAP>MEDIAN}$) is also a significant determinant of the fraction of an issuer's equity sold at the IPO, but with a negative coefficient. In addition, older firms sell larger fractions: the fraction sold is positively related to the log of the issuer's age $Log(AGE)$.

Panel B of Table 7 reports the estimates for our models of IPO pricing. Column (1) reports estimates for equation (6), the model without the grey market return. Of the endogenous variables in this model, only the range center has a coefficient that is significantly different from zero. The sign of this coefficient is negative: the higher the underwriter sets the price range, the smaller the subsequent revision of the offer price from the range center. For our measure of underwriter reputation ($UMSHARE$), the insignificant coefficient is consistent with the results of Habib and Ljungqvist (2001).

Price revisions are significantly positively related to both secondary and primary market returns, and to the number of recent IPOs. We include in our regression dependent variables for the primary market returns on both the Neuer Markt and on Nasdaq. We find that price revisions of Neuer Markt IPOs are significantly positively related to initial returns of recent IPOs in both of these markets. That is, we find significant cross-market effects. This relationship is found both for Nasdaq IPOs that occurred during the two months prior to

[40] While rankings such as that developed by Carter and Manaster (1990) can be used to measure the reputation of underwriters that are active in the U.S., no such ranking is available for many of the underwriters on the Neuer Markt. Thus, we follow Ljungqvist and Wilhelm (2003) and use as a substitute the share of total IPO volume for which an underwriter acts as lead manager. See Appendix B.

range setting, and for those that occurred after the range setting. However, this cross-market effect is significant only for issuers in similar industries. While not reported in Table 7, we find no significant relation between IPO pricing on the Neuer Markt and the average initial return of recent Nasdaq IPOs across all industries.[41]

Column (2) of Panel B reports the estimates for the pricing model with the grey market return, equation (7). The explanatory variables of equation (6) all cease to be significant once we include the variable $GREYMKT$. This suggests that these variables contain no significant information beyond what is impounded in the prices of grey market trading.

Testing the hypotheses $\mathbf{H^{Inf}_{GREY}}$ and $\mathbf{H^{Adj}_{GREY}}$: We reject the hypothesis $\mathbf{H^{Inf}_{GREY}}$. The latent price revision $PREV^*$ *is* significantly related to the price of the last trade in the grey market prior to the pricing date t_P. Indeed, the explanatory power of our model substantially increases when we include the grey market return ($GREYMKT$). Thus, when-issued trading does reveal information of relevance for IPO pricing.

We also reject the hypothesis $\mathbf{H^{Adj}_{GREY}}$. The relation between the grey market return and the price revision is not one-to-one. As indicated by the p-value stated at the bottom of column (2), the coefficient of the variable $GREYMKT$ is significantly *smaller* than one. In column (3), we confirm that this finding is not due to any interaction between this variable and other explanatory variables. Thus, underwriters do not fully revise the pricing of IPO shares relative to information revealed through grey market trading. Since our tests and hypotheses are for the *latent* price revision, this result is *not* due to constrained IPO pricing. Instead, we find an "under-revision", and hence a reduction in IPO proceeds, as if issuers leave money on the table in order to pay for information that is revealed through grey market trading. On the surface this is at odds with the fact that this information is freely available. However, grey market trading may simply reveal information that underwriters need *before* this trading begins, in order to set the price ranges at time t_W. Such information is *not* freely available when it is needed. Hence, underwriters may resort to bookbuilding in order to obtain the information directly from investors in exchange for informational rents. This explanation is plausible since the setting of the price ranges represents a potentially impor-

[41] See Appendix C for a detailed description of how our variables for primary market conditions are formed.

tant pricing decision: as discussed in Sections 4 and 5, the range may subsequently constrain the pricing of the IPO. In rejecting the hypothesis $\mathbf{H^{Adj}_{GREY}}$, we thus find evidence consistent with information being gathered directly from investors, as in bookbuilding, despite the fact that the grey market later reveals this information.

We also conduct a robustness check in order to test whether our results are driven by our treatment of IPO pricing as being right-censored only. In this robustness check, we regard IPO pricing as left-censored for IPOs that were priced exactly at the lower bound of the price range and that had a grey market price strictly below this lower bound. Our qualitative results remain unchanged. For the specification in column (2) of Panel B, the coefficient of the variable $GREYMKT$ increases to 0.824 with a z-value of 12.95; the coefficient in column (3) increases to 0.848 with a z-value of 14.21. In both cases, we obtain the same qualitative result as before: we reject the hypothesis that the coefficients are equal to one.

6.2 IPO Underpricing

In this section, we test the hypotheses $\mathbf{H^{U}_{REV}}$ and $\mathbf{H^{C}_{REV}}$. As we discussed in Section 5, these hypotheses concern the informational role of bookbuilding *after* price ranges are posted, and thus after grey market trading begins. We test for a relation between initial returns (a proxy for informational rents received by investors) and a proxy for information i that investors provide to the underwriters in bookbuilding, after the posting of the range. To construct the latter proxy, we draw on results of the last section. We assume that model (6) explains $PREV_0$, the price revision that would result if underwriters received no information beyond what is publicly available. Thus, any difference between $PREV_0$ and the latent price revision, $PREV^*$, is due to nonpublic information i. Equation (4) specifies the relation between such information and initial returns.

To convert equation (4) into an econometric model, we need to address the problem that we can directly observe the latent price revision $PREV^*$ only for unconstrained IPOs. For the other IPOs we draw on information impounded in the grey market prices to estimate the latent price revision. As argued in the last section, these prices contain information of relevance for IPO pricing, including non-public information about the value of IPO shares.

We thus use the model in column (2) of Table 7, Panel B, to compute a measure for the price revision $PREV^*$ that would have been observed for IPOs with constrained offer prices, if pricing had not been restricted by the price ranges.[42] We denote this price revision by $PREV_G$. For those IPOs that are unconstrained we use the actual price revision, which we denote simply as $PREV$.

Substituting $PREV$ and $PREV_G$ for $PREV^*$ in equation (4) we obtain:

$$IR = IR_0 + \begin{cases} \gamma_U \times (PREV - PREV_0) \ + \ \epsilon_U & \text{if } I_{CON} = 0 \ , \\ \gamma_C \times (PREV_G - PREV_0) \ + \ \delta \times (PREV_0 - MAXREV) \ + \ \epsilon_C & \text{if } I_{CON} = 1 \ . \end{cases} \tag{8}$$

As in the regressions of Table 7, Panel B we normalize the price revisions by the range center. Thus, $PREV_0$ is: (latent price revision, if underwriters receive no private information − range center)/range center. $PREV$ and $PREV_G$ are similarly defined, and $MAXREV$ is: (upper bound of price range − range center)/range center. For all IPOs we calculate $PREV_0$ using the model of column (1) of Table 7, Panel B. I_{CON} is a dummy variable that is equal to one for constrained IPOs and zero for unconstrained IPOs. As described earlier, we categorize as constrained all IPOs for which the grey market price is above the range *and* the IPO offer price is equal to the range maximum. ϵ_U and ϵ_C denote econometric disturbances.

We will estimate model (8) for two different specifications. In the first specification we estimate the model as it is stated. Hence, we regress initial returns on the following variables:

$SURP = PREV - PREV_0$ denotes the "surprise" component of the price revision of IPOs with unconstrained offer prices,

$SURP_G = PREV_G - PREV_0$ denotes the "surprise" component of the latent price revision of IPOs with constrained offer prices, and

$CEXTENT = PREV_0 - MAXREV$ denotes the percentage by which offer prices are constrained, for $i = 0$.

Upon substituting these variables into model (8), we obtain the following simple model for initial returns of unconstrained and constrained IPOs:

$$IR = IR_0 + \begin{cases} \gamma_U \times SURP \ + \epsilon_U & \text{if } I_{CON} = 0, \\ \gamma_C \times SURP_G \ + \ \delta \times CEXTENT \ + \ \epsilon_C & \text{if } I_{CON} = 1. \end{cases} \tag{8'}$$

[42] We are aware of the resulting errors-in-variables problem (even though the explanatory power of the model in column (2) of Table 7 is very high). As will be discussed below, we use instrumental variables to address this problem.

In the second specification we will relax several constraints that are implicitly imposed in model (8). Instead, we will regress initial returns directly on the variables $PREV$, $PREV_G$, and $CEXTENT$ as well as on a set of control variables that we used to compute $PREV_0$. We thus ease the constraints imposed in model (8) that a number of the coefficients must be identical (in absolute value). The purpose of this specification is to more closely replicate Hanley's (1993) test for a partial adjustment phenomenon.

Panel A of Table 8 reports descriptive statistics for the explanatory variables of models (8) and (8′). Both groups of IPOs, unconstrained and constrained, exhibit on average positive latent price revisions related to public information ($PREV_0$). However, the mean value of $PREV_0$ is higher for constrained than unconstrained IPOs. In addition, the surprise component of the price revision is on average negative for unconstrained IPOs and positive for constrained IPOs. For the IPOs with constrained offer prices, the fourth column of Panel A reports the extent to which IPO pricing is constrained: $CEXTENT$ is on average equal to 20.2% of the range center (with a maximum of 113.3%). For issuers this represents foregone IPO proceeds. After multiplying $CEXTENT$ by issue size for each constrained IPO, we calculate that, within the set of constrained IPOs, an average of more than 12 million Euros per IPO were left on the table, due to the policy of not pricing above the range. Across the 174 IPOs within this set, the total amount of money left on the table is more than two billion Euros.

Panel B of Table 8 contains the results of our regressions explaining initial returns. Before estimating models (8) and (8′), we first regress initial returns just on the set of control variables that captures that part of initial returns, IR_0, that can be predicted using publicly available information. Column (1) reports the results of this regression. The set of control variables includes all of the variables defined in Panel A of Table 6 as well as a risk measure, the log of the sales of the issuer ($Log(SALES)$). We also include the three variables that are treated as endogenous in the analysis of IPO pricing in the last section: underwriters' market share ($UMSHARE$), the range center ($RCENTER$), and the fraction of the issuers' stock sold ($FSOLD$). A Durbin-Wu-Hausman test shows that for these regressions we can regard these variables as exogenous.[43] Columns (2) through (4) of Panel B present the results

[43]In this test, we use the same set of instruments as in the first stage regressions in Panel A of Table 7. Hence, we remove

from estimating models (8) and (8′). In Column (2) we estimate model (8′); in column (3) we estimate the same model but add the control variables that are included in column (1). In column (4), as discussed above, we estimate a rather standard "partial adjustment" regression, similar to that proposed by Hanley (1993). In all of these regressions we interact the explanatory variables from Panel A with either the indicator variable I_{CON}, that indicates constrained IPOs, or $1 - I_{CON}$, that indicates unconstrained IPOs.

The estimates in Table 8 are consistent with a number of findings of prior studies of IPO pricing. We find that initial returns are positively related to prior market conditions (consistent with findings of Lowry and Schwert (2002), Loughran and Ritter (2002a) and Bradley and Jordan (2002) for U.S. markets) and negatively related to the number of recent IPOs in the same industry (consistent with Booth and Chua (1996) and Benveniste, Ljungqvist, Wilhelm, and Yu (2003)). Habib and Ljungqvist (2001), Loughran and Ritter (2002a,b), and Bradley and Jordan (2002) find evidence of a negative relation between initial returns and the fraction of an issuer's outstanding shares that are sold in the IPO ($FSOLD$). Our results are consistent with this, but not significant.

The estimates in Table 8 are also consistent with a feature of our model: the one-to-one correspondence between initial returns and the amount of money left on the table due to constrained IPO pricing, measured by $CEXTENT$. As indicated by the p-values at the bottoms of columns (2) and (3) of Table 8 Panel B, we are unable to reject the hypothesis that the coefficient on $CEXTENT$, δ, is equal to one.

Econometric robustness checks: Columns (5) and (6) present econometric robustness checks. In column (5), we report GLS estimates in order to check for effects of heteroscedasticity. We allow for a different disturbance variance across the two groups of IPOs with un-/constrained offer prices. While the disturbance variance is significantly different across the two groups, the estimated coefficients of the price revision variables are not significantly different from those in column (4).

In column (6) we check whether attenuation bias or simultaneity bias affects our results.

the variable $Log(SALES)$ from the underpricing regressions of Table 8, Panel B. For these models, Durbin-Wu-Hausman tests fail to reject the exogeneity of the variables $UMSHARE$, $RCENTER$, and $FSOLD$.

Ljungqvist and Wilhelm (2003) point out that the price revision $PREV^*$ is endogenous to the initial return IR, resulting in a simultaneity bias of the coefficients when model (8) is estimated using OLS. In addition, we face an errors-in-variables problem stemming from measurement errors in the variable $PREV_G$ that may give rise to attenuation bias. To check whether biased coefficients affect our results, we use two instruments for each of the variables $PREV$ and $PREV_G$. The first of these instruments is the expected price revision $PREV_0$, as has been suggested by Ljungqvist and Wilhelm (2003). The second instrument exploits higher moment information to improve estimation efficiency. As suggested by Lewbel (1997), we construct two higher moment instruments by subtracting the means from, and then squaring, each of the price revision variables $PREV$ and $PREV_G$.[44] The instrumental variables estimates of the coefficients of the price revision variables are not significantly different from those of column (4).

Testing the hypotheses $\mathbf{H^U_{REV}}$ and $\mathbf{H^C_{REV}}$: As discussed in Section 5, if we reject the hypotheses $\mathbf{H^U_{REV}}$ and $\mathbf{H^C_{REV}}$, in favor of the alternatives of $\gamma_U > 0$ and $\gamma_C > 1$, then this is consistent with an informational role of bookbuilding, during the time in which the grey market is open. We are, however, unable to reject $\mathbf{H^U_{REV}}$ or $\mathbf{H^C_{REV}}$. According to the p-values stated at the bottom of Table 8 Panel B, the coefficients γ_U and γ_C of the surprise variables $SURP$ and $SURP_G$ are not significantly different from zero and one, respectively. Thus, we find no evidence of an informational role of bookbuilding *after* the opening of the grey market. This is the case both for unconstrained IPOs, for which we can directly observe the latent price revision ($PREV^* = PREV$), and for constrained IPOs, for which we must estimate the latent price revision ($PREV^* = PREV_G$). Consistent with this result, the coefficients of the price revision variables $PREV$ and $PREV_G$ in columns (4)-(6) of Table 8, Panel B are also not significantly larger than zero and one respectively. Hence, we find no "partial adjustment effect" of the form defined by Hanley (1993).

[44] Alternatively, we could address the errors-in-variables problem by adjusting the standard errors using Murphy-Topel estimates. In contrast to the instrumental variables approach, the latter approach merely raises the estimated standard errors of the coefficients without changing the point estimates. As a consequence, our results would be strengthened since we would obtain wider confidence intervals. In order to be conservative, we abstain from such an adjustment: instead we report "naive" standard errors.

Interpretation: In interpreting this result, there are two possible explanations. First, it may be that after the opening of the grey market, underwriters simply do not gather information through bookbuilding. That is, underwriters may have already completed their (direct) information gathering activities by the time that they set the price ranges. Second, it may be the case that underwriters obtain some information from investors after setting the price ranges, but this information is also contained in the grey market prices. Since these prices are freely and publicly available, the investors do not receive rents for providing the information. Thus, we may fail to reject hypotheses $\mathbf{H^U_{REV}}$ and $\mathbf{H^C_{REV}}$ for reasons related to either part of these joint hypotheses: after setting the price ranges, underwriters may no longer gather information ($i = 0$), or if they do, they may get the information for free ($\beta = 1$).[45] Either way, we fail to find evidence for the Benveniste and Spindt (1989) model of how underwriters gather costly information, through bookbuilding *after* the onset of grey market trading.

A possible alternative interpretation of this result is suggested by Ljungqvist, Jenkinson and Wilhelm (2001). They provide evidence that underwriters outside the U.S. may lack both competence and informed investors to talk to. That is, underwriters may simply be unable to gather information directly from investors. In order to investigate whether our interpretation has explanatory power beyond that of the arguments given by Ljungqvist, Jenkinson and Wilhelm (2001), we conducted a robustness check. We repeated our analysis but included only those IPOs that were lead managed by the banks which are most likely to have U.S. experience in IPO pricing and/or contact with sophisticated investors.[46] The main results of our analysis were unchanged. (We do not report the details of the regressions in this paper, but they can be obtained from the authors.) It appears that even experienced underwriters do not find it efficient to gather information through bookbuilding after the

[45] These alternative explanations for our findings are put into perspective by the findings of Jenkinson and Jones (2002). They analyze the books of 27 European IPOs and find that only 7% of the bids are price sensitive. Since these bids are placed in bookbuilding after the opening of the when-issued market, this finding is consistent with such bookbuilding not serving an informational purpose.

[46] We included in our robustness check data for IPOs lead managed by banks which have a Carter-Manaster ranking, as stated in Table A of the Appendix. We also included IPOs underwritten by the "DG Bank AG". Our sample for this robustness check includes 164 IPOs. Even though no Carter-Manaster ranking is available for DG Bank AG, it has served as lead manager in more IPOs than any other underwriter on the Neuer Markt, and so is more likely to have developed a network of experienced investors. In addition, including these 31 observations allowed us to repeat our analysis without convergence problems in the maximum likelihood estimation of model (6).

opening of when-issued trading.[47]

A second alternative explanation that has been suggested is that investors who provide information after the opening of grey market trading may be rewarded simply by receiving larger allocations.[48] We are unable to test this directly, however, the absence of any partial adjustment effect suggests that the *total amount* of money paid to investors who provide information is not adjusted relative to information learned after grey market trading starts. Thus, if investors who provide late information are rewarded, perhaps with larger allocations, then this entails a *redistribution* of the total reward for information. While we cannot say unequivocally that this is suboptimal, we cannot think of any optimal mechanism that would lead to such a policy. Thus, the most logical explanation for our empirical results is that investors do not receive payment for information provided *after* grey market trading starts.

7 Conclusion

In the German IPO market there is no partial adjustment phenomenon, as has been documented in the U.S. IPO market. This is despite the fact that, as in the U.S., bookbuilding is the method of choice for pricing and marketing IPOs. Thus, it appears that bookbuilding in Germany is not the same as bookbuilding in the U.S.

To understand how IPOs are priced in the German market, we now bring together the results of the two parts of this paper: the results on the relation between IPO pricing and the prices of shares in the pre-IPO when-issued market, and the results on IPO pricing relative to price ranges set just before this market opens. When put together, these results shed light on how the existence of a liquid when-issued market affects IPO pricing. We find that underwriters do not fully revise IPO offer prices with respect to information impounded in prices in the when-issued market. Consistent with the theory of Benveniste and Spindt (1989), this "under-revision" can be interpreted as evidence of rents that investors receive for providing underwriters with information. However, such rents are *not* paid for information that underwriters obtain *after* the opening of when-issued trading. Otherwise, we should

[47] Note, this result is not inconsistent with Ljungqvist, Jenkinson and Wilhelm (2001), because it relates only to information gathering *after* the opening of when-issued trading.

[48] We thank David Goldreich for suggesting that we address this possibility.

find a partial adjustment phenomenon as defined by Hanley (1993). The lack of such a phenomenon suggests that, in the presence of when-issued trading, bookbuilding is not a source of costly information for IPO pricing. Any such informational role of bookbuilding is therefore confined to the period before the opening of the when-issued market. Indeed, our findings suggest that underwriters do gather information through bookbuilding in order to set price ranges *before* when-issued trading begins.

Our findings raise the question of why underwriters seem unable to just wait for all relevant information to be revealed through when-issued trading. Put differently, why do underwriters not set arbitrarily wide ranges, so as not to constrain IPO pricing prior to learning information from when-issued trading? We believe that this is because of externalities of the bookbuilding process, in the absence of which when-issued trading cannot open. In setting price ranges, underwriters give publicly observable indications of the likely value of IPO shares. Such revelation of information can mitigate informational asymmetries across traders in the when-issued market, and thus facilitate the opening of the market. This argument is consistent with three stylized facts. First, when-issued trading never opens before the underwriter posts the price range. Second, price ranges vary across IPOs, perhaps due to information that underwriters obtain through bookbuilding before they set the range. Third, the setting of a price range is not just "cheap talk", since the range imposes a potentially costly constraint on the subsequent pricing of the IPO. This last fact has two implications. First, there is a value to gathering information before setting the range. Second, the range is a signal of information held by the underwriter.

Our results are also of relevance for our understanding of IPO pricing on markets without when-issued trading. Specifically, we provide an indirect validation of the common interpretation of a well-documented empirical regularity: the partial adjustment phenomenon (Hanley (1993)). This phenomenon is typically interpreted as evidence that underwriters pay informational rents to investors who submit informative orders for IPO shares during the bookbuilding process. The institutional framework in Germany allows us to test and confirm this interpretation. Our test relies on the hypothesis that when-issued trading of IPO shares reveals investors' private information for free. If so, then there is no need to pay

them informational rents after when-issued trading commences. Since when-issued trading commences immediately after the posting of ranges, the German market should therefore not exhibit a partial adjustment phenomenon. And indeed, we find no evidence of such a phenomenon in Germany. This contrast between the German and U.S. IPO markets bolsters the interpretation that the partial adjustment phenomenon found in the U.S. is due to informational rents that are paid to investors who provide information during the bookbuilding process.

A number of open questions remain. Most importantly, we cannot determine from our data whether when-issued trading enhances the efficiency of IPO pricing. Based on our results, it is plausible that the existence of the when-issued market lowers the cost of information gathering. Even if when-issued trading is not able to fully supplant bookbuilding as a source of information for pricing, it may allow underwriters to reduce the scale of costly information gathering through bookbuilding. Thus, allowing for when-issued trading may benefit issuers. Alternatively, it is also possible that when-issued trading interferes with information gathering through bookbuilding. For example, investors may conceal information about the value of IPO shares in order to realize profits by trading in the when-issued market. To obtain information from the investors in spite of this, underwriters may have to offer them higher informational rents. Recent theoretical work (discussed in the introduction) tends to support the former rather than the latter argument. In addition, we find that even after taking into account the lower fraction of internet IPOs on the German Neuer Markt, average underpricing on the Neuer Markt was lower than on Nasdaq for the years 1999 and 2000. This could, however, be due to factors other than the existence of a when-issued market. In order to test whether the presence of when-issued trading is beneficial for issuers, we would need a more controlled experiment than what is provided by a simple comparison of two different markets. We thus leave this question open for future research, although we believe that our findings represent an important step towards an answer.

Appendix

A: Development of the IPO pricing model

Our model of IPO pricing, equation (6), is influenced by a number of other papers on IPO underpricing and IPO pricing. The first group of papers proposes **underwriter reputation** as an explanatory variable for the (under)pricing of IPOs. While rankings such as that developed by Carter and Manaster (1990) can be used to measure the reputation of underwriters that are active in the U.S., no such ranking is available for many of the underwriters on the Neuer Markt. Thus, we follow Ljungqvist and Wilhelm (2003) and use as a substitute the share of total IPO volume (in Euros) for which an underwriter acts as lead manager. The idea behind this alternative measure is that a high market share commits underwriters to honor implicit contracts between themselves and investors. To measure underwriters' market share, we construct the variable $UMSHARE$ as described in Appendix B.

Carter and Manaster (1990), Booth and Chua (1996) and Lowry and Schwert (2002) find, consistent with Titman and Trueman's (1986) model, that initial returns are negatively related to underwriter reputation. Using only data from the 1990's, Beatty and Welch (1996) and Habib and Ljungqvist (2001) find a positive relation. However, Habib and Ljungqvist also provide evidence that the choice of underwriter is endogenous. To avoid an endogeneity bias, we therefore instrument underwriter choice. The set of instruments is based on the notion that renowned underwriters may be chosen for IPOs that are expected to generate higher proceeds (Habib and Ljungqvist (2001)) or for IPOs of larger issuers (Beatty and Welch (1996)). As instruments we use indicator variables for whether an issuer intends to sell a high fraction of its equity ($I_{FSOLD>MEDIAN}$), whether the expected proceeds are above the median ($I_{EPROC>MEDIAN}$), whether the issuer's expected market capitalization is above the median ($I_{EMCAP>MEDIAN}$), the log of the sales of the issuer ($Log(SALES)$), the issuer's total assets ($ASSETS$), and indicators for the issuer's industry affiliation and whether the issuer is headquartered outside Germany ($I_{INTERNET}$, $I_{HIGHTECH}$, and $I_{FOREIGN}$). Of this set of instruments, we use as identifying variables $I_{FSOLD>MEDIAN}$, $I_{EPROC>MEDIAN}$, and $Log(SALES)$. These three variables are excluded from our empirical model, other than

acting as explanatory variables for underwriter choice.[49] In modeling the underwriter choice we also control for fixed effects for IPOs in different months.

A second body of studies is related to the effect on underpricing of the **IPO pricing process prior to the posting of the price range** at time t_W. For U.S. IPOs, Bradley and Jordan (2002) and Boehmer and Fishe (2001) consider the relation between range amendments and initial returns. Both studies find that this relation is significantly positive but convex in that it is stronger for positive than for negative range amendments. Even though we are modeling IPO pricing (instead of underpricing), this suggests that range amendments may have a significant effect. On the Neuer Markt range amendments are rare. (We found only three range amendments in 1999 and 2000.) However, as discussed earlier, we expect that underwriters do collect information prior to setting the price ranges, just as underwriters collect information prior to amending ranges in the U.S. Therefore, we use the range center ($RCENTER$) as an explanatory variable for the subsequent price revision. Since the range center is endogenous to the pricing process, we instrument it using as instrumental variables both issuer characteristics and variables that serve as proxies for the primary market conditions and for IPO activity during the two months prior to the range posting (the variables with the subscript $t_W - 2m$ defined in Panel A of Table 6). The identifying variables are the earnings per share of the issuer (EPS) and an indicator variable $I_{EPS>0}$ that equals one for issuers with positive earnings.

A third group of papers analyzes the relation between IPO underpricing and the **fraction of equity sold at the IPO**. Habib and Ljungqvist (2001), Loughran and Ritter (2002a) and (2002b), and Bradley and Jordan (2002) find that initial returns are negatively related to the fraction of an issuer's outstanding shares that are sold at the IPO ($FSOLD$). We again are concerned that this variable is endogenous to the pricing process. It is likely that the range center and the fraction sold are joint decisions, as both numbers are first posted in the same filing. Thus, we instrument these two variables in similar ways, the only difference being that the identifying variable for $FSOLD$ is the log of the issuer's age ($Log(AGE)$), while $RCENTER$ is identified by the issuer's earnings per share (EPS, $I_{EPS>0}$). Moreover, we allow for correlation between the residuals of the first stage regressions. This can be

[49] We test these exclusion restrictions as part of testing the model's overidentifying restrictions.

interpreted as an unrestricted reduced form of a structural model simultaneously explaining the range center and the fraction sold.[50]

The next group of papers deals with the effect of **primary and secondary market conditions** on IPO underpricing. Bradley and Jordan (2002), Loughran and Ritter (2002a) and Lowry and Schwert (2002) all found that initial returns are positively related to the performance of secondary market indices prior to the IPOs. The latter two papers also allow this relation to be piecewise linear and find that it is strongest for positive secondary market returns. Furthermore, Bradley and Jordan (2002) and Lowry and Schwert (2002) show that initial returns are also positively related to primary market conditions, i.e. the average initial returns of recent IPOs. Given these results, we allow for a piecewise linear relation of the price revision to both primary and secondary market performance. To obtain indices for primary market conditions, we compute for each IPO in our sample the average initial return of "similar" IPOs on the Neuer Markt and Nasdaq that occurred during the period between setting the price range (at t_W) and setting the offer price (at t_P). These indices are denoted respectively as $\bar{IR}^{NM}_{t_W \to t_P}$ and $\bar{IR}^{NQ}_{t_W \to t_P}$. We also compute indices for primary market returns during the two months before setting the range, denoted as $\bar{IR}^{NM}_{t_W - 2m}$ and $\bar{IR}^{NQ}_{t_W - 2m}$. IPOs are "similar" if they have the same industry classification (e.g., hightech *and* internet). In Appendix C we describe in detail how we construct these indices for primary market conditions. In addition, we use the return of the Neuer Markt All Share Index during the period between setting the price range and setting the offer price ($IX_{t_W \to t_P}$) to control for secondary market performance.[51]

Finally, we take into account findings by Booth and Chua (1996) and Benveniste, Ljungqvist, Wilhelm and Yu (2003) that initial returns are negatively related to the number of recent IPOs in the same industry.[52] To capture this effect, we include as measures for **IPO activity** the number of IPOs by issuers in the same industry that occurred on the Neuer Markt

[50] Strictly speaking, the same explanatory variables should be used in both equations of such an unrestricted reduced form. We check, and confirm, that the identifying variables for $RCENTER$ and $FSOLD$ are not significantly related to the respective other variable.

[51] Like Lowry and Schwert (2002), we include in our regressions not only the indices for primary and secondary market performance but also interactions of these indices with dummy variables indicating above-median-level market performance: in Table 7, these interactions are denoted as $IX^{+}_{t_W \to t_P}$, $\bar{IR}^{NM+}_{t_W \to t_P}$, and $\bar{IR}^{NQ+}_{t_W \to t_P}$.

[52] Benveniste, Busaba and Wilhelm (2002) provide a rationale for this. They argue that underwriters bundle IPOs in the same industry to economize on costs of information production and thus reduce IPO underpricing.

during the period between setting the price range and setting the offer price ($N^{NM}_{t_W \to t_P}$) and in the two months before ($N^{NM}_{t_W - 2m}$).

We do not include data on withdrawn offerings. However, as argued by Benveniste, Ljungqvist, Wilhelm and Yu (2003) this is endogenous and we do include many of the variables that they use to explain the probability of withdrawal. In addition, we have run a robustness check of our results by repeating our analysis using only data for the year 1999 and then only data for 2000. As there were almost no withdrawals in 1999 but a number in 2000, we should obtain different results for these two years if withdrawals matter. However, the results are qualitatively the same for both years.

Appendix B: Underwriters on the Neuer Markt

Table A summarizes data on the banks that were active as lead underwriters in the Neuer Markt IPO market from February 1999 to December 2000. Close to half of the IPOs (115 out of 253) were lead managed by banks that do not have a Carter-Manaster rank assigned to them, presumably because these banks have not been active in U.S. IPO markets. For this reason, we use market share as a proxy for underwriter reputation in our regressions. The market share of a particular underwriter is defined as the **total proceeds** of IPOs on the Neuer Markt featuring this underwriter as lead or co-lead manager divided by the total proceeds of all Neuer Markt IPOs in this period. Proceeds are defined as the offer price times the number of shares sold at the IPO, including shares sold under the greenshoe option. If an IPO has a lead and a co-lead manager, half of the proceeds contribute to the market share order of each underwriter. "C-M Rank" is Jay Ritter's update of the Carter-Manaster reputation ranking, taken from Ritter's homepage: http://bear.cba.ufl.edu/ritter/rank.htm.

Table A: Underwriters on the Neuer Markt

Underwriter	Market share $UMSHARE$ (%)	No of IPOs as lead manager	No of IPOs as co-lead manager	C-M Rank
Dresdner Bank AG	13.14	16	1	7
Goldman, Sachs & Co.	11.99	5	2	9
Commerzbank AG	10.81	23	2	7
DG Bank AG	9.81	31	5	none
Deutsche Bank AG	9.55	16	4	9
Hypo- und Vereinsbank AG	6.76	19	2	none
WestLB	4.11	13	0	5
BHF-Bank AG	2.91	11	0	6
Credit Suisse First Boston	2.57	7	0	9
Baden-Württembergische Bank AG	2.54	7	1	none
Sal. Oppenheim jr. & Cie. KGaA	2.52	10	1	none
HSBC Trinkaus & Burkhardt KGaA	2.11	12	0	8
BNP Paribas Group	2.10	7	0	7
Bank J. Vontobel & Co. AG	1.69	4	1	6
Morgan Stanley Bank AG	1.65	3	0	9
Gontard & Metallbank AG	1.52	10	0	none
Salomon Smith Barney International	1.33	2	0	9
UBS Warburg	1.24	1	0	8
Norddeutsche LB Girozentrale	1.18	6	1	none
Concord Effekten AG	1.12	8	0	none
BancBoston Robertson Stephens	1.05	3	0	8
Warburg Dillon Read	0.87	1	1	8
Merrill Lynch International	0.83	2	0	9
M.M. Warburg & Co. KGaA	0.78	5	0	none
LB Baden-Württemberg	0.75	4	1	none
LB Rheinland -Pfalz Girozentrale	0.52	0	1	5
Market share < 0.5%: 20 underwriters	4.55[a]	27	4	[b]
Total	100.00	253	27	

[a] This is the cumulative market share of all underwriters with a market share below 0.5%. The value of the variable $UMSHARE$ for each of these underwriters is <0.5.

[b] 2 underwriters have a ranking of 9, 2 have a ranking of 8, 1 has a ranking of 7, the remainder have no ranking.

Appendix C: Indices for Primary Market Conditions and IPO Activity

To construct indices for primary market conditions, we first identify for each IPO on the Neuer Markt, (i) an industry classification for that IPO, determined by the values of *both* industry indicator variables $I_{HIGHTECH}$ and $I_{INTERNET}$, (ii) the time t_W at which the price range has been set, and (iii) the time of pricing, t_P. We then identify all IPOs with the same industry classification that started trading on Nasdaq or the Neuer Markt (i) during the two months before time t_W and (ii) between time t_W and time t_P.[53] Finally, we count these IPOs and compute the average initial return. The count is denoted as $N^{MKT}_{t_W-2m}$ and $N^{MKT}_{t_W \to t_P}$ respectively, and the average initial return is denoted as $\bar{IR}^{MKT}_{t_W-2m}$ and $\bar{IR}^{MKT}_{t_W \to t_P}$ respectively, where $MKT \in \{NM, NQ\}$ indicates whether the variable refers to IPOs on the Neuer Markt (NM) or on Nasdaq (NQ).

In constructing these variables we needed to address the fact that there were periods during which there were no IPOs with the same industry classification as an IPO on the Neuer Markt. For each of our IPOs, there was at least one similar IPO on Nasdaq during the two months prior to setting the price range ($t_W - 2m$), and for all but eight there was at least one IPO on the Neuer Markt during this period. However, for 109 of our IPOs there were no Neuer Markt IPOs during the period $t_W \to t_P$, and for 65 of our IPOs there were no Nasdaq IPOs during this period. (27 of our IPOs had neither a Neuer Markt or Nasdaq IPO during this period.) We fill the missing values for each index with the average of all other (non-missing) values of that index across IPOs with the same industry classification. This strategy for filling in the missing values avoids introducing a bias into the coefficient of that index in our regressions.[54]

[53] For IPOs to match on the industry classification, they must match on both categories: hightech and internet.

[54] We thank Jay Ritter for suggesting this strategy for dealing with missing values.

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Table 1
Size of different IPO markets (number of IPOs)

Market	1996	1997	1998	1999	2000
NYSE	88	87	68	49	48
Nasdaq	**680**	**494**	**273**	**485**	**397**
AMEX	18	22	21	11	6
Frankfurt - Neuer Markt	**0**	**12**	**41**	**131**	**132**
Frankfurt - Amtlicher Handel	n.a.	10	16	27	15
LSE (UK only)	230	135	124	106	172
LSE (International)	52	41	33	28	38
Paris (Premier and Second Marches)	n.a.	n.a.	83	34	28
Paris (Nouveau Marche)	18	20	43	22	52

(Source: Stock Exchanges)

Table 2
Minimum Listing Requirements

Criteria:		Nasdaq	Neuer Markt
Issuer:	operating history*	1 year	3 years
	assets/equity**	net tangible assets US$4 million	equity EUR 1.5 million
		or market cap. US$50 million	
	profitability	net income US$750,000	
Issue:	size		EUR 5 million
	free float***	US$5 million	25% of market cap.
	market makers	3	2

*At Nasdaq, the operating history must exceed 1 year for issuers with a market capitalization below US$50 million.

**At the Neuer Markt, issuers' equity must exceed EUR 1.5 million at the time of the application for listing.

***At the Neuer Markt (Nasdaq), free float comprises shares held by beneficial owners of less than 5% (10%) of the equity, not including executive ownership. A smaller float of only 10% is required for Neuer Markt issues with a market cap above EUR 100 million.

Table 3
Descriptive Statistics

This table provides summary statistics for IPOs on the Neuer Markt and Nasdaq from February 1999 through December 2000. In both panels and in each market, IPO firms are categorized according two criteria: hightech versus non-hightech and internet versus non-internet. To identify Neuer Markt hightech firms the hightech industry description in Appendix 4 of Loughran and Ritter (2002b) is used. Neuer Markt IPOs are defined as internet firms if the NEMAX industry classification is internet. To identify Nasdaq hightech firms we use the SIC codes and the hightech industry description in Appendix 4 of Loughran and Ritter (2002b); for Nasdaq internet IPOs we use the list of internet IPOs from Jay Ritter's homepage (http://bear.cba.ufl.edu/ritter/ipodata.htm).

Panel A. The issue size is the offer price times the number of shares sold at the IPO, not including the greenshoe option (million Euros for Neuer Markt IPOs and million US$ for Nasdaq IPOs).

Panel B. The market capitalization is the offer price times the number of shares outstanding after the IPO, not including any shares issued under the greenshoe option (million Euros for Neuer Markt IPOs and million US$ for Nasdaq IPOs). Fraction sold is 100% × the number of shares sold at the IPO divided by the number of shares outstanding.

Panel A: Issue Size

		Total	Hightech	Non-Hightech	Internet	Non-Internet
Neuer Markt	Mean	69.9	66.3	78.9	112.9	58.2
(million Euros)	Std.Dev.	171.4	186.1	127.9	342.3	73.3
	Median	38.8	39.9	35.9	45.4	37.8
	Minimum	8.0	8.0	9.5	9.5	8.0
	Maximum	2,489.4	2,489.4	790.5	2,489.4	790.5
	Total	17,674.4	11,992.3	5,682.1	6,095.8	11,578.6
		100.0 %	67.9 %	32.1 %	34.5 %	65.5 %
	No. of IPOs	253	181	72	54	199
Nasdaq	Mean	97.0	94.4	101.1	94.5	99.5
(million US$)	Std.Dev.	161.6	103.8	225.0	130.2	188.1
	Median	67.2	67.2	67.0	67.8	65.0
	Minimum	5.0	5.0	5.3	6.0	5.0
	Maximum	3,230.0	1,138.5	3,230.0	1,913.0	3,230.0
	Total	74,378.3	44,447.3	29,931.0	36,273.8	38,104.4
		100.0 %	59.76 %	40.24 %	48.77 %	51.23 %
	No. of IPOs	767	471	296	384	383

Table 3 (continued)
Panel B: Market Capitalization and Fraction Sold

			Total	Hightech	Non-Hightech	Internet	Non-Internet
Neuer Markt	Market Cap.	Mean	351.7	348.9	358.9	835.1	220.6
	(million Euros)	Std.Dev.	1,745.3	2,000.6	814.8	3,703.4	352.7
		Median	136.5	135.0	154.1	193.8	133.3
		Minimum	26.4	26.4	33.8	38.3	26.4
		Maximum	27,000.0	27,000.0	5,472.0	27,000.0	4,355.5
	Fraction Sold	Mean	28.2	28.6	27.1	24.6	29.2
	(%)	Std.Dev.	7.9	8.0	7.4	5.0	8.3
		Median	26.6	26.6	26.7	24.2	28.0
		Minimum	6.1	9.2	6.1	9.2	6.1
		Maximum	66.7	66.7	46.0	35.9	66.7
	No. of IPOs		253	181	72	54	199
Nasdaq	Market Cap.	Mean	563.7	645.0	434.4	599.2	528.2
	(million US$)	Std.Dev.	1,087.2	1,336.5	443.0	832.4	1,293.5
		Median	339.7	367.4	302.0	382.0	297.6
		Minimum	11.0	13.4	11.0	13.2	11.0
		Maximum	21,315.0	21,315.0	3,231.0	11,837.9	21,315.0
	Fraction Sold	Mean	21.9	20.2	24.7	19.7	24.2
	(%)	Std.Dev.	11.1	9.3	13.0	9.9	11.7
		Median	19.9	18.8	22.2	17.8	21.9
		Minimum	4.1	4.1	7.0	5.4	4.1
		Maximum	100.0	100.0	100.0	100.0	100.0
	No. of IPOs		767	471	296	384	383

Table 4
Neuer Markt Offer Prices and Grey Market Prices, relative to Ranges

Panel A shows how IPOs are priced relative to the price ranges.

Panel B shows how underwriters set the offer price, given the price at which IPO shares trade in the when-issued market.

Panel A: IPO Pricing relative to Ranges

	Number of IPOs	Percent of Sample
offer<min	9	3.5%
offer=min	25	9.9%
min<offer<max	43	17.0%
offer=max	176	69.6%
Total	253	100%

Panel B: IPO Pricing relative Ranges and Grey Market Prices

	Number of IPOs (Percent of Subsample)				
grey market price:	offer < min	offer = min	min <offer < max	offer = max	Total
below range	7 (50.0%)	5 (35.7%)	2 (14.3%)	0 (0%)	14 (100%)
within range	2 (3.5%)	19 (32.8%)	30 (51.7%)	7 (12.1%)	58 (100%)
above range	0 (0%)	1 (0.6%)	11 (6.1%)	169 (93.4%)	181 (100%)

Table 5

Summary statistics for Neuer Markt IPOs: Pricing Relative to Grey Market Prices and Initial Returns

In this table, IPOs are divided into constrained and unconstrained IPOs. To identify constrained IPOs two criteria are used: First, the offer price of an IPO must equal the upper bound of the price range, and second, a price higher than this upper bound must have been paid for shares in the last grey market transaction prior to the pricing date

Panel A presents summary statistics on the pricing of IPOs relative to grey market prices, defined as 100(%)x(offer price – last grey market price before t_P)/last grey market price before t_P.

Panel B presents summary statistics the initial returns of IPOs. Initial returns are defined as 100(%)x(1st day close at time t_C – offer price)/offer price.

Panel A: Pricing Relative to Grey Market Prices (%)

100(%)x(OFFER – last grey mkt price before t_P)/last grey mkt price before t_P

	Total	unconstrained IPOs	constrained IPOs
Mean	-21.89	-4.50	-29.78
Std.Dev.	21.42	9.75	20.61
Median	-16.33	-2.56	-25.95
Minimum	-79.84	-29.27	-79.84
Maximum	26.32	26.32	0.00
No. of IPOs	253	79	174

Panel B: Initial Returns (%)

IR=100(%)x(1stCLOSE – OFFER)/OFFER

	Total	unconstrained IPOs	constrained IPOs
Mean	46.66	1.70	67.07
Std.Dev.	71.78	14.84	77.88
Median	19.57	0.39	38.00
Minimum	-30.00	-30.00	-13.00
Maximum	444.44	63.00	444.44
No. of IPOs	253	79	174

Table 6
Variables for IPO Pricing Model

Table 6, Panel A: Explanatory Variables IPO Pricing

Underwriter reputation:

$\hat{UMSHARE}$	Underwriter market share (%), (See details in Appendix B) instrumented as stated in Panel B of Table 6.

IPO pricing process up to range setting (at time t_W):

$\hat{RCENTER}$	Center of price range, instrumented as stated in Panel B of Table 6

Issue(r) characteristics:

$\hat{FSOLD}$	Fraction of issuer's stock sold at the IPO = 100% ×(# of shares sold)÷(# of shares outstanding after the IPO, excluding the greenshoe), instrumented as stated in Panel B of Table 6
$I_{INTERNET}$	Dummy variable indicating internet IPOs
$I_{HIGHTECH}$	Dummy variable indicating hightech IPOs

Primary and secondary market conditions: (See details in Appendix B)

$IX_{t_W \to t_P}$	Return on the Neuer Markt All Share Index after the posting of the range and before t_P
$\bar{IR}^{NM}_{t_W \to t_P}$	Average initial return of Neuer Markt IPOs after the posting of the range and before t_P
$\bar{IR}^{NQ}_{t_W \to t_P}$	Average initial return of Nasdaq IPOs after the posting of the range and before t_P
$\bar{IR}^{NM}_{t_W - 2m}$	Average initial return of Neuer Markt IPOs during the 2 months before the posting of the range
$\bar{IR}^{NQ}_{t_W - 2m}$	Average initial return of Nasdaq IPOs during the 2 months before the posting of the range

IPO activity:

$N^{NM}_{t_W \to t_P}$	Number of Neuer Markt IPOs after the posting of the range and before t_P
$N^{NM}_{t_W - 2m}$	Number of Neuer Markt IPOs during the 2 months before the posting of the range

Grey market return:

$GREYMKT$	100%×(last grey market price before t_P – $RCENTER$)÷ $RCENTER$

Table 6, Panel B: Instruments for Endogenous Explanatory Variables

Identifying Variables are indicated in boldface.

Underwriter Market Share, $UMSHARE$**:**	
$\mathbf{I_{FSOLD>MEDIAN}}$	Dummy variable indicating IPOs with above-median FSOLD
$\mathbf{I_{EPROC>MEDIAN}}$	Dummy variable indicating IPOs with above-median expected proceeds[(a)]
$I_{EMCAP>MEDIAN}$	Dummy variable indicating IPOs with above-median expected capitalization[(a)]
Log(SALES)	Log of sales of the issuer in the year prior to the IPO
$ASSETS$	Total assets of the issuer
$I_{FOREIGN}$	Dummy variable indicating IPOs by foreign issuers
$I_{INTERNET}$	Dummy variable indicating internet IPOs
$I_{HIGHTECH}$	Dummy variable indicating hightech IPOs
Monthly fixed effects	Dummy variables indicating the month of the first 2ndary market trading day
Center of Price Range, $RCENTER$**:**	
$I_{EMCAP>MEDIAN}$	Dummy variable indicating IPOs with above-median expected capitalization[(a)]
EPS	Earnings per share
$\mathbf{EPS} * \mathbf{I_{EPS>0}}$	Earnings per share interacted with a dummy indicating IPOs by issuers with positive **EPS**
$ASSETS$	Total assets of the issuer
$I_{FOREIGN}$	Dummy variable indicating IPOs by foreign issuers
$I_{INTERNET}$	Dummy variable indicating internet IPOs
$I_{HIGHTECH}$	Dummy variable indicating hightech IPOs
$\bar{IR}^{NM}_{t_W-2m}$	Average initial return of Neuer Markt IPOs during the 2 months before the posting of the range
$\bar{IR}^{NQ}_{t_W-2m}$	Average initial return of Nasdaq IPOs during the 2 months before the posting of the range
$N^{NM}_{t_W-2m}$	Number of Neuer Markt IPOs during the 2 months before the posting of the range
$N^{NQ}_{t_W-2m}$	Number of Nasdaq IPOs during the 2 months before the posting of the range
Fraction of Issuer's Stock sold in the IPO, $FSOLD$**:**	
$I_{EMCAP>MEDIAN}$	Dummy variable indicating IPOs with below-median expected capitalization[(a)]
Log(AGE)	Log of the age of the issuer (in years)
$ASSETS$	Total assets of the issuer
$I_{FOREIGN}$	Dummy variable indicating IPOs by foreign issuers
$I_{INTERNET}$	Dummy variable indicating internet IPOs
$I_{HIGHTECH}$	Dummy variable indicating hightech IPOs
$\bar{IR}^{NM}_{t_W-2m}$	Average initial return of Neuer Markt IPOs during the 2 months before the posting of the range
$\bar{IR}^{NQ}_{t_W-2m}$	Average initial return of Nasdaq IPOs during the 2 months before the posting of the range
$N^{NM}_{t_W-2m}$	Number of Neuer Markt IPOs during the 2 months before the posting of the range
$N^{NQ}_{t_W-2m}$	Number of Nasdaq IPOs during the 2 months before the posting of the range

[(a)] The term "expected" is used, because these values are calculated using the range center as the expected offer price.

Table 7
Price-Range-to-Offer-Price Revision

Panel A reports first-stage models for the 2SLS models in Panel (B). Column (1) states fixed effects (FE) estimates for underwriter market share, $UMSHARE$. (The regression controls for fixed effects of IPOs in different months.) Columns (2) and (3) report SUR estimates: in column (2), the dependent variable $RCENTER$ is the center of the price range; in column (3), the dependent variable $FSOLD$ is the percent of an issuer's stock sold at the IPO. These dependent variables are precisely defined in Panel A of Table 6; all explanatory variables are defined in Panel B of Table 6. Identifying variables are printed in boldface. t-statistics are reported in parentheses for column (1) and Z-statistics for columns (2) and (3).

Panel B reports generalized TOBIT regressions (interval regressions $INTREG$) where the dependent variable $PREV^*$ (latent price revision) is the percentage revision of the latent offer price from the center of the indicative price range. For each IPO, this variable is censored at a different point, given by the upper bound of the respective price range. There are three endogenous right-hand-side variables, $UMSHARE$, $RCENTER$, and $FSOLD$, instrumented using the models in Panel A as the first stage. All other right-hand-side variables are defined in Panel A of Table 6. Variables with the superscript "+" equal the variables without this superscript whenever these variables take values exceeding their 50th percentile and equal zero otherwise. In estimating these models, we assume multiplicative conditional heteroskedasticity specified by our four industry categories and the year of issue. Z-statistics for robust standard errors are reported in parentheses.

Table 7, Panel A

Dependent Variable	FE Underwriter market share $UMSHARE$ (%)	SUR Range center $RCENTER$ (EUR)	 Fraction sold $FSOLD$ (%)
	(1)	(2)	(3)
Intercept	2.357[a] (3.99)	14.191[a] (5.65)	23.231[a] (10.90)
Issue-specific Variables:			
$\mathbf{I_{FSOLD>MEDIAN}}$	0.626[b] (2.18)		
$\mathbf{I_{EPROC>MEDIAN}}$	0.762[b] (2.12)		
$I_{EMCAP>MEDIAN}$	1.315[a] (3.08)	6.264[a] (4.84)	-5.033[a] (-5.38)
Log(SALES)	0.602[a] (7.74)		
$\mathbf{I_{EPS>0}}$		-3.474[b] (-2.11)	
EPS		8.055[a] (5.41)	
Log(AGE)			2.472[a] (3.78)
$ASSETS$	0.001[c] (1.77)	-0.001 (-0.20)	-0.002 (-0.84)
$I_{FOREIGN}$	-0.155 (-0.22)	-5.105[a] (-2.68)	-0.699 (-0.52)
Industry dummies:			
$I_{INTERNET}$	-0.642 (-0.26)	-0.334 (-0.08)	-1.459 (0.50)
$I_{HIGHTECH}$	-0.654 (-1.51)	-0.172 (-0.09)	1.245 (0.88)
$I_{HIGHTECH} \times I_{INTERNET}$	2.586 (1.03)	-0.824 (-0.19)	-3.665 (-1.14)
Market conditions & IPO Activity:			
$\bar{IR}^{NM}_{t_W-2m}$ (%)		0.056[a] (4.20)	0.011 (1.12)
$\bar{IR}^{NQ}_{t_W-2m}$ (%)		0.023 (1.02)	-0.004 (-0.22)
$N^{NM}_{t_W-2m}$		0.223[c] (1.68)	0.152 (1.50)
$N^{NQ}_{t_W-2m}$		0.008 (0.11)	-0.021 (-0.42)
Corr. of residuals		-0.152[b]	
p: all coeff. equal 0	0.000	0.000	0.000
F/χ2	13.90 (F)	121.00	79.42
R^2	23.7%	32.0%	24.1%
No. of observations	253	253	253

[a]Significant at 1%-level. [b]Significant at 5%-level. [c]Significant at 10%-level.

Table 7: Panel B

Dependent variable: $PREV^* = 100(\%) \times (OFFER^* - RCENTER)/RCENTER$

	INTREG (1)	INTREG (2)	INTREG (3)
Intercept	15.228	0.471	-0.872
	(0.87)	(0.06)	(-1.60)
$GREYMKT$ (%)		0.791[a]	0.817[a]
		(14.59)	(15.51)
$\hat{R}CENTER$ (EUR)	-0.580[c]	-0.287	
	(-1.68)	(-1.54)	
$\hat{U}MSHARE$ (%)	-0.111	0.690	
	(-0.10)	(1.24)	
$\hat{F}SOLD$ (%)	-0.526	-0.199	
	(-1.00)	(-0.81)	
Industry dummies:			
$I_{INTERNET}$	-10.243	3.016	
	(-0.99)	(0.62)	
$I_{HIGHTECH}$	-19.108[a]	0.363	
	(-3.04)	(0.15)	
$I_{HIGHTECH} \times I_{INTERNET}$	4.752	-6.680	
	(0.39)	(-1.25)	
Secondary market index:			
$IX_{t_W \to t_P}$ (%)	0.991[a]	0.102	
	(2.72)	(0.41)	
$IX^+_{t_W \to t_P}$ (%)	-0.668	-0.409	
	(-0.84)	(-0.97)	
Primary market indices:			
$I\bar{R}^{NM}_{t_W \to t_P}$ (%)	0.120	-0.023	
	(1.36)	(-0.61)	
$I\bar{R}^{NM+}_{t_W \to t_P}$ (%)	0.039	0.048	
	(0.39)	(1.22)	
$I\bar{R}^{NQ}_{t_W \to t_P}$ (%)	0.114[c]	0.024	
	(1.74)	(0.69)	
$I\bar{R}^{NQ+}_{t_W \to t_P}$ (%)	-0.027	-0.024	
	(-0.46)	(-0.72)	
$I\bar{R}^{NM}_{t_W - 2m}$ (%)	0.211[a]	0.048	
	(4.75)	(1.49)	
$I\bar{R}^{NQ}_{t_W - 2m}$ (%)	0.295[a]	0.066	
	(3.98)	(1.58)	
IPO Activity:			
$N^{NM}_{t_W \to t_P}$	1.103	-0.044	
	(0.83)	(-0.07)	
$N^{NM}_{t_W - 2m}$	0.960[a]	0.241	
	(2.82)	(1.58)	
Estimation of log(dist. var.)			
Intercept	3.279[a]	2.266[a]	2.254[a]
$I_{INTERNET}$	-0.730	0.717[b]	0.749[b]
$I_{HIGHTECH}$	-0.558[b]	0.287	0.273
$I_{HIGHTECH} \times I_{INTERNET}$	1.155[c]	-0.689[c]	-0.770[b]
$I_{YEAR=99}$	-0.319[b]	-1.220[a]	-1.043[a]
p: zero coeff. of $IX_{t_W \to t_P} + IX^+_{t_W \to t_P}$	0.561	0.196	
p: zero coeff. of $I\bar{R}^{NM}_{t_W \to t_P} + I\bar{R}^{NM+}_{t_W \to t_P}$	0.012	0.233	
p: zero coeff. of $I\bar{R}^{NQ}_{t_W \to t_P} + I\bar{R}^{NQ+}_{t_W \to t_P}$	0.013	0.994	
p: zero coeff. of industry dummies	0.014	0.177	
p: zero coeff. of primary market indices	0.000	0.201	
p: coeff. of $GREYMKT$ equals 1		0.000	0.000
p: all coeff. equal 0	0.000	0.000	0.000
$\chi 2$	110.17	431.40	240.42
R^2_{ML}	35%	82%	61%
No. of observations	253	253	253

[a]Significant at 1%-level. [b]Significant at 5%-level. [c]Significant at 10%-level.

Table 8
Initial Returns and Price-Range-to-Offer-Price Revision

Panel A reports descriptive statistics for some right-hand-side variables of the regressions in Panel B. An IPO is constrained if its last grey market price before setting the offer price is above the range maximum *and* if the offer price is equal to the range maximum. For IPOs that are unconstrained ($I_{CON} = 0$) the variables are: the actual percentage revision, $PREV = 100(\%) \times (OFFER - RCENTER)/RCENTER$; the predicted price revision, $PREV_0$, estimated using the model in column (1) of Panel B of Table 7; the surprise price revision, $SURP = PREV - PREV_0$. For IPOs that are constrained ($I_{CON} = 1$) these are: $PREV_0$ (calculated as above); the latent price revision, $PREV_G$, estimated using the model in column (2) of Panel B of Table 7; the surprise price revision, $SURP_G = PREV_G - PREV_0$; the extent of censoring, $CEXTENT = PREV_0 - MAXREV$, where $MAXREV$ denotes the percentage difference between the center and the upper bound of the range.

Panel B reports OLS, GLS, and instrumental variables (IV) estimates. The dependent variable is the initial return between the offer price and the closing price on the first trading day. Column (1) reports estimates for a set of control variables defined in Panel B of Table 6, as well as an indicator variable I_{CON} that equals one for IPOs with constrained pricing. Columns (2) and (3) report estimates for the variables that capture the "surprise" price revision. Columns (4)–(6) report estimates for the actual price revision, $PREV$ (for unconstrained IPOs) and the estimated latent price revision, $PREV_G$ (for constrained IPOs). Column (5) reports GLS estimates which allow for different disturbance variances across the two groups of IPOs: those with unconstrained offer prices ($I_{CON} = 0$) and with constrained offer prices ($I_{CON} = 1$). Column (6) reports instrumental variables estimates using the expected price revision $PREV_0$ and two higher moment instruments for the variables $PREV$ and $PREV_G$. t- or Z-statistics for robust standard errors are reported in parentheses.

Table 8, Panel A

	79 Unconstrained IPOs ($I_{CON} = 0$)			
	$SURP$	$PREV$	$PREV_0$	
Mean (%)	-15.575	-6.523	9.052	
Std.Dev. (%)	14.884	8.609	13.793	
Median (%)	-16.435	-5.000	10.330	
Min (%)	-46.630	-28.889	-20.746	
Max (%)	19.159	9.091	40.322	
	174 Constrained IPOs ($I_{CON} = 1$)			
	$SURP_G$	$PREV_G$	$PREV_0$	$CEXTENT$
Mean (%)	32.068	60.485	28.418	20.202
Std.Dev. (%)	51.916	60.938	23.237	23.272
Median (%)	15.624	37.151	22.345	14.563
Min (%)	-37.371	5.980	-11.691	-22.802
Max (%)	305.680	359.597	120.423	113.280

Table 8, Panel B

Dependent variable: $INITIAL\ RETURN = 100(\%) \times (1stCLOSE - OFFER)/OFFER$

	OLS (1)	OLS (2)	OLS (3)	OLS (4)	GLS (5)	IV (6)
Intercept	43.327^b	0.519	12.681	19.770	13.720	16.437
	(2.43)	(0.31)	(0.86)	(1.56)	(1.56)	(1.28)
I_{CON}	40.371^a	12.626^a	15.971^b	1.517	0.931	-3.864
	(6.98)	(2.74)	(2.55)	(0.28)	(0.19)	(-0.42)
$SURP * (1 - I_{CON})$ (%): coeff. γ_U		-0.076	-0.385			
		(-0.78)	(-1.28)			
$SURP_G * I_{CON}$ (%): coeff. γ_C		1.102^a	1.108^a			
		(10.83)	(10.84)			
$PREV * (1 - I_{CON})$ (%)				-0.154	-0.013	-0.182
				(-0.58)	(-0.07)	(-0.67)
$PREV_G * I_{CON}$ (%)				1.089^a	1.047^a	1.240^a
				(10.62)	(10.55)	(5.55)
$CEXTENT * I_{CON}$ (%): coeff. δ		0.921^a	1.042^a			
		(4.75)	(2.72)			
$RCENTER$ (EUR)	0.011		0.612^c	0.592^b	0.079	0.673^b
	(0.03)		(1.85)	(2.44)	(0.55)	(2.48)
Issue-specific variables:						
$UMSHARE$	-0.713		-0.939	-0.935	-0.154	-0.966
	(-0.72)		(-1.62)	(-1.61)	(-0.45)	(-1.64)
$FSOLD$ (%)	-0.780		-0.263	-0.320	-0.361^c	-0.256
	(-1.45)		(-0.70)	(-0.86)	(-1.70)	(-0.70)
$Log(SALES)$	-4.424^c		-2.309	-1.962	0.407	-1.621
	(-1.90)		(-1.46)	(-1.18)	(0.53)	(-0.96)
$ASSETS$	-0.015		-0.007	-0.011	-0.008	-0.010
	(-1.12)		(-1.08)	(-1.43)	(-1.23)	(-1.37)
Industry dummies:						
$I_{INTERNET}$	-41.857^c		-11.633	-13.083	16.410	-9.065
	(-1.71)		(-0.73)	(-0.82)	(1.43)	(-0.53)
$I_{HIGHTECH}$	2.466		0.362	-2.213	0.832	-2.877
	(0.22)		(0.05)	(-0.32)	(0.16)	(-0.43)
$I_{HIGHTECH} \times I_{INTERNET}$	18.987		-6.479	-4.039	-21.008^c	-7.254
	(0.66)		(-0.35)	(-0.22)	(-1.72)	(-0.37)
Secondary market index:						
$IX_{t_W \to t_P}$ (%)	1.905^a		0.411	0.428	0.420^c	0.223
	(3.62)		(0.94)	(1.20)	(1.88)	(0.51)
Primary market indices:						
$I\bar{R}^{NM}_{t_W \to t_P}$ (%)	0.074		-0.024	-0.023	-0.034	-0.037
	(0.48)		(-0.25)	(-0.26)	(-0.57)	(-0.45)
$I\bar{R}^{NQ}_{t_W \to t_P}$ (%)	0.118		0.049	0.047	-0.037	0.037
	(1.25)		(0.86)	(0.82)	(-0.93)	(0.63)
$I\bar{R}^{NM}_{t_W - 2m}$ (%)	0.276^b		-0.053	-0.049	-0.014	-0.094
	(2.42)		(-0.57)	(-0.55)	(-0.29)	(-0.96)
$I\bar{R}^{NQ}_{t_W - 2m}$ (%)	0.185		-0.058	-0.054	0.087	-0.087
	(1.09)		(-0.34)	(-0.44)	(0.98)	(-0.65)
IPO activity:						
$N^{NM}_{t_W \to t_P}$	-0.177		-1.503	-1.413	-0.367	-1.586
	(-0.07)		(-0.82)	(-0.79)	(-0.30)	(-0.89)
$N^{NM}_{t_W - 2m}$	-2.317^a		-0.330	-0.261	-0.269	0.026
	(-2.86)		(-0.66)	(-0.48)	(-0.84)	(0.04)
Estimation of log(dist.variance): Intercept					5.174^a	
I_{CON}					2.374^a	
p: hypothesis **INFO$_U$** (H_0: $\gamma_U = 0$, H_A: $\gamma_U > 0$)		0.782	0.900			
p: hypothesis **INFO$_C$** (H_0: $\gamma_C = 1$, H_A: $\gamma_C > 1$)		0.159	0.147			
p: H_0: coeff of $PREV * (1 - I_{CON}) = 0$, H_A: coeff > 0				0.719	0.528	0.505
p: H_0: coeff of $PREV_G * I_{CON} = 1$, H_A: coeff > 1				0.195	0.319	0.141
p: H_0: $\delta = 1$, H_A: $\delta \neq 1$		0.682	0.913			
p: zero coeff. of issue-specific variables	0.066		0.040	0.065	0.251	0.075
p: zero coeff. of industry dummies	0.118		0.301	0.243	0.3133	0.302
p: zero coeff. of primary market indices	0.006		0.782	0.542	0.718	0.387
p: all coeff. equal 0	0.000	0.000	0.000	0.000	0.000	0.000
F/χ2	8.70	94.67	24.84	24.30	439.23 (χ2)	22.73
$R2/R^2_{ML}$	38%	74%	76%	76%	82% (R^2_{ML})	75%
No. of observations	253	253	253	253	253	253

^{a}Significant at 1%-level. ^{b}Significant at 5%-level. ^{c}Significant at 10%-level.

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(lix) This paper was presented at the ENGIME Workshop on "Mapping Diversity", Leuven, May 16-17, 2002
(lx) This paper was presented at the EuroConference on "Auctions and Market Design: Theory, Evidence and Applications", organised by the Fondazione Eni Enrico Mattei, Milan, September 26-28, 2002
(lxi) This paper was presented at the Eighth Meeting of the Coalition Theory Network organised by the GREQAM, Aix-en-Provence, France, January 24-25, 2003
(lxii) This paper was presented at the ENGIME Workshop on "Communication across Cultures in Multicultural Cities", The Hague, November 7-8, 2002
(lxiii) This paper was presented at the ENGIME Workshop on "Social dynamics and conflicts in multicultural cities", Milan, March 20-21, 2003
(lxiv) This paper was presented at the International Conference on "Theoretical Topics in Ecological Economics", organised by the Abdus Salam International Centre for Theoretical Physics - ICTP, the Beijer International Institute of Ecological Economics, and Fondazione Eni Enrico Mattei – FEEM Trieste, February 10-21, 2003
(lxv) This paper was presented at the EuroConference on "Auctions and Market Design: Theory, Evidence and Applications" organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003

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